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## **DOCUMENT N° 3: DOCUMENTS ANNEXOS**

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- Documents Annexos de l'Agitador.
- Documents Annexos de la Bomba Centrífuga.
- Documents Annexos de l'Hidrocicló.
- Documents Annexos dels Dispositius de Mesura i Control.
- Norma TAPPI : càlcul de les cendres provinents d'una pasta de paper.
- Annex de la taula pel dimensionament de les línies elèctriques.

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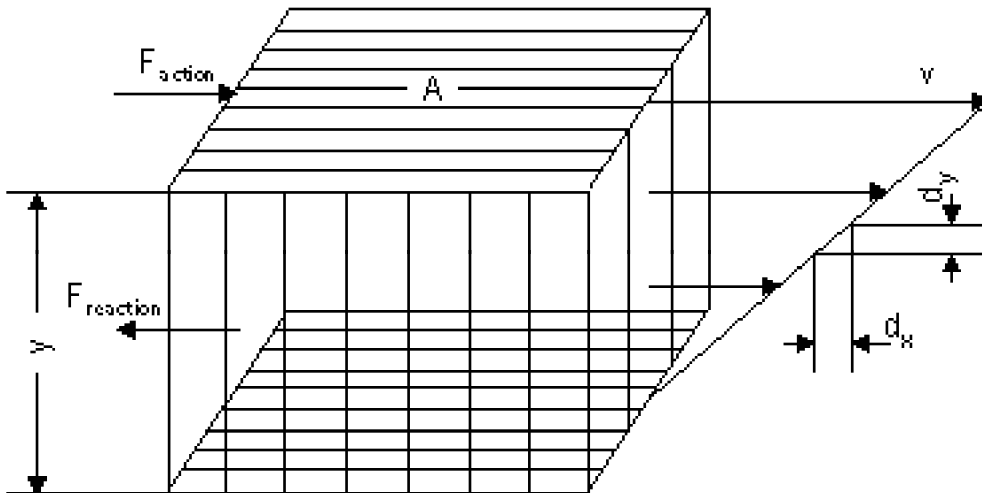
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Looking at two parallel plates with the surface  $A$  and the distance  $y$ , displaced against each other as a result of a force  $F_{\text{action}}$  with a velocity  $v$ , a force  $F_{\text{reaction}}$  opposes to this displacement and increases with increasing dynamic viscosity of the medium between the two plates.

**dynamic viscosity  $\eta$**



The ratio of  $F$  to  $A$  is called shear stress  $\tau$ .

$$\tau = \frac{F}{A}$$

The shear stress  $\tau$  increases in proportion to the shear velocity  $D$  and the dynamic viscosity  $\eta$ .

$$\tau = D \times \eta$$

The ratio of  $v$  to  $y$  is defined as shear velocity  $D$ .

$$D = \frac{v}{y}$$

Thus the resulting dynamic viscosity  $\eta$ :

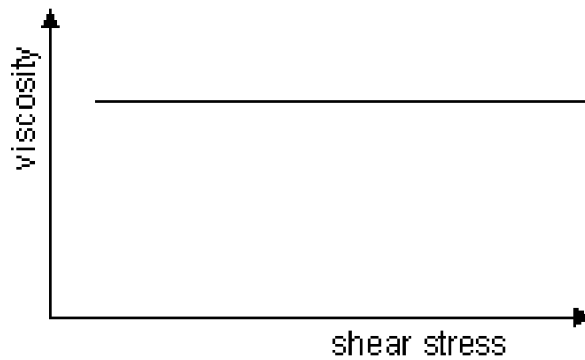
$$\eta = \frac{\tau}{D}$$

Thus, the dynamic viscosity  $\eta$  is a characteristic parameter of the fluid concerned and depends on the temperature. Therefore the viscosity is always indicated together with the corresponding temperature.

**Flow behaviour of  
fluids**

**Ideal viscous flow behaviour:**

Fluids with an ideal viscous flow behaviour are called Newtonian fluids. They are viscous fluids with linear molecules. They show a proportional flow behaviour.



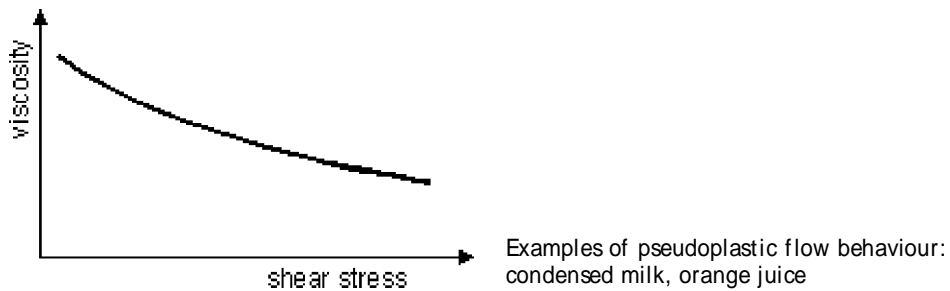
Typical Newtonian fluids are:  
water, salad oil, milk, sugar  
solutions, honey.

**Pseudoplastic flow behaviour:**

The flow behaviour of fluids depends on their physicochemical properties. Adding a filling agent to a pure solvent, will increase the viscosity and change the flow behaviour.

With increasing shear stress, in general the viscosity of highly molecular products in solutions and melts tends to decrease.

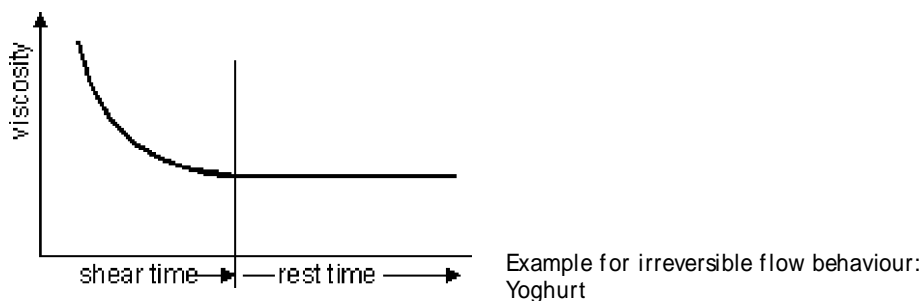
Such a flow behaviour is called pseudoplastic.



**Irreversible flow behaviour:**

Fluids deformed under applied shear stress in a way that the structure after the destructive phase (shear time) can not be restored show an irreversible flow behaviour.

The result is a permanent, shear time dependent change of viscosity.



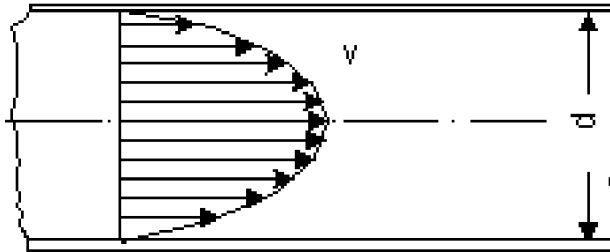
**Types of flow**

Depending on the Reynolds number, the flow passing through a pipe shows specific, typical flow patterns with different physical properties.

In this context the generation of a laminar or turbulent flow is of particular concern.

**Laminar flow**

In case of a laminar flow, the particles move in a streamline form and parallelly to the pipe axis without being mixed.



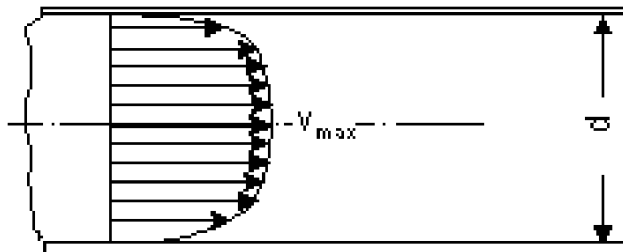
The roughness of the inside wall of pipes has no effect on the friction loss.

You will find a laminar flow mainly with high viscous fluids.

The loss of head changes linearly with the flow velocity.

**Turbulent flow**

In case of a turbulent or vortical flow the particles are mixed because of the movement along the pipe axis and an additional, transverse movement..



The roughness of the pipe inside has great effect on the friction loss.

Turbulent flows are mainly found with water or fluids similar to water.

The loss on pump head varies by square of the flow velocity.

The Reynolds number describes the correlation between the flow velocity  $v$ , the viscosity  $\eta$  and the inner diameter of the pipe  $d$ .

## Reynolds number

The Reynolds number has no dimension.

$$Re = \frac{v \times d_i \times \rho}{\eta}$$

Flow velocity	$v$	[m/s]
Viscosity	$\eta$	[Pa s]
Inner pipe diameter	$d_i$	[mm]
Density	$\rho$	[kg/dm <sup>3</sup> ]

With a Reynolds number of 2320 the laminar flow passes to a turbulent flow.

**Laminar flow <  $Re_{krit} = 2320$  < turbulent flow**

### Example:

In one second, 2 litres of acetic acid passes through a pipe with a nominal bore of 50 mm.

The acetic acid has a kinematic viscosity of  $\eta = 1.21 \text{ mPa s} = 0.00121 \text{ Pa s}$  and a density of  $1.04 \text{ kg/dm}^3$ .

Is the flow laminar or turbulent?

The average flow velocity amounts to:

$$v = \frac{Q}{A} = \frac{Q}{\frac{d^2 \times \pi}{4}} = \frac{2 \times 1000}{\frac{50^2 \times \pi}{4}} = 1.02 \text{ m/s}$$

Q [l/s]  
d [mm]  
v [m/s]

Thus the calculated Reynolds number is:

$$Re = \frac{v \times d \times \rho}{\eta} = \frac{1.02 \times 50 \times 1.04}{0.00121} = 43634$$

The Reynolds number exceeds the critical Reynolds number  $Re_{krit} = 2320$ . The flow is turbulent.

### NPSH value [m]

NPSH is the abbreviation for **Net Positive Suction Head**

Besides the flow rate Q and the pump head H, the NPSH value is one of the most important characteristic parameter of a centrifugal pump.

### NPSH value of the pump

The NPSH value of the pump depends on the design and speed of the pump. The higher the speed of the pump, the higher the NPSH value will be.

The NPSH value is measured on a pump test stand and cannot be modified without supplementary means.

### NPSH value of the plant

The NPSH value of the plant depends on the loss of head including the losses in fittings and apparatus in the line of the plant, and should be always checked by calculation.

$p_E$  = pressure at the inlet cross section of the plant [bar]

$p_A$  = pressure at the outlet cross section of the plant [bar]

$p_D$  = vapour pressure of the fluid at the middle of the suction connection of the pump [bar]

$p_b$  = air pressure at the installation site of the pump [bar]

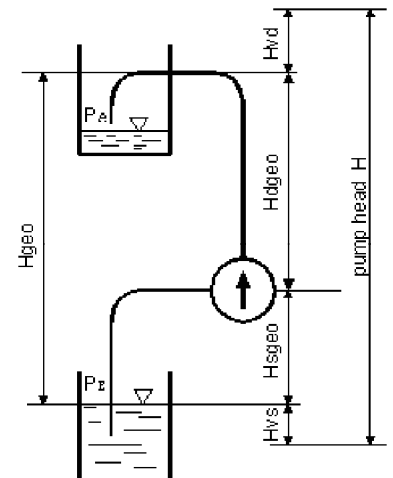
$H_{vs}$  = loss of head of the suction line, from the inlet cross section of the plant to the inlet cross section of the pump [m]

$H_{sgeo}$  = geodetic suction height (negative, in case of flooded suction) [m]

$\rho$  = density of the fluid [kg/m<sup>3</sup>]

$v_E$  = inlet flow velocity [m/s]

$$NPSH = \frac{p_E + p_b - p_D}{\rho \times g} + \frac{v_E^2}{2g} + H_{sgeo} - H_{vs}$$



In order to ensure a correct operation of the pump the following condition must be given:

$$\mathbf{NPSH_{plant} > NPSH_{pump}}$$

Boiling fluids with a velocity up to 0,3 m/s are a special case.

In this case:  $p_E = p_D$ ; as  $\frac{v_E^2}{2g}$  and  $H_{vs}$  become negligible resulting in:

$$\mathbf{NPSH_{plant} = H_{sgeo}}$$



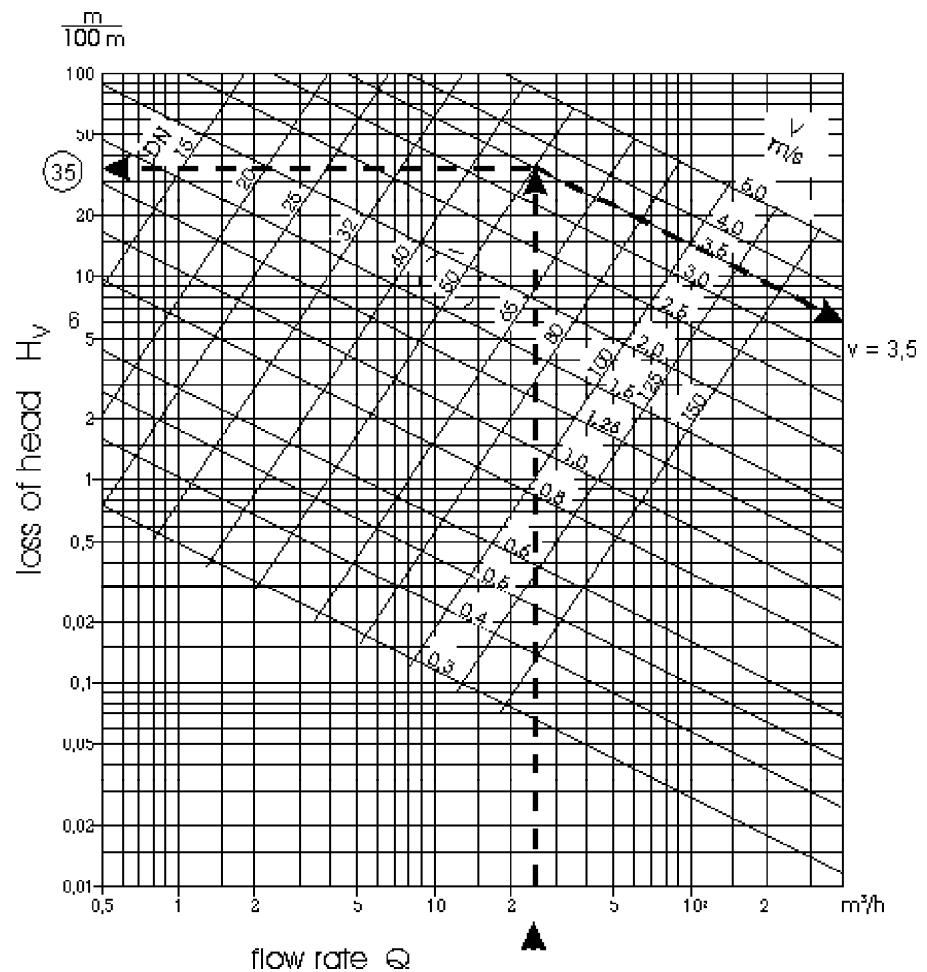
## Loss of head calculation

Already during design of the plant and piping layout in front of and behind the pump, losses can be limited when considering:

- the pipe diameter is sufficiently dimensioned,
- less fittings are used,
- fittings with low friction loss are selected,
- short pipe runs are planned.

### Loss of head in straight pipe runs

The diagram shows the loss of head for straight pipe runs as a function of a pipe length of 100 m and a given flow velocity  $v$  depending on the flow rate and the pipe diameter.



## Loss of head calculation

### Example:

Flow rate	$Q = 25 \text{ m}^3/\text{h}$
Pipe diameter	$d = 50 \text{ mm}$
From the diagram results:	
Flow velocity	$v = 3.5 \text{ m/s}$
<b>Loss of head</b>	<b><math>H_v = 35 \text{ m}/100 \text{ m}</math></b>

The loss of head in fittings can be determined almost exactly when using adequate pipe lengths.

### Loss of head caused by fittings

The loss of head in a fitting is considered equal to a straight pipe with corresponding length.

This calculation is valid only for water and fluids similar to water.

With the same diameter of pipes and fittings we can simplify the calculation.

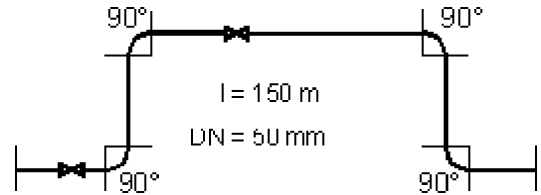
Equivalent pipe lengths in meter for fittings  
(valid for  $Re \geq 100,000$  and roughness  $k < 0.04 \text{ mm}$ )

Diameter DN [mm]	25	40	50	65	80	100	125	150
Standard valve	2.1	4.6	7.5	11.0	14.0	20.0	28.0	37.0
Free-flow valve	0.7	0.9	1.2	1.5	1.8	2.2	2.9	3.7
90° valve	3.2	5.0	7.2	10.0	13.0	17.0	23.0	31.0
Elbow 90° $R = 4 \times d$	0.5	0.6	0.7	0.9	1.2	1.5	1.9	2.3
Elbow 90° $R = 3 \times d$	0.7	0.9	1.1	1.4	1.7	2.2	2.8	3.5
Tee (diffusion)	1.6	2.0	2.5	3.3	4.0	4.8	5.7	6.8
Tee (junction)	2.0	2.6	3.2	4.4	5.8	7.5	10.0	13.0

## Loss of head calculation

### Example:

Flow rate  $Q = 25 \text{ m}^3/\text{h}$   
 Straight pipe length  $l = 150 \text{ m}$   
 Diameter  $DN = 50 \text{ mm}$   
 Elbow  $90^\circ$  4 pieces  
 Free-flow valves 2 pieces



from diagram (page 16):

$$v = 3.5 \text{ m/s}$$

$$H_v = 35 \text{ m}/100 \text{ m pipe length}$$

from table :

equivalent pipe length 4 elbows:	$l_{\text{bend}} = 1.1 \times 4 = 4.4 \text{ m}$
equivalent pipe length 2 free-flow valves:	$l_{\text{slide}} = 1.2 \times 2 = 2.4 \text{ m}$
straight pipe length:	$l_{\text{pipe}} = 150.0 \text{ m}$
total pipe length	$l_{\text{total}} = 156.8 \text{ m}$

loss of head:

$$H_{\text{total}} = H_v \times l_{\text{total}}$$

$$H_{\text{total}} = \frac{35}{100} \times 156.8 = 55 \text{ m}$$

with laminar flow (high viscosities) the loss of head  $\Delta p_v$  can be calculated using the Hagen- Poiseuille formula:

$$\Delta p_v = \frac{v_M \times 32 \times \eta \times l}{d^3 \times 10^3}$$

$$v_M = Q/A \text{ [m/s]}$$

$$\eta \text{ [Pa s = kg/m s]}$$

$$l \text{ [m]}$$

$$d \text{ [m]}$$

$$\Delta p_v \text{ [bar]}$$

$$H_v \times 10 \approx \Delta p_v$$

Once the required total head has been calculated, the pump type can be selected and the required pump can be sized by means of the **Fristam** pump curves.

The viscosity of the fluid is an important parameter for the pump selection and leads us to the right decision.



## Pump type selection

**Fristam** centrifugal pumps are equipped with open impellers which are suitable for the transfer of liquids with viscosities up to 1000 mPa s.

Centrifugal pumps have the following features:

- pulsation free transfer without alteration of flow rate and total head.
- high reliability in operation due to low number of moving parts.
- high operating speed, directly coupled to high-speed electric motors.
- small dimensions and therefore low space requirement.
- low operating costs.
- excellent performance control by speed adjustment.

**Fristam** positive displacement pumps

Usually it is recommended to use positive displacement pumps for low flow rates and high pressures. Even though the viscosity of the fluid would not require its use, because a centrifugal pump would work under these conditions with a very low efficiency rate.

### Note:

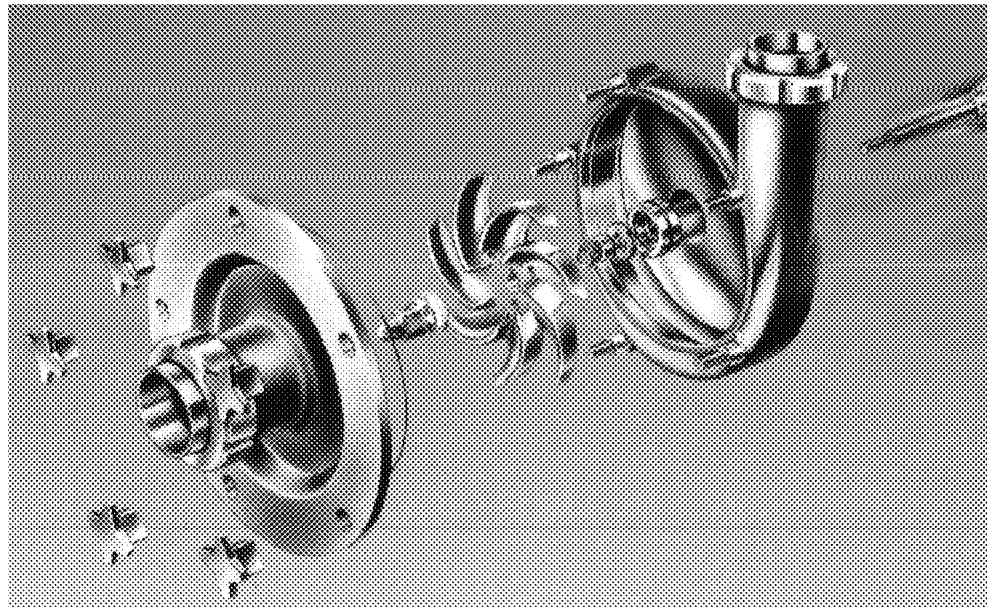
In the following chapters the various pump types, centrifugal and positive displacement are described with tips for the correct selection of the pump size. Each general pump type description is followed by a section dealing with the correct use of the pump curves provided.

## Centrifugal pumps

### Features of the centrifugal pump

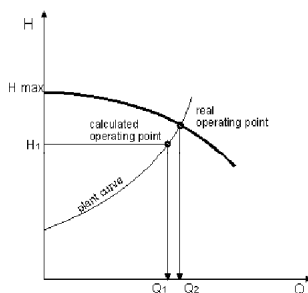
Centrifugal pumps are fluid-kinetic machines designed for power increase within a rotating impeller. Therefore it is also called the hydrodynamic pumping principle.

According to this principle, the fluid is accelerated through the impeller. In the outlet connection of the centrifugal pump, the resulting increase in speed is converted into delivery head.



### Q/H curve

In centrifugal pumps the delivery head  $H$  depends on the flow rate  $Q$ . This relationship, also called pump performance, is illustrated by curves.



During a bench test, the pump is operated at constant speed and the values  $Q$  and  $H$  are determined for the various operating points. In order to allow a comparison between the various pump types these measurements are carried out using only water as liquid. With these operating points a Q/H curve be drawn connecting the points on the graph.

Once the flow rate  $Q$  is defined and the delivery head  $H$  is calculated, the operating point of the plant can be determined. Usually the operating point is not on the Q/H curve of the pump. Depending on the required delivery head, the centrifugal pump will find its operating point when the plant curve and pump curve meet. The flow rate rises from  $Q_1$  to  $Q_2$ .

The required operating point is obtained by adapting the pump to the specified operating conditions.

This can be done by the following actions:

- throttling the flow
- correcting the diameter of the impeller
- Adjusting the speed of the drive

Partially closing a throttle valve or mounting an orifice plate into the discharge pipe of the pump will increase the pressure drop. The plant curve is shifted.

The operating point B1 (intersection point between pump curve and plant curve) moves on the pump curve to B2.

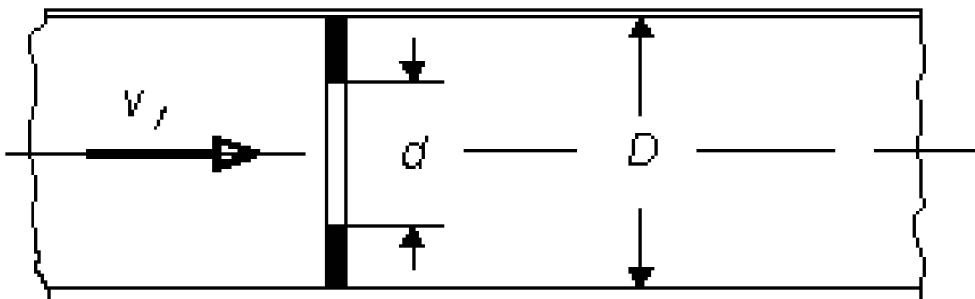
**Note:** throttling reduces the overall efficiency.

A throttle control or a mounted orifice plate is the less expensive control regarding the investment expenses. In case of significant power requirement, an economic appraisal is highly recommended.

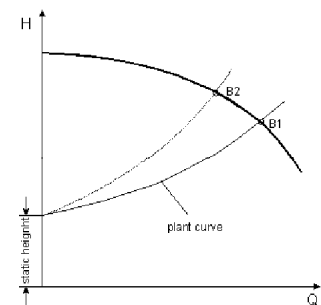
The friction loss in an orifice plate can be calculated easily:

$$\Delta p_v = \zeta \times \frac{\rho}{2} v_1^2 \times 10^{-5}$$

$\rho$  [kg/m<sup>3</sup>]  
 $v_1$  [m/s]  
 $\Delta p_v$  [bar]



## Throttling the flow



## Orifice plate calculation

## Centrifugal pumps

See the values  $\zeta$  stated in the table below.

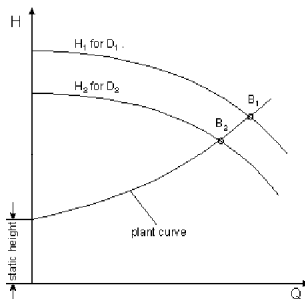
Aperture ratio $m = (d/D)^2$	Resistance value $\zeta$
0.05	600
0.1	250
0.2	50
0.3	20
0.4	4

Calculation:

- take the figure stated in the table for  $d$ , see table  $\zeta$ , calculate  $\Delta p_v$ .
- if  $\Delta p_v$  varies from the required value, take new value for  $d$  and calculate once more  $\Delta p_v$ .

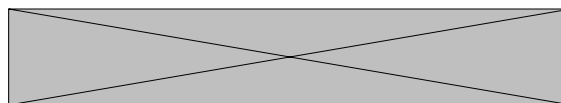
### Correction of the impeller diameter

A correction of the impeller diameter is to be favoured when a permanent reduction of flow rate or differential head is required. The performance of the pump is adjusted towards the duty point by reducing the impeller diameter.



The operating point is shifted from B1 to B2. This is the point where the new pump curve meets the plant curve.

The required impeller diameter can be determined easily using following formulae:



$N$  = power consumption

$D$  = impeller diameter

$Q$  = flow rate

$H$  = total head

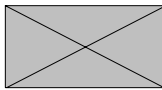
**Note:** the efficiency of the pump decreases with increasing correction.

## Centrifugal pumps

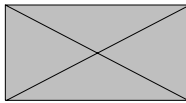
A great number of various operating points can be set continuously, when modifying the pump speed using a variable speed drive or frequency inverter. The operating point moves on the pump curve from B to B2.

Considering the overall efficiency, this is the best way of flow control. Using a variable-speed drive or a frequency inverter additional costs can arise and should be evaluated in an economic appraisal.

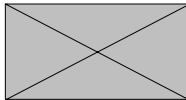
The flow rate changes linearly to the speed.



The total head changes with the square of speed.

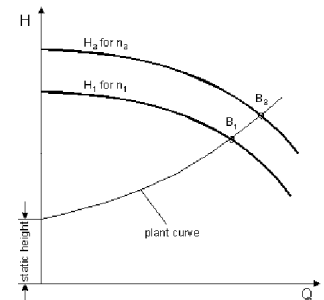


The power consumption changes with the third power of the speed.

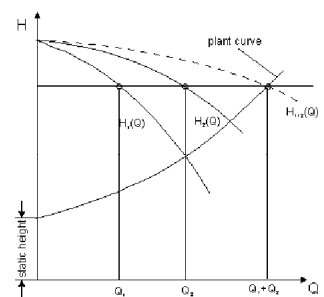


In the case of pumps connected in parallel the fluid flows are added with corresponding delivery head. This applies to pumps even with different Q/H curve.

### Pump speed control



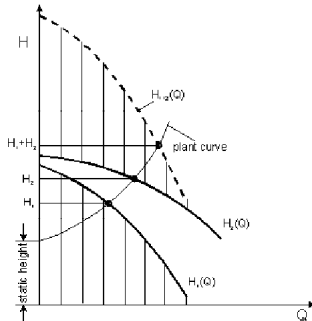
### Parallely connected pumps





## Centrifugal pumps

### Pumps connected in series



A multistage centrifugal pump performs as single stage pumps connected in series.

#### Note:

A stationary pump in a system creates a considerable pressure drop. Therefore it is recommendable to install a by pass around pumps which are connected in series.

The overall performance curve of centrifugal pumps connected in series can be calculated by adding the differential head of each pump at the relevant flow rate .

### Cavitation

Cavitation can be recognised by a strongly increased noise level of the pump with a simultaneous reduced flow rate.

What causes cavitation in centrifugal pumps ?

The lowest pressure point in a pump occurs at the inlet of the pump impeller. Due to local pressure reduction part of the fluid may evaporate generating small vapour bubbles. These bubbles are carried along by the fluid and implode instantly when they get into areas of higher pressure. These implosions can create local pressure peaks up to 100.000 bar.

If a pump is cavitating over longer periods, the impeller, the pump housing and cover will wear out. The surface is typically perforated and pitted.

How to avoid cavitation?

We should ensure that at all points of the pump, the fluid pressure is higher than the vapour pressure at the corresponding temperature. Take the pressure stated in the vapour-pressure-table of the product to be transferred.

The NPSH value of the plant must be at least 0.5 m higher than the NPSH value of the pump.

For a safe and cavitation free operation the following formula is valid:

$$\text{NPSH}_{\text{plant}} > \text{NPSH}_{\text{Pump}} + 0.5 \text{ m}$$

The vapour pressure of the product is dependent on the temperature and will rise with increasing temperature.

If the product is pumped at different temperatures the maximum vapour pressure should be used to determine the NPSH value of the plant.

### Vapour pressure

## Centrifugal pumps

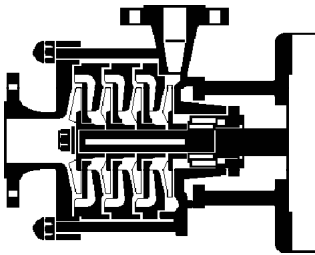
### Centrifugal pump types

The **Fristam** centrifugal pump range consists of following pump types:



- **Fristam** centrifugal pump **FP**

The design principle of the **Fristam** centrifugal pump FP with open impeller and optimised volute guarantees shear sensitive handling of and minimum heat transfer to the product. Viscosities up to 1000 mPa are no problem. The fluid may contain air or gas, may be homogeneous or contain additives. Low NPSH values make it possible to use the pump also under unfavourable conditions. The **Fristam** centrifugal pump FP is designed as a pump for flooded suction and fully suitable for CIP and SIP application.



- **Fristam** multistage centrifugal pump **FM**

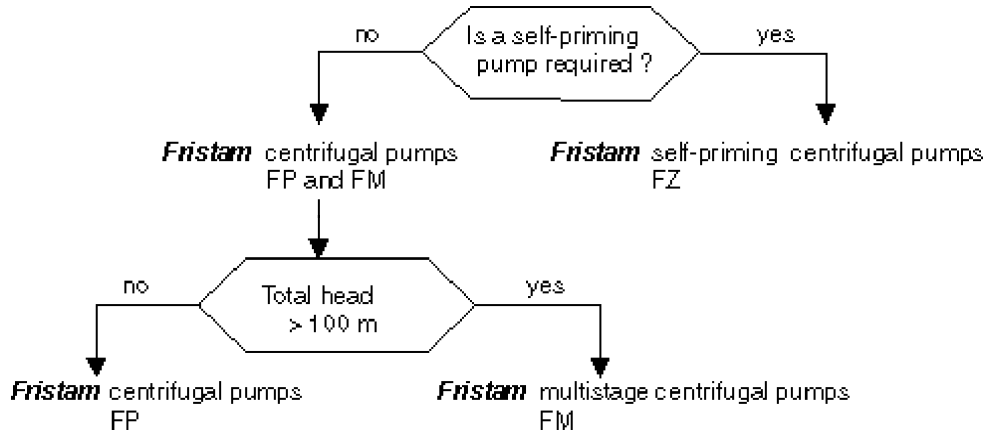
The centrifugal pump FM is designed as a multistage pump especially developed for high delivery heads. The centrifugal pump FM can be used for difficult pressure conditions such as feed pump for filters, heat exchangers and fillers, as well as for recirculation and as booster pump in membrane filtration and reverse osmosis plants.



- **Fristam** self-priming centrifugal pump **FZ**

The centrifugal pump FZ works on the water ring-side channel principle. Impellers with radial blades transfer the pressure energy to the liquid. Close clearances make it possible to obtain an excellent suction performance. Thus it is possible to pump gaseous products and to deaerate the suction line. This ensures also an optimum drain of the plant..

Selection criteria



The selection between the pump types FP and FM also depends on the required flow rate.

# Centrifugal pumps

## Centrifugal pump FP



### Selecting the correct size

#### Example:

Flow rate  $Q_A = 90 \text{ m}^3/\text{h}$

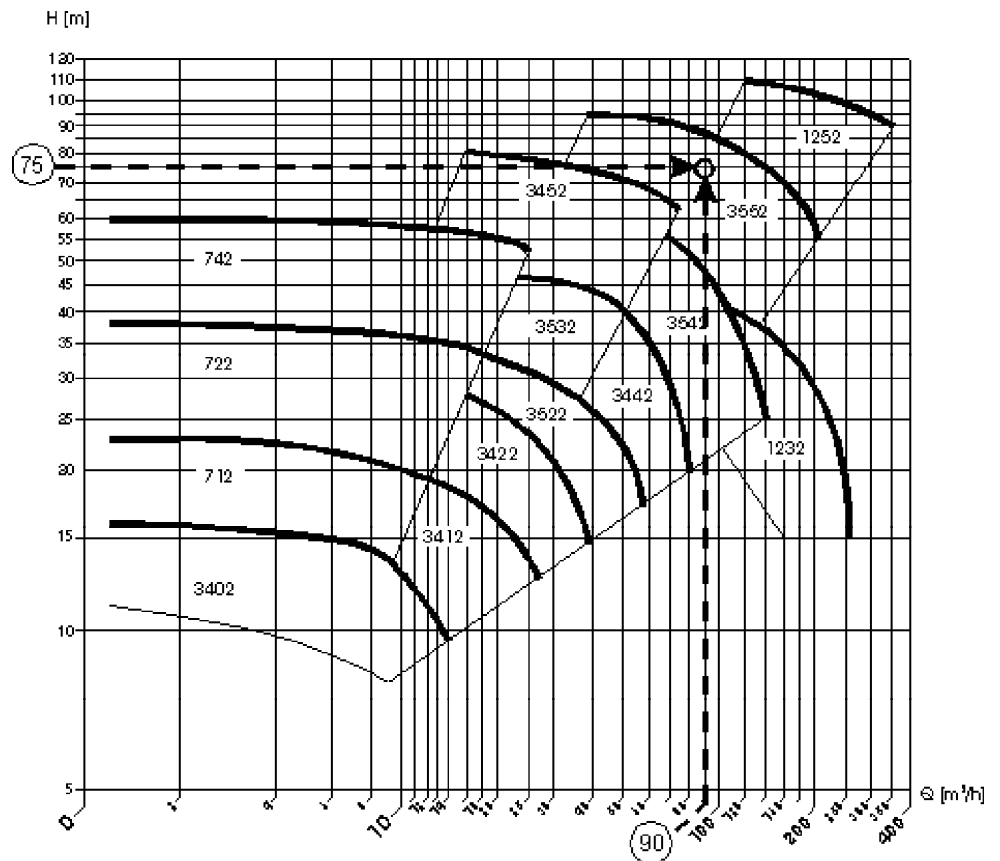
Total head  $H_A = 75 \text{ m}$

#### Step 1:

Select the pump size.

### FP sizes

### Size selection



Selected pump size: **FP 3552**

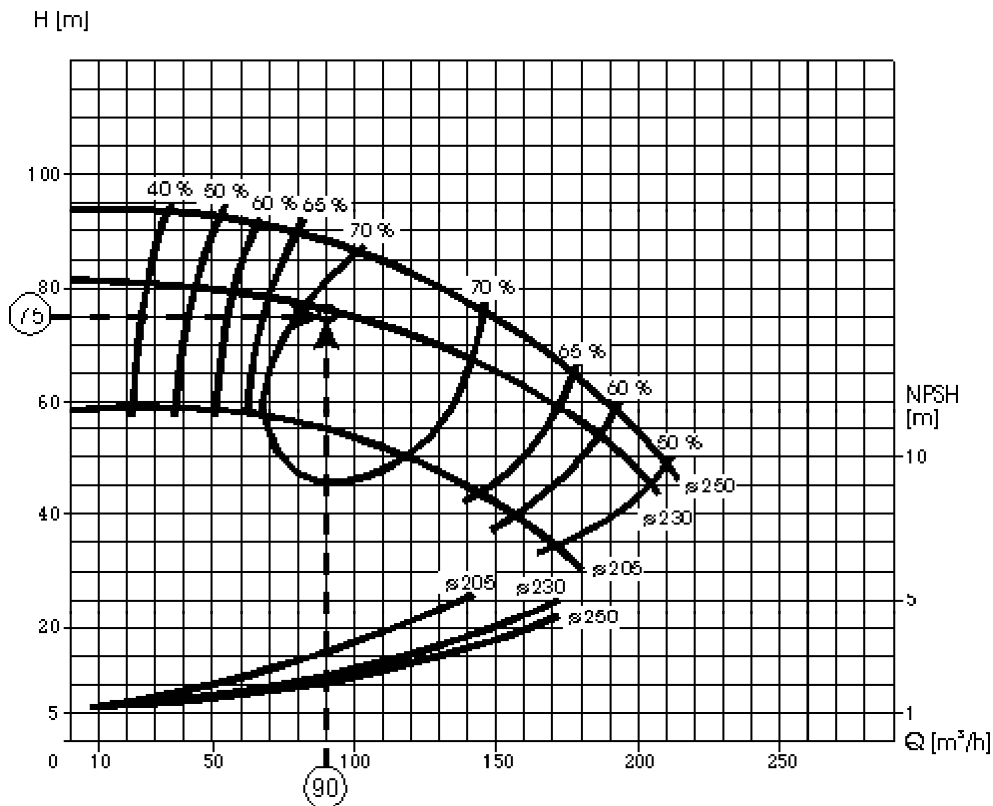
**Step 2:**

Enter the operating point of your plant into the pump diagram.

**Centrifugal pump FP performance diagram**

If the duty point is not exactly on the pump curve, the performance of the pump can be adjusted by throttling the flow, reducing the impeller diameter or adjusting the output speed of the drive. (see page 21–23)

**FP 3552**



Impeller diameter resulting from the diagram = 230 mm

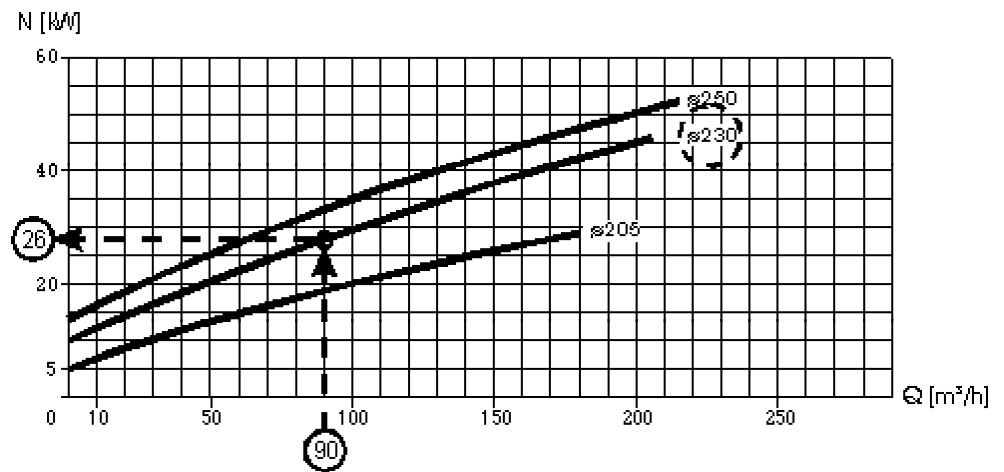
## Centrifugal pumps

### Power consumption of the pump

#### Step 3:

Find the power consumption of the pump at the point in the diagram where the power curve of the impeller used meets the design flow rate.

Select the motor with the next higher power rating.



Power consumption according to the diagram:  $N = 26 \text{ kW}$

selected motor: 30.0 kW

### pump efficiency

#### Step 4:

Check the efficiency

$$\eta = \frac{Q \times H \times \rho}{367 \times N}$$

$Q [\text{m}^3/\text{h}]$   
 $H [\text{m}]$   
 $N [\text{kW}]$   
 $\rho [\text{kg}/\text{dm}^3]$

$$\eta = \frac{90 \times 75 \times 1}{367 \times 26}$$

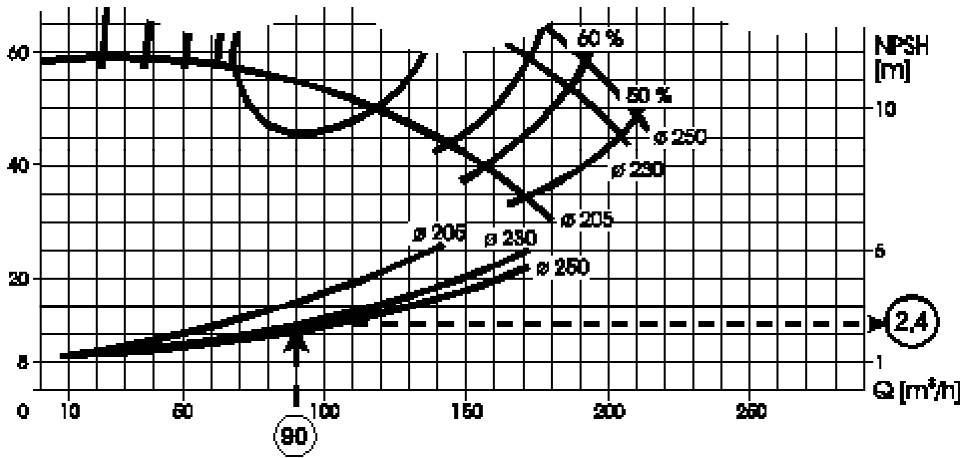
$\rho_{\text{water}} = 1 \text{ kg}/\text{dm}^3$

$$\eta = 0.7 \Rightarrow 70\%$$

Step 5:

Check if  $NPSH_{plant} > NPSH_{Pump}$

Check NPSH value



Resulting NPSH value of the pump from the diagram = 2.4 m



# Centrifugal pumps

## Self-priming centrifugal pump FZ



### Selecting the correct size

#### Example:

Flow rate  $Q_A = 30 \text{ m}^3/\text{h}$

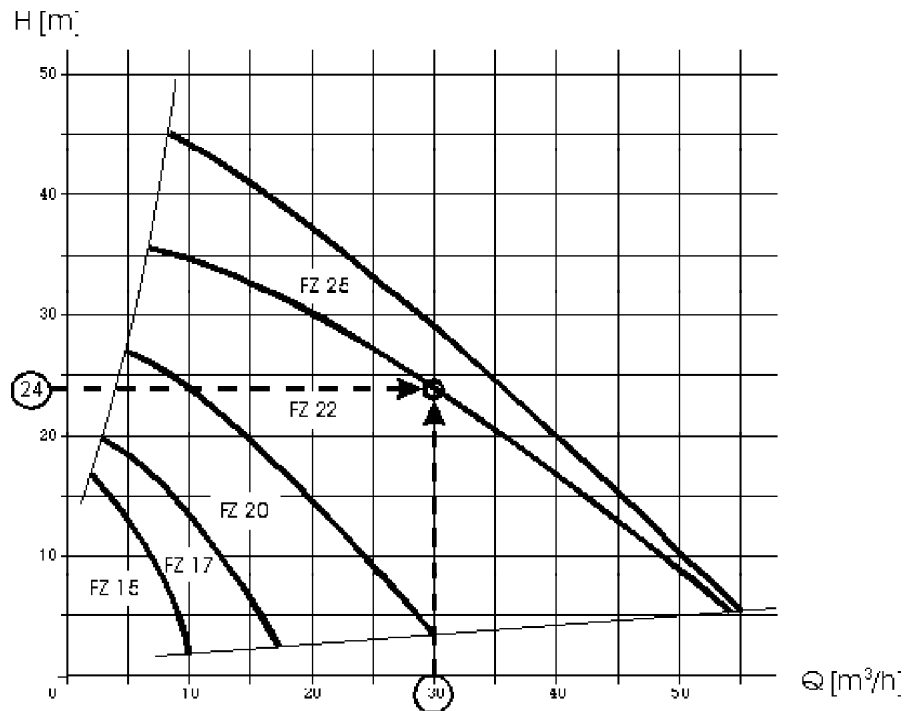
Total head  $H_A = 24 \text{ m}$

### Size selection

#### Step 1:

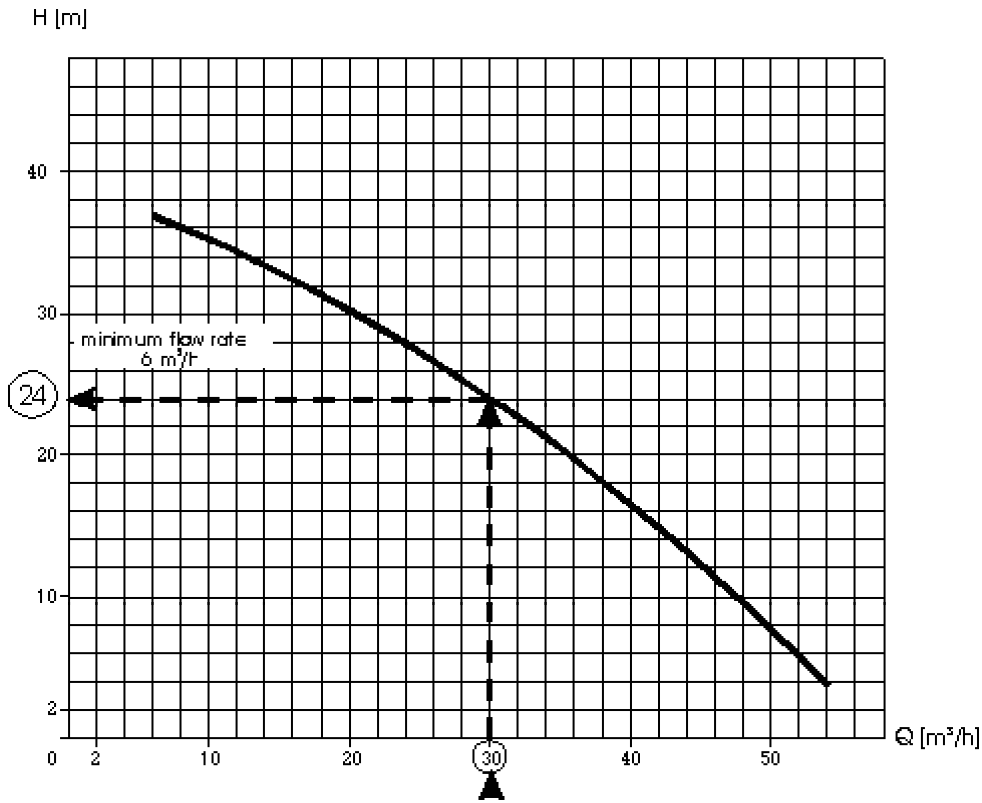
select the pump size whose curve is above to the operating point of the plant.

### FZ sizes



Selected pump size: **FZ 22**

Power consumption of the pump



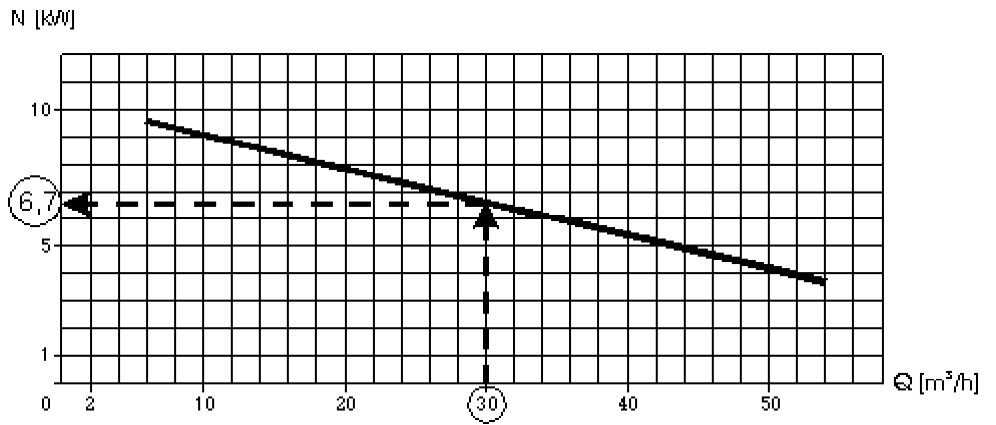
**Note:**

The performance of FZ pumps can be adjusted to the required operating point only by throttling the flow (see page 21/22) or variation of the speed (see page 23). It is **not possible** to modify the impeller diameter.

# Centrifugal pumps

## Step 2:

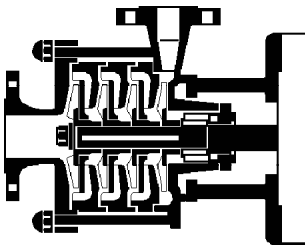
Find the power consumption of the pump at the point in the diagram where the power curve meets the design flow rate. Select the motor with the next higher power rating.



From the diagram:  $N = 6.7$  kW, selected motor: 7.5 kW

## Multistage centrifugal pump FM

The selection is carried out the same way as single-stage centrifugal pumps FP are selected (See page 28).



## *Positive displacement pumps*

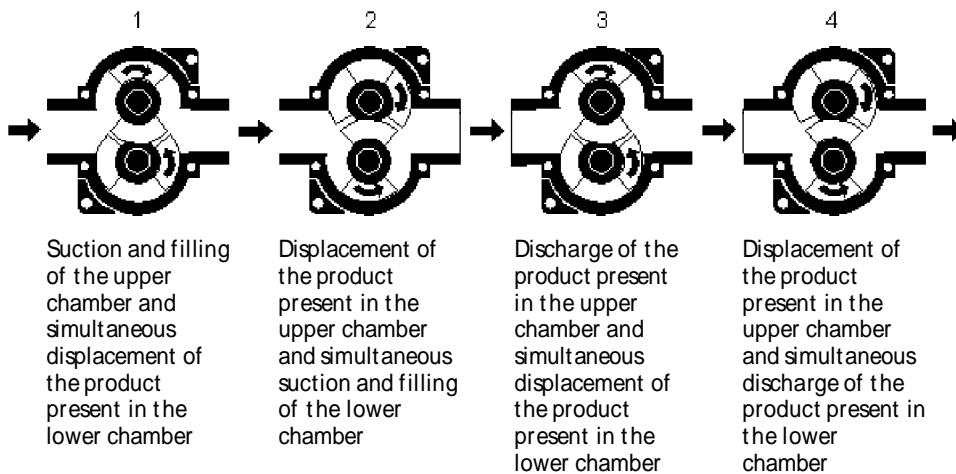
Positive displacement pumps are hydrostatic machines. They operate with a positive transfer and should not work against a closed system.

All rotary pumps are designed after the same principle. Two rotors are arranged on parallel shafts and driven by an external synchronous gear box.

The rotors rotate in opposite directions to each other. Small radial and axial clearances assure that they have no contact with each other, or the pump body. The rotors are designed to form a barrier between the suction and pressure side of the pump in any position. The sealing is only maintained by narrow gaps. There are no additional seals or valves.

The increasing cavity between the rotors on the suction side is filled with the product. The product is displaced in a circumferential direction and discharged on the pressure side as the cavity between the rotors is collapsing. This generates a constant flow from the suction to the discharge side of the pump.

### **Features and operating principle of a positive displacement pump**

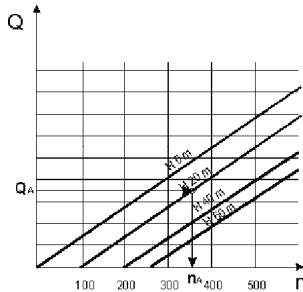


**Operating scheme**

Rotary pumps ensure a gentle fluid transfer with minimum stress or damage to the product.

## Positive displacement pumps

### Performance curve (only for water)



With positive displacement pumps the flow rate  $Q$  is linear dependent on the pump speed  $n$ .

On a test stand the flow rate is determined for various speeds and total head. In order to allow a comparison between the various pump designs and types, these tests are always carried out with water.

Once the flow rate  $Q$  and the total head  $H$  have been determined, a pump speed  $n$  that corresponds to this operating point will result from the diagram.

The positive displacement pump is usually operated with a fixed speed drive. The flow rate is constant.

### Pump speed

The flow rate can be adjusted to the various operating conditions by changing the pump speed.

### Viscosity

The viscosity of the product must be always taken into consideration for the design and selection of the pump type.

Fluids with higher viscosities require more time to enter the displacement chamber. In those cases the pump speed must be adjusted accordingly to avoid cavitation which reduces the volumetric efficiency and increases the wear. A pump operating with cavitation creates a considerable noise level.

### Clearance losses

Regardless of the low clearance between the rotor and the pump body, a slip from the pressure side back to the suction side will be generated when waterlike products are transferred.

In case of circumferential piston pumps the slip stops at a product viscosity of about 200 mPa s and at about 500 mPa s in the case of rotary lobe pumps.

## Positive displacement pumps

**Fristam** supplies two different positive displacement pump designs depending on the application.

- **Fristam** circumferential piston pumps **FK** and **FKL**  
The circumferential piston pumps type FK and FKL have a very narrow clearance in the pump chamber and a gland sealing all over. Due to these design features circumferential piston pumps have an outstanding suction performance and are suitable for high differential heads.
- **Fristam** rotary lobe pumps **FL**  
Due to the gland/line sealing, rotary lobe pumps type FL are mainly used for flooded suction conditions. They reach slightly lower differential heads than the circumferential piston pumps especially at low viscous products, but can run at higher speeds.

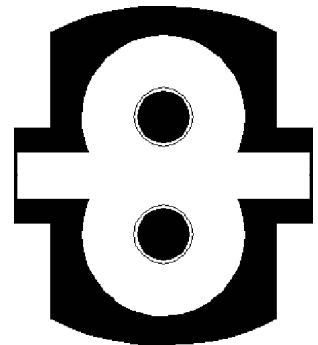
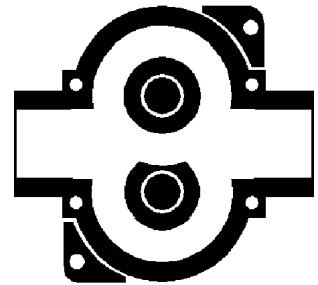
Circumferential piston pumps and rotary lobe pumps can be used for hot products

- up to approx. 90 °C using **rotors with standard dimensions**
- up to approx. 150 °C using **rotors with high temperature dimensions.**

They are suitable for automatic cleaning (CIP process) and sterilisation (SIP process).

The pumps can be supplied with horizontal or vertical ports. Various types of connections such as flanges, clamps or different threads are available.

### Designs



### Design versions

# Positive displacement pumps

## Selection of design

The design selection depends amongst other:

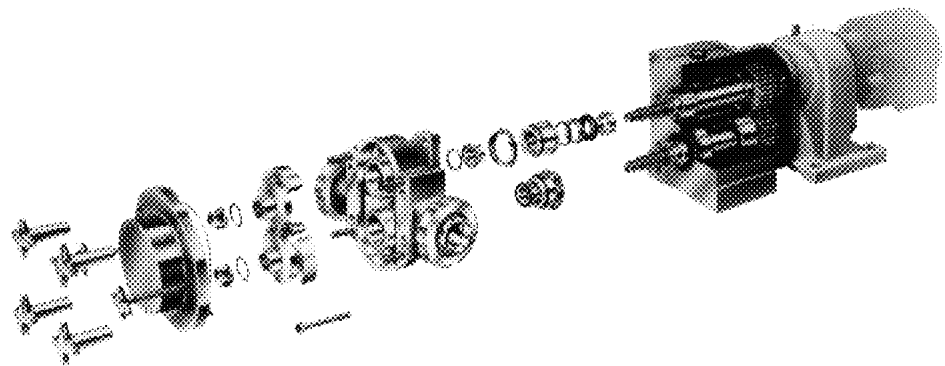
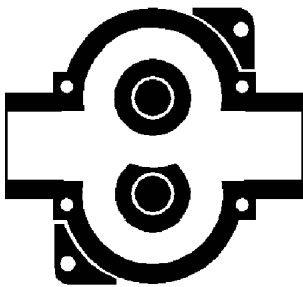


An additional selection criteria is the difference in pressure performance of the various types.

- **Fristam** rotary lobe pumps **FL**, maximum total head 120 m (12 bar)
- **Fristam** circumferential piston pump **FK**, maximum total head 200 m (20 bar)
- **Fristam** circumferential piston pump **FKL**, maximum total head 250 m (25 bar)

## Circumferential piston pumps FK, FKL

The Fristam circumferential piston pumps are manufactured with very close clearances. Thus they can generate a small vacuum in the suction pipeline. Due to the atmospheric pressure or system pressure the product is forced into the pump chambers.



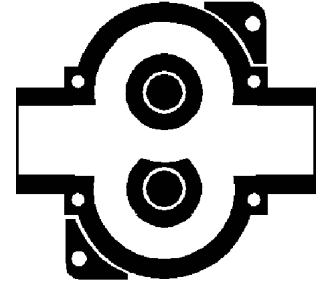
Positive displacement pumps

Example:

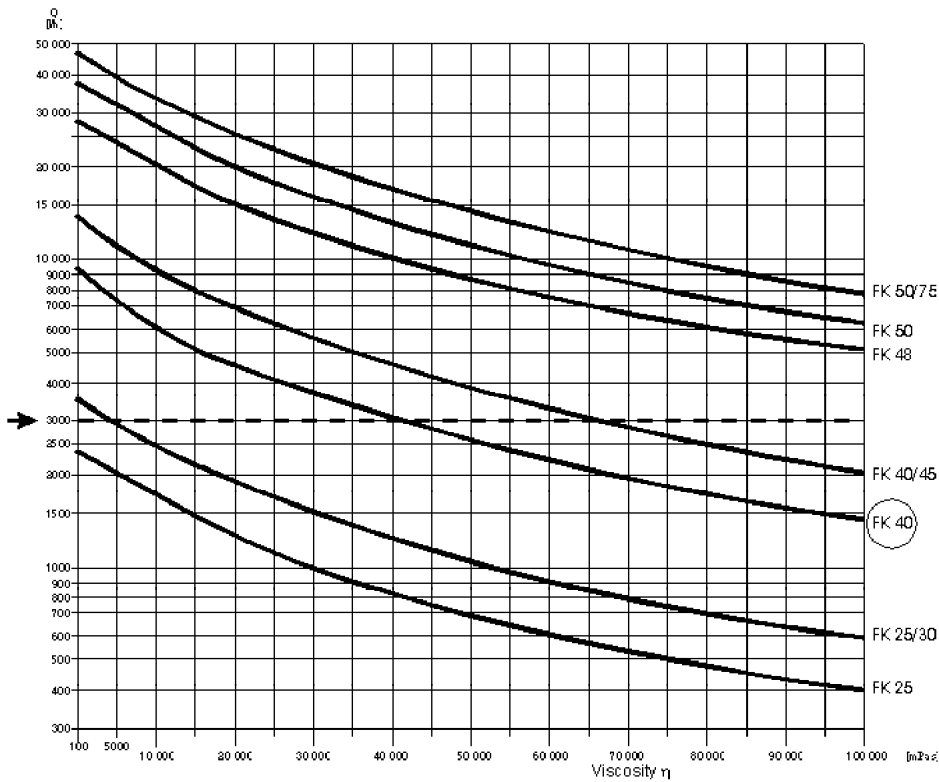
Flow rate  $Q = 3000 \text{ l/h}$   
Total head  $H = 120 \text{ m}$

Pump to be used for products with different viscosities.

Type selection



FK pump basic selection diagram



for case 1: water  
case 2:  $10 \text{ mPa}\cdot\text{s}$  | selected: **FK 40**  
case 3:  $10,000 \text{ mPa}\cdot\text{s}$

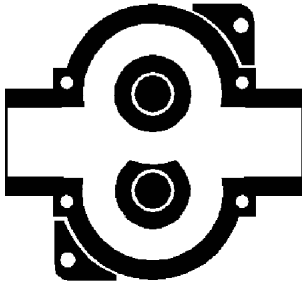


Positive  
displacement  
pumps

Case 1: viscosity  
 $\eta = 1 \text{ mPa s}$

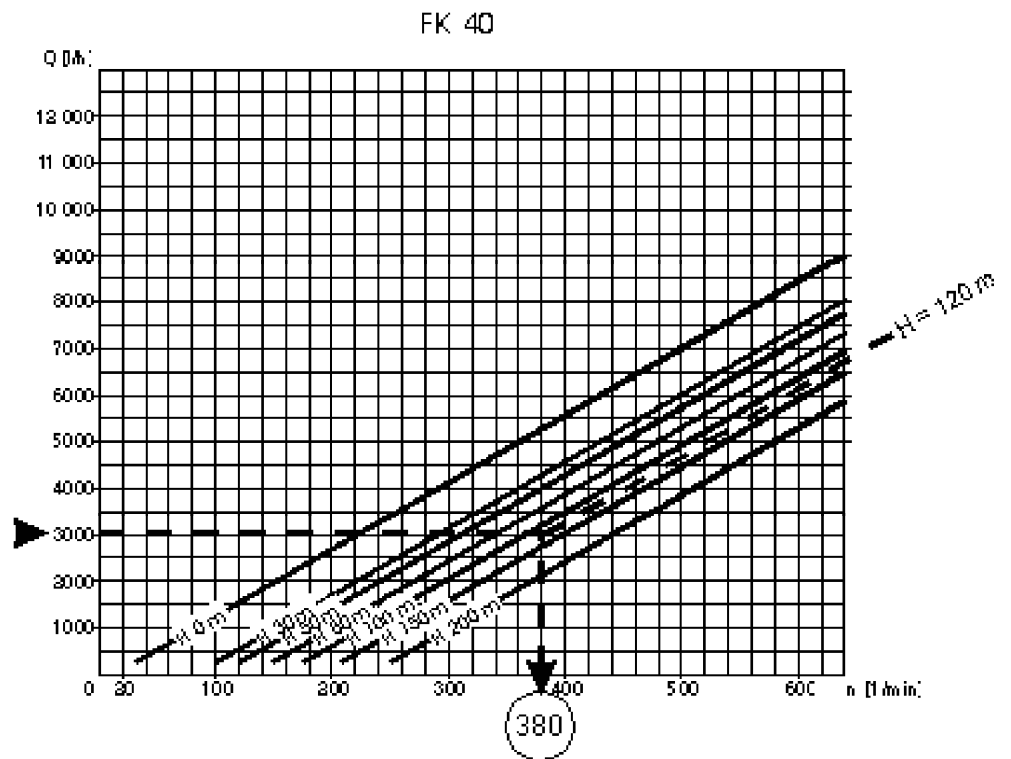
Example:

$Q = 3000 \text{ l/h}$   
 $H = 120 \text{ m} \cup p = 12 \text{ bar}$   
 $\eta = 1 \text{ mPa s}$



Step 1:

read speed  $n$  [1/min]

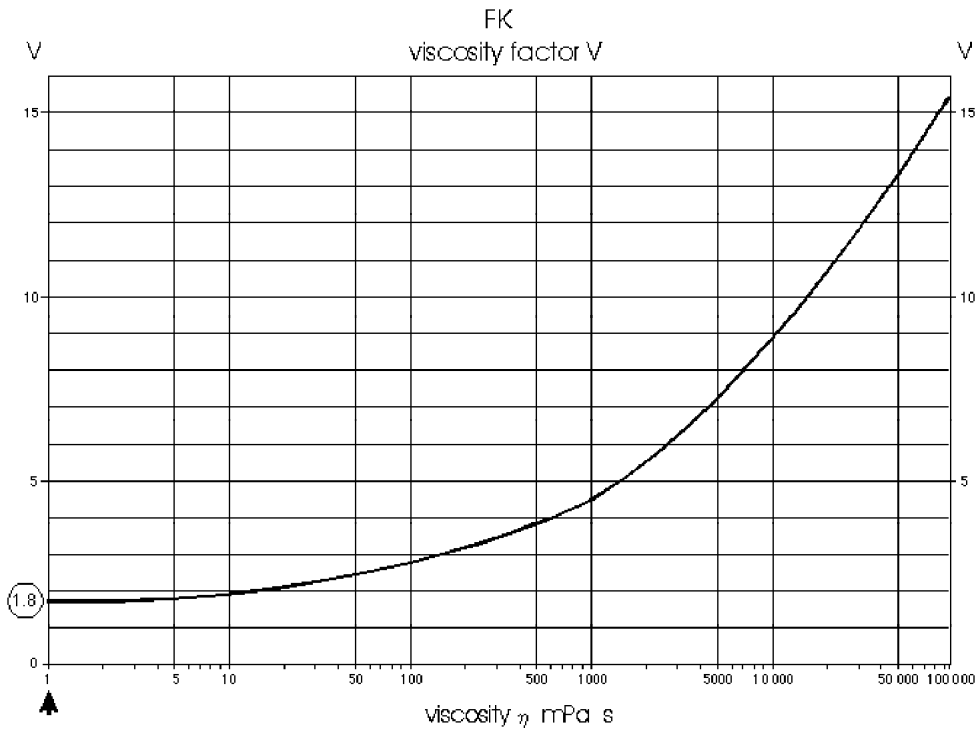


resulting from the diagram: speed  $n = 380 \text{ 1/min}$

*Positive  
displacement  
pumps*

**Step 2:**  
define viscosity factor

**Case 1 : viscosity**  
 $\eta \cup 1 \text{ mPa s}$



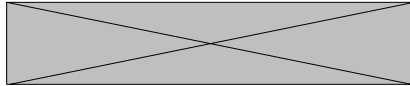
Viscosity factor  $V = 1.8$

*Positive  
displacement  
pumps*

**Case 1: viscosity**  
 $\eta \leq 1 \text{ mPa s}$

**Step 3:**

Calculate the power N [kW] required for the pump drive.



p = pressure [bar]

V = viscosity factor

n = speed [1/min], stated in the diagram

C = flow rate/revolution [l/rev.]

<b>FK</b>	25	25/30	40	40/45	48	50	50/75
<b>C</b>	0,07	0,11	0,26	0,36	0,77	1,1	1,37

Example: 
$$N = \frac{(2 \times 12 + 1.8) \times 360 \times 0.26}{1000} = 2.5 \text{ kW}$$

Positive  
displacement  
pumps

**Example:**

$Q = 3000 \text{ l/h}$

$H = 120 \text{ m} \cup p = 12 \text{ bar}$

$\eta = 10 \text{ mPa s}$

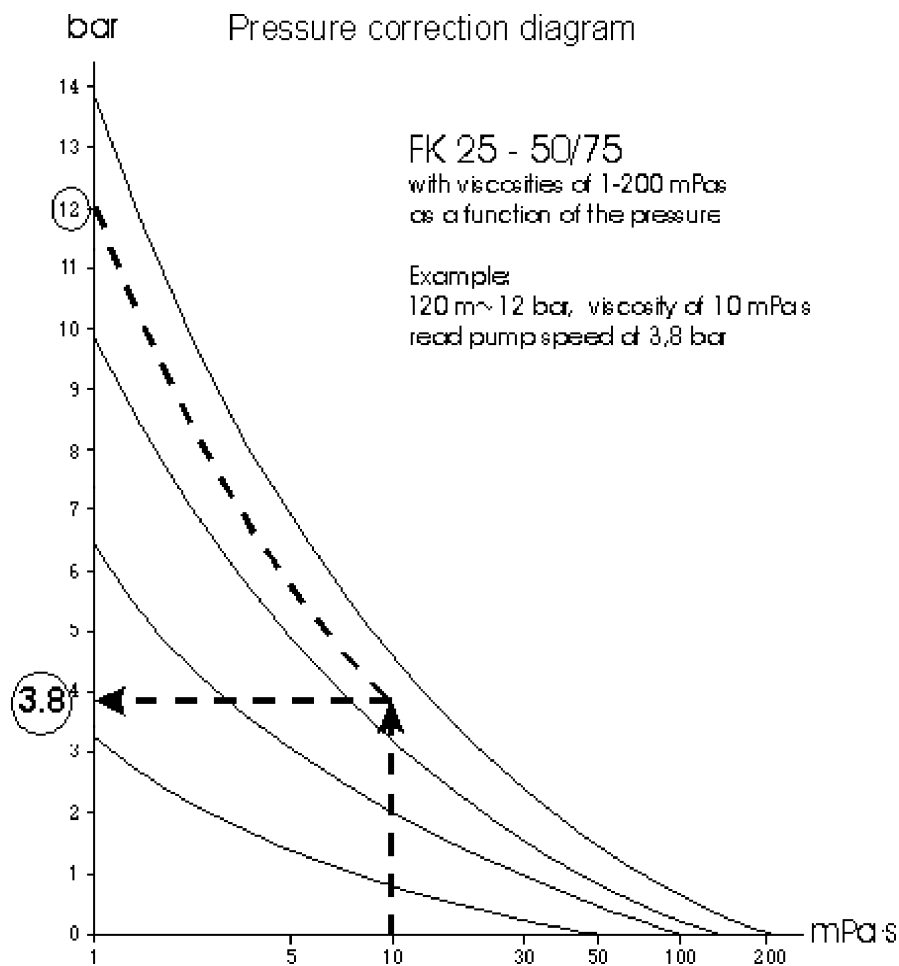
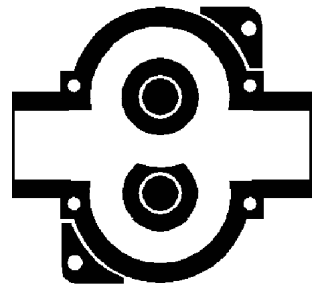
**Step 1:**

speed correction

**Case 2:**

viscous product

$\eta$  up to  $200 \text{ mPa s}$



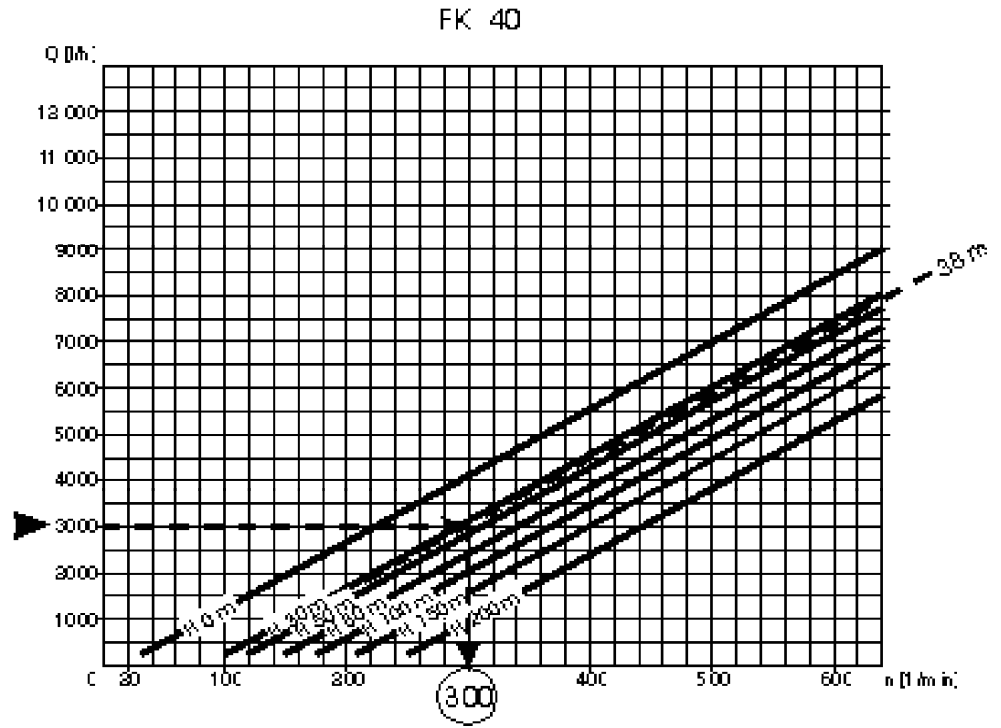
stated in the diagram:  $p = 3.8 \text{ bar}$ .

Define now the speed required for the corrected pressure.

Positive  
displacement  
pumps

**Case 2:**  
viscous product  
 $\eta$  up to 200 mPa s

**Step 2:**  
read speed  $n$  [1/min]

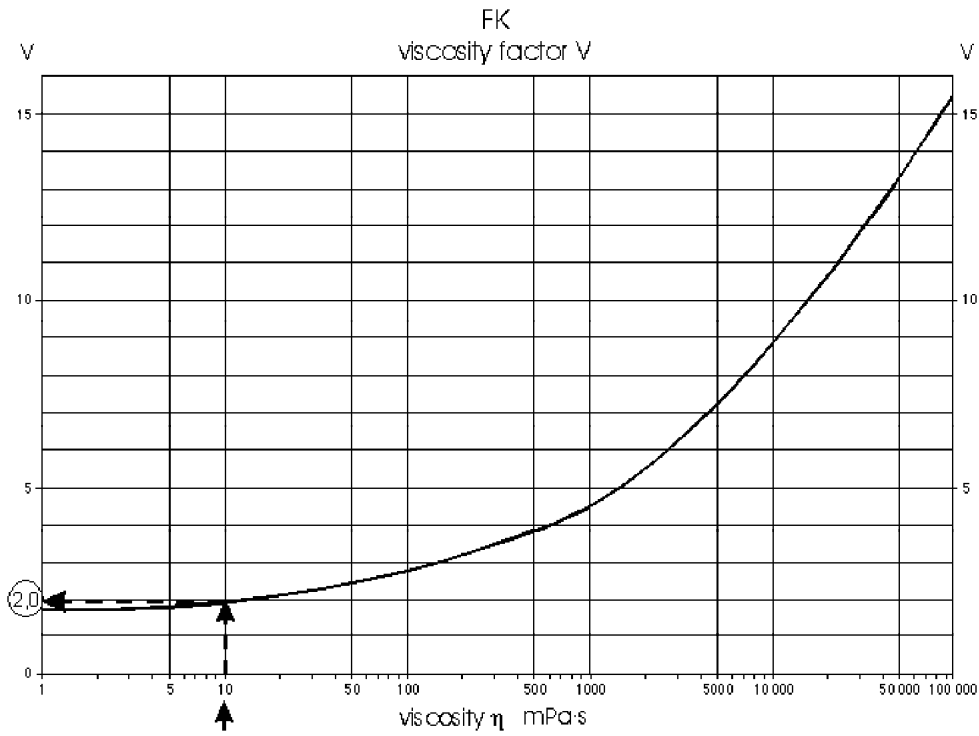


stated in the diagram: speed  $n = 300$  1/min

*Positive  
displacement  
pumps*

**Step 3:**  
define viscosity factor

**Case 2:**  
viscous product  
 $\eta$  up to 200 mPa s



stated in the diagram: viscosity factor  $V = 2.0$

*Positive  
displacement  
pumps*

**Case 2:**  
**viscous product**  
 **$\eta$  up to 200 mPa s**

**Step 3:**

Calculate power consumption N [kW] to select the pump drive.

$$N = \frac{(2 \times p + V) \times n \times C}{1000}$$

p = pressure in bar  $\cup$  H/10

V = viscosity factor

n = speed with H = 38 m

C = flow rate/revolution [l/rev.]

<b>FK</b>	25	25/30	40	40/45	48	50	50/75
<b>C</b>	0.07	0.11	0.26	0.36	0.77	1.1	1.37

Example:

$$N = \frac{(2 \times 12 + 2) \times 300 \times 0.26}{1000} = 2.03 \text{ kW}$$

Positive  
displacement  
pumps

Example:

$$Q = 3000 \text{ l/h}$$

$$H = 120 \text{ m} \cup p = 12 \text{ bar}$$

$$\eta = 10,000 \text{ mPa s}$$

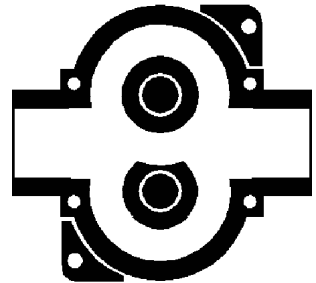
**Step 1:**

read speed with  $H = 0, \eta > 200 \text{ mPa s}$

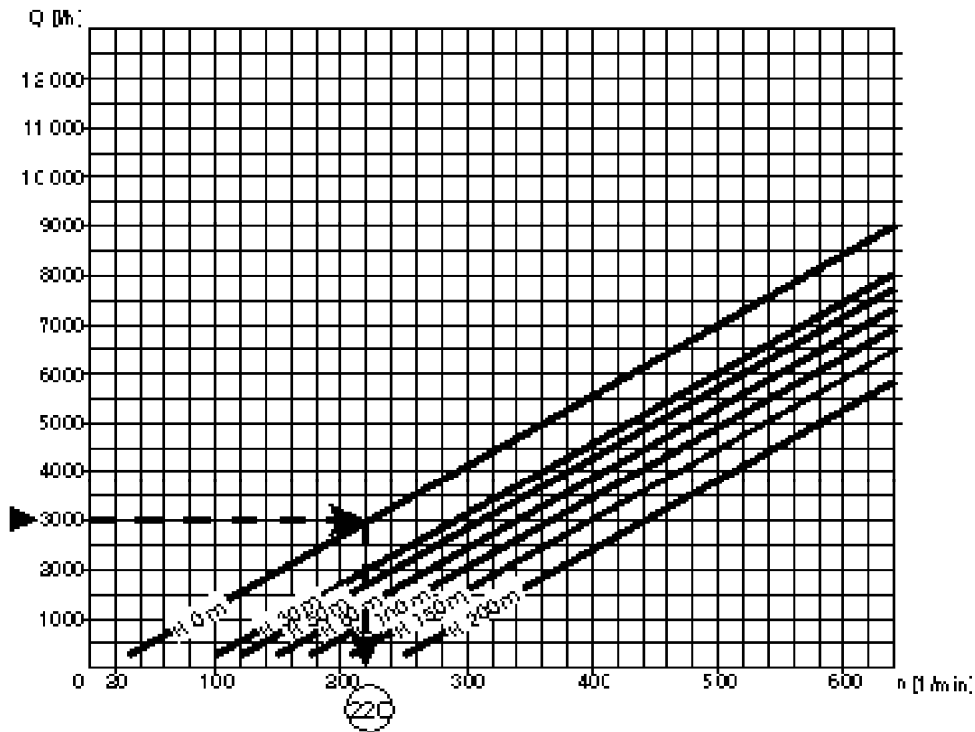
**Case 3:**

viscous product

$$\eta = 200\text{--}100,000 \text{ mPa s}$$



FK 40



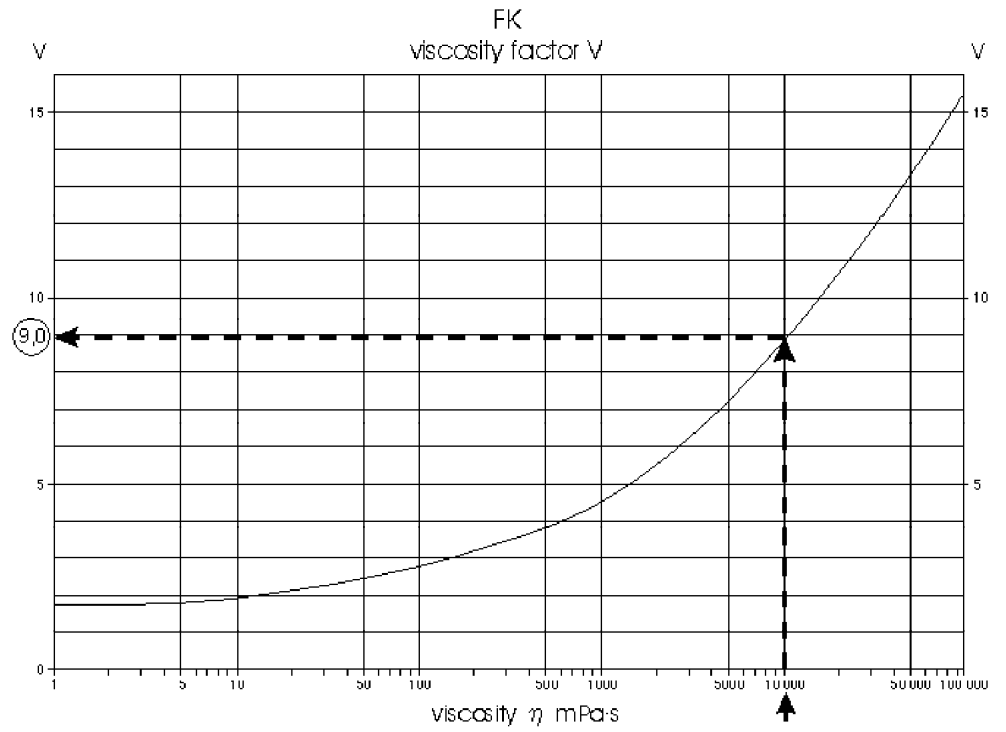
Stated in the diagram:  $n = 220 \text{ 1/min}$



*Positive  
displacement  
pumps*

**Case 3:**  
**viscous product**  
 $\eta = 200\text{--}100,000 \text{ mPa s}$

**Step 2:**  
read viscosity factor V.



stated in the diagram:  $V = 9.0$

*Positive  
displacement  
pumps*

**Step 3:**

Calculate the absorbed power N [kW] to select the pump drive.

$$N = \frac{(2 \times p + V) \times n \times C}{1000}$$

p = pressure [bar]  $\cup$  H/10

V = viscosity factor

n = speed [1/min], stated in the diagram

C = flow rate/revolution [l/rev.]

Example:

$$N = \frac{(2 \times 12 + 9.0) \times 220 \times 0.26}{1000} = 1.9 \text{ kW}$$

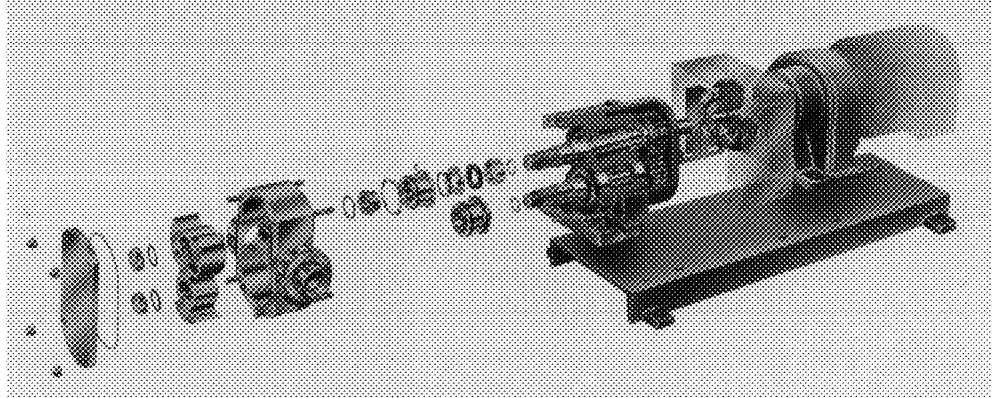
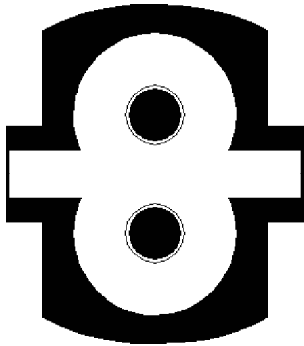
**Case 3:**

**viscous product**

$\eta = 200\text{--}100,000 \text{ mPa s}$

Positive  
displacement  
pumps

Rotary lobe pump FL



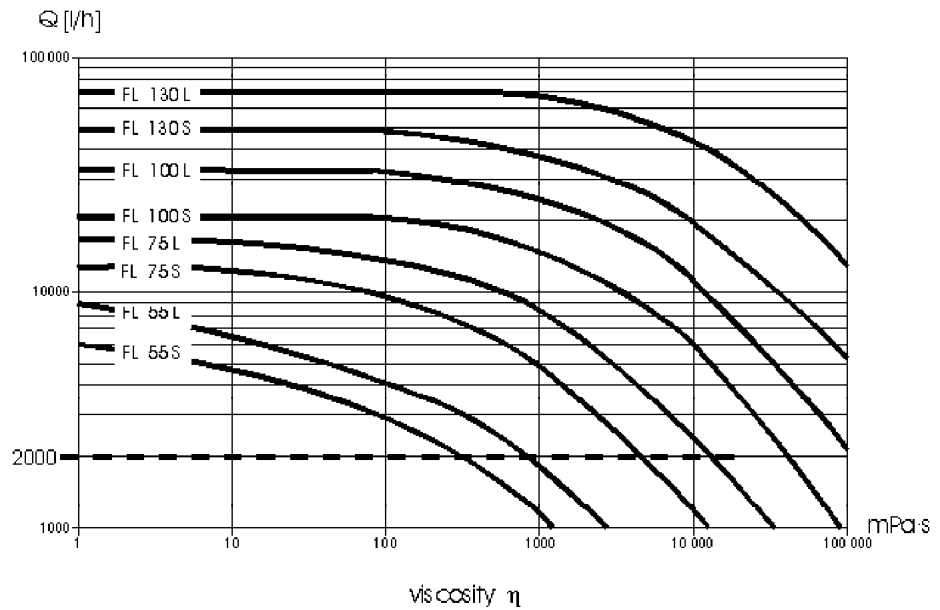
**Example:**

Flow rate  $Q = 2000 \text{ l/h}$   
Total head  $H = 60 \text{ m}$

**Selection**

Pump to be used for products with different viscosities.

FL - basic selection diagram



for case number 1: water  
case number 2:  $10 \text{ mPa s}$   
case number 3:  $10,000 \text{ mPa s}$

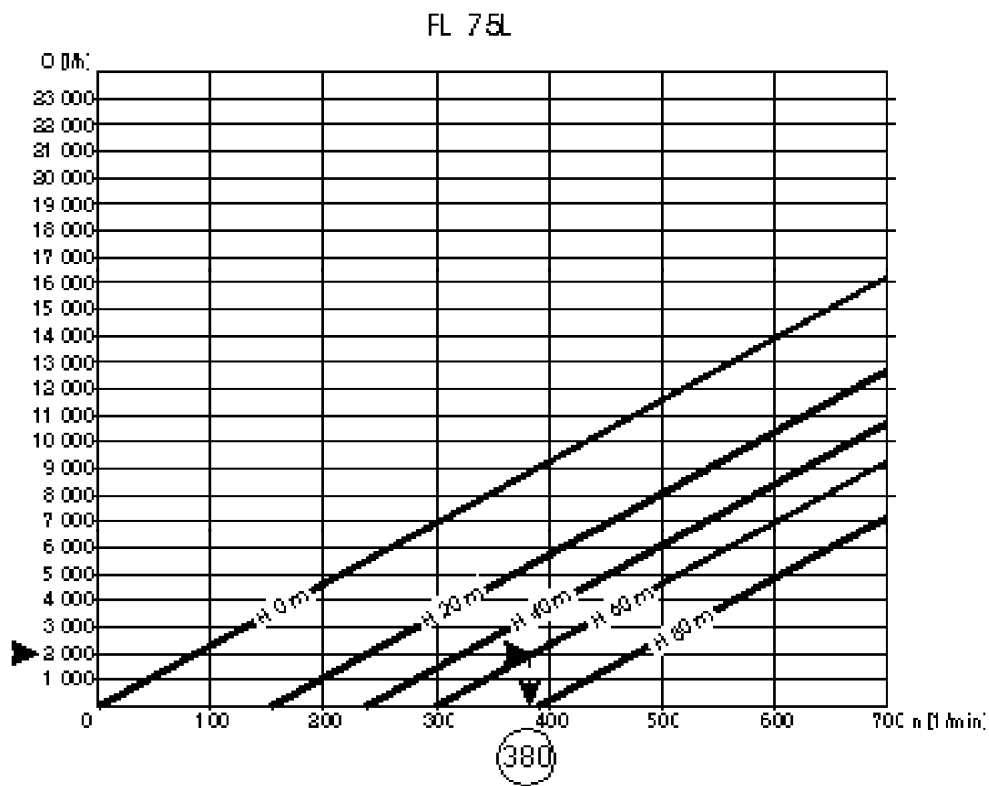
| selected: **FL 75 L**  
≠

Positive displacement pumps

Flow rate  $Q = 2000 \text{ l/h}$   
Total head  $H = 60 \text{ m}$   
 $\eta = 1 \text{ mPa s (water)}$

Case 1: viscosity  
 $\eta = 1 \text{ mPa s}$

Step 1:  
read speed  $n$  [1/min] .

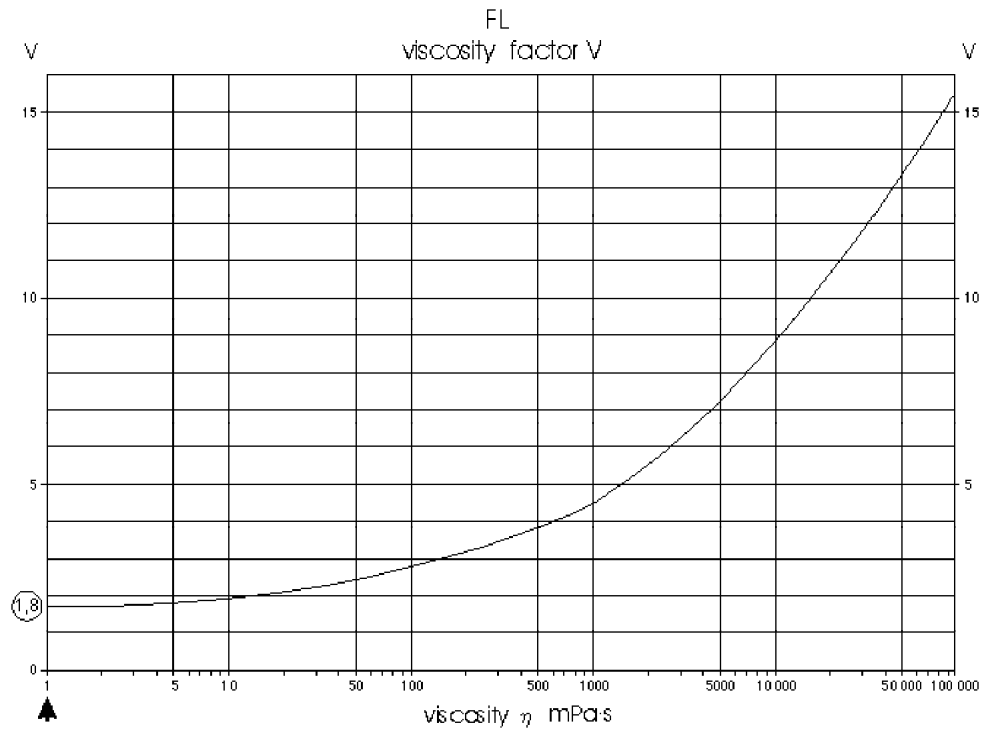


read: speed  $n = 380$  1/min

*Positive  
displacement  
pumps*

**Case 1: viscosity**  
 $\eta \leq 1 \text{ mPa s}$

**Step 2:**  
define viscosity factor



stated in the diagram: viscosity factor  $V = 1.8$

*Positive  
displacement  
pumps*

**Step 3:**

Calculate the absorbed power N [kW] to select the pump drive.

**Case 1 : viscosity**  
 $\eta \approx 1 \text{ mPa s}$

$$N = \frac{(2 \times p + V) \times n \times C}{1000}$$

p = pressure in bar  $\approx H/10$

V = viscosity factor

n = speed with H = 0

C = flow rate/revolution [l/rev.]

FLF	55S	55L	75S	75L	100S	100L	130S	130L
C	0.106	0.152	0.283	0.389	0.69	1.07	1.80	2.54

Example:

$$N = \frac{(2 \times 6 + 1.8) \times 360 \times 0.389}{1000} = 2.04 \text{ kW}$$

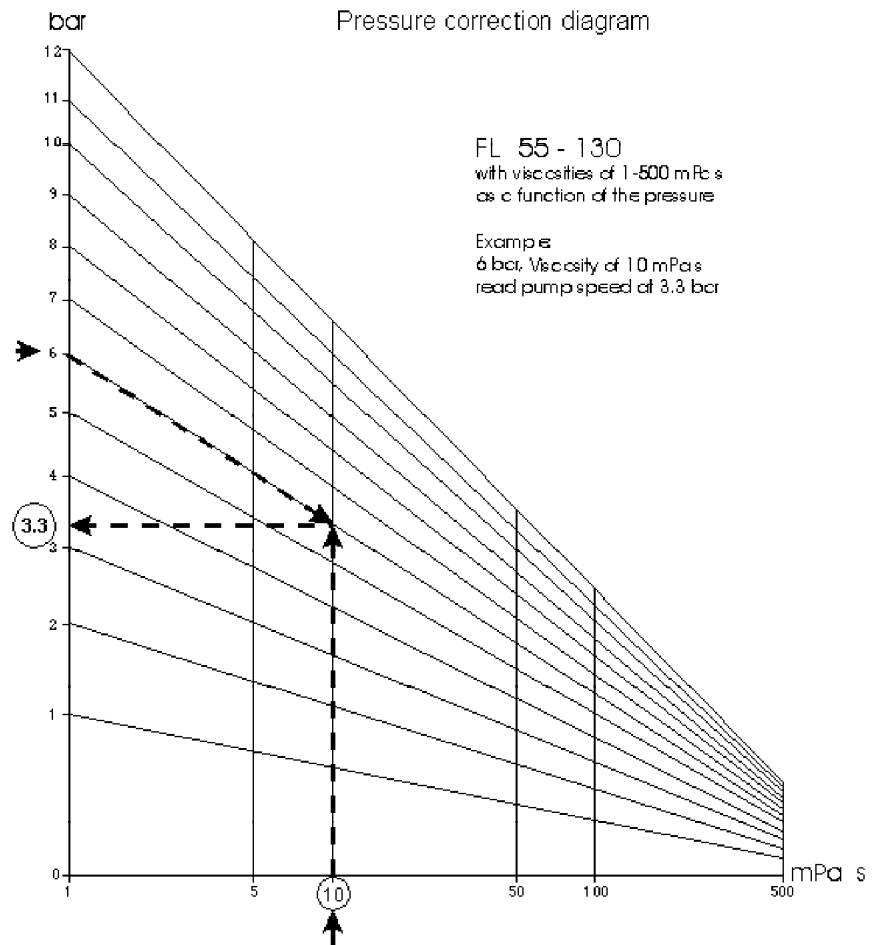
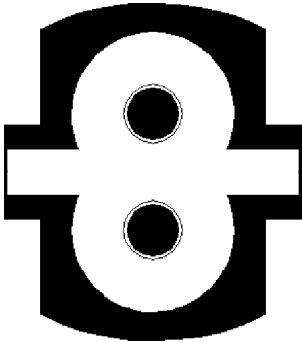
*Positive  
displacement  
pumps*

**Case 2:**  
**viscous product**  
 $\eta$  up to 500 mPa s

Flow rate  $Q = 2000$  l/h  
Total head  $H = 60$  m  
Viscosity  $\eta = 10$  mPa s

**Step 1:**  
define correction for the speed

$H = 60$  m  $\cup$  6 bar



read speed at  $H = 33$  m (equal to  $p = 3.3$  bar)

Positive  
displacement  
pumps

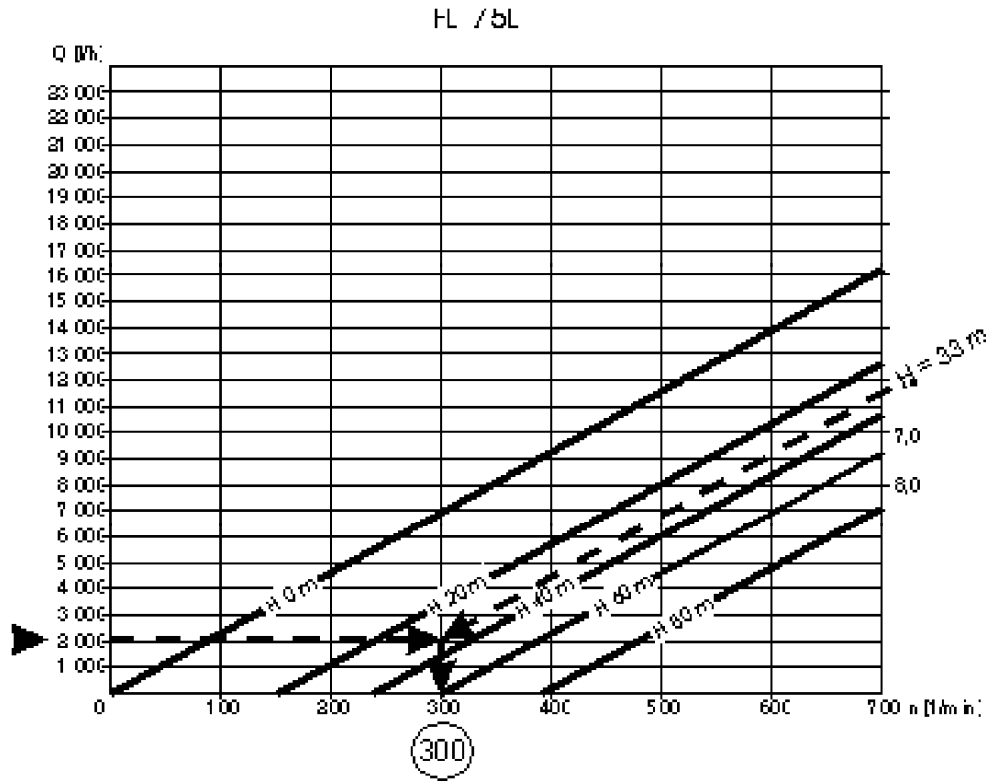
**Step 2:**

read speed at  $H = 33 \text{ m}$  ( $\approx 3.3 \text{ bar}$ )

**Case 2:**

viscous product

$\eta$  up to  $500 \text{ mPa s}$



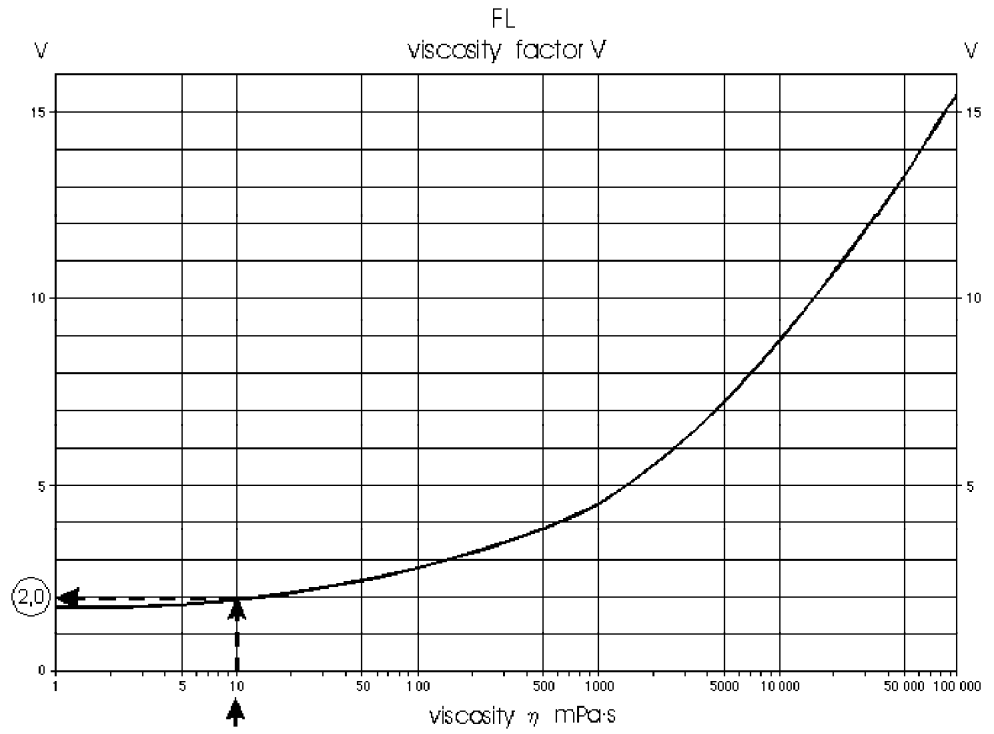
read: speed  $n = 300 \text{ 1/min}$



*Positive  
displacement  
pumps*

**Case 2:**  
**viscous product**  
 **$\eta$  up to 500 mPa s**

Step 3:  
define viscosity factor



stated in the diagram: viscosity factor  $V = 2.0$

*Positive  
displacement  
pumps*

**Step 4:**

Calculate absorbed power N [kW] to select the pump drive.

$$N = \frac{(2 \times p + V) \times n \times C}{1000}$$

p = pressure in bar  $\cup$  H/10

V = viscosity factor

n = speed at H = 0

C = flow rate/revolution [l/rev.]

**Case 2:**

**viscous product**

**$\eta$  up to 500 mPa s**

FLF	55S	55L	75S	75L	100S	100L	130S	130L
C	0.106	0.152	0.283	0.389	0.69	1.07	1.80	2.54

Example:

$$N = \frac{(2 \times 6 + 2) \times 300 \times 0.389}{1000} = 1.63 \text{ kW}$$

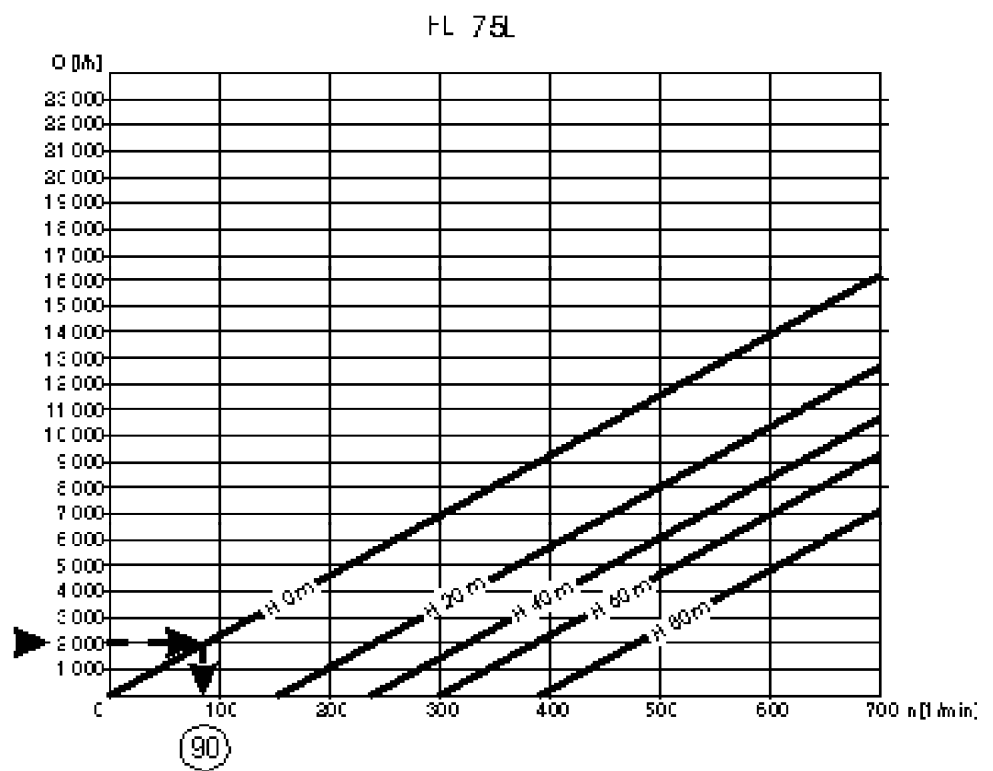
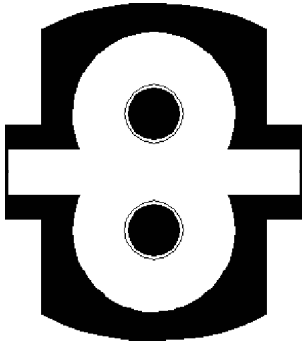
Positive  
displacement  
pumps

**Case 3:**  
viscous product  
 $\eta = 500\text{--}100,000 \text{ mPa s}$

Flow rate  $Q = 2000 \text{ l/h}$   
Total head  $H = 60 \text{ m (}\simeq 6 \text{ bar)}$   
viscosity  $\eta = 10,000 \text{ mPa s}$

**Step 1:**

read speed at  $H = 0 \text{ m}$ , as  $\eta > 500 \text{ mPa s}$

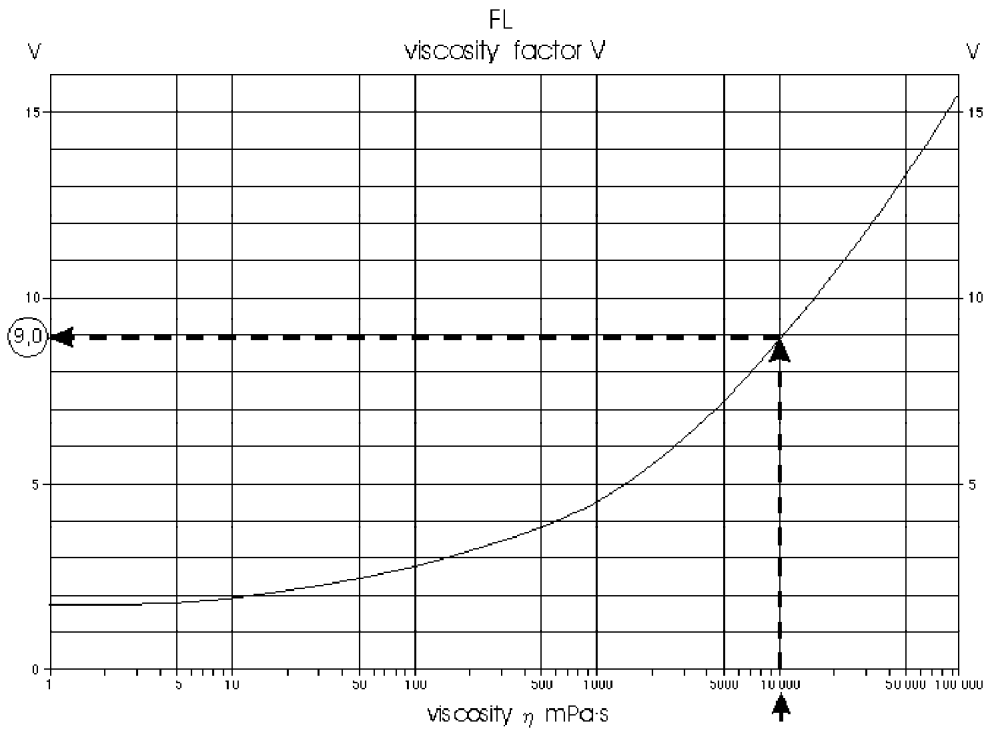


read:  $n = 90 \text{ 1/min}$

*Positive  
displacement  
pumps*

**Step 2:**  
define viscosity factor

**Case 3:**  
viscous product  
 $\eta = 500\text{--}100,000 \text{ mPa s}$



Viscosity factor  $V = 9.0$

*Positive  
displacement  
pumps*

**Case 3:**  
**viscous product**  
 $\eta = 500\text{--}100,000 \text{ mPa s}$

**Step 3:**

calculate absorbed power N [kW].

$$N = \frac{(2 \times p + V) \times n \times C}{1000}$$

p = pressure in bar  $\cup$  H/10

V = viscosity factor

n = speed at H = 0

C = flow rate/revolution [l/rev.]

FLF	55S	55L	75S	75L	100S	100L	130S	130L
C	0.106	0.152	0.283	0.389	0.69	1.07	1.80	2.54

Example:

$$N = \frac{(2 \times 6 + 9) \times 90 \times 0.389}{1000} = 0.74 \text{ kW}$$

Mechanical seals are devices to seal machines between rotating parts (shafts), and stationary parts (pump housing).

## **Mechanical seal**

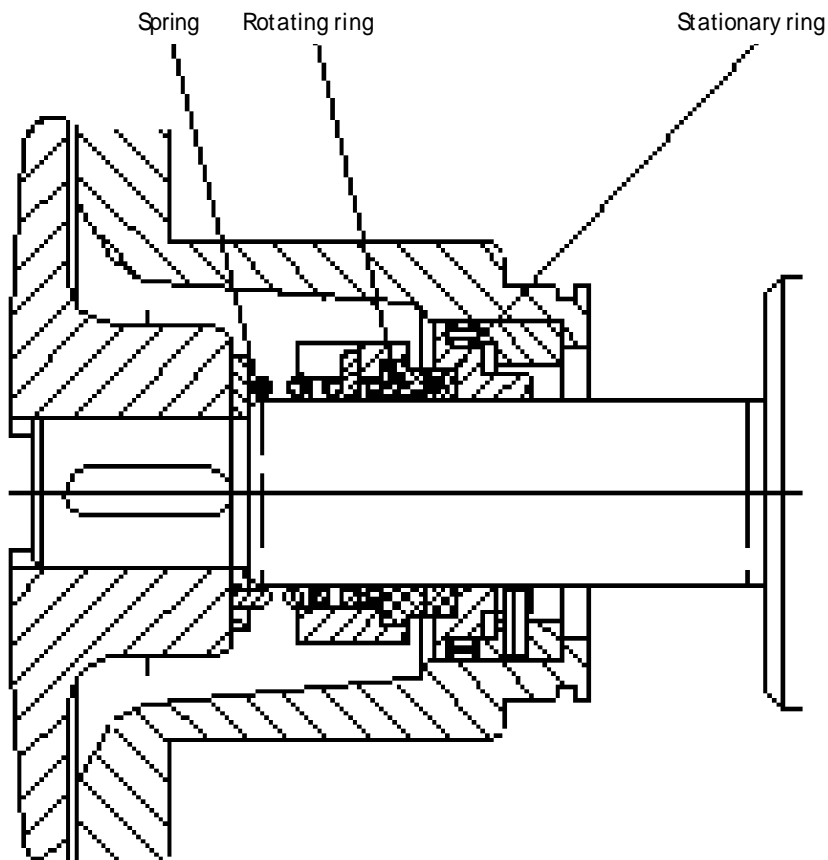
There are two types of mechanical seals:

- single mechanical seals
- double mechanical seals

Mechanical seals consist of two surfaces which slide against each other. The surfaces are pressed together by a spring. Between these two surfaces a fluid film is generated by the pumped product.

## **Single mechanical seals**

This fluid film prevents that the mechanical seal touches the stationary ring. The absence of this fluid film will result in frictional heat and the destruction of the mechanical seal (dry run of the pump).



## *Mechanical seal selection*

The spring is in the product. The product pressure acts additional to the spring on the rotating seal part.

Therefore standard mechanical seals are used only for a pressure up to 10 bar. For higher pressures, balanced mechanical seals are used.

### **Double mechanical seals**

In this case two mechanical seals are arranged in series. The inboard or, "primary seal" keeps the product in the pump housing. The outboard or, "secondary seal" prevents leakage of the flush liquid into the atmosphere.

The double mechanical seals can be provided by **Fristam** in two different arrangements:

- Back to Back
- Face to Face

These mechanical seal arrangements are used,

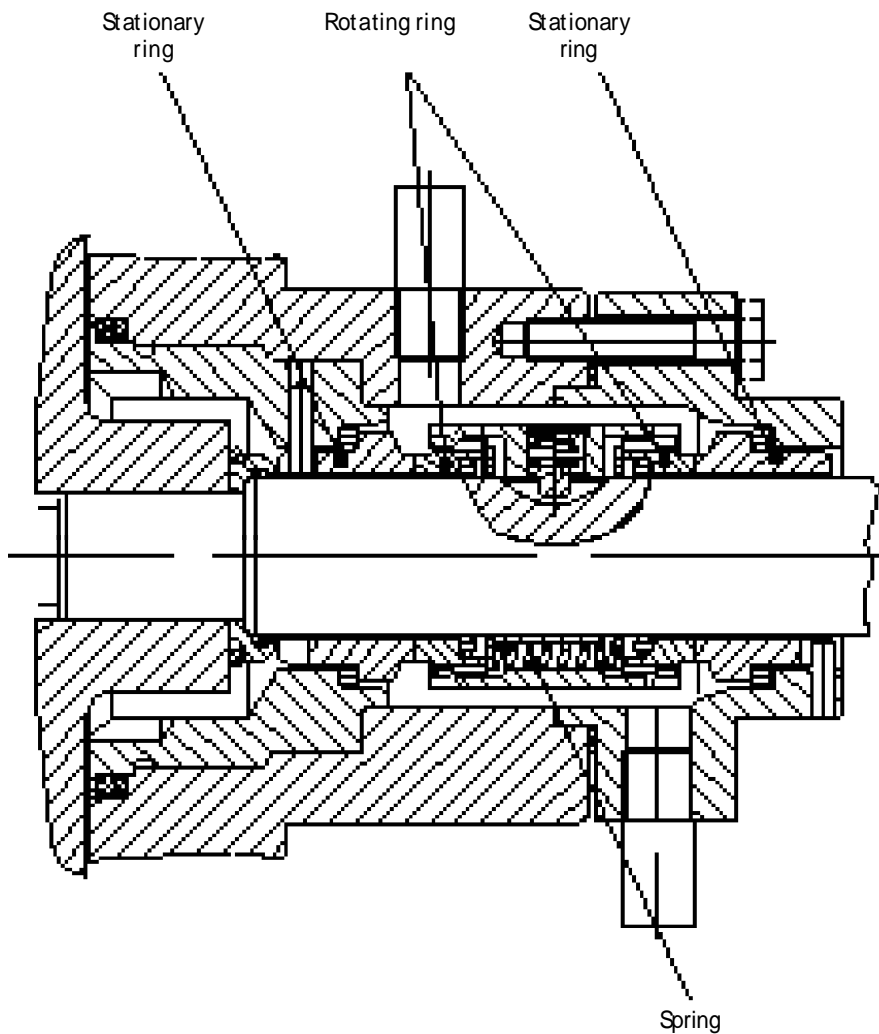
- if a fluid product leakage needs to be avoided,
- when aggressive media are used or at high pressures and temperatures,
- for many polymerising, sticky media and media which tend to sedimentation,
- for vacuum applications.

## *Mechanical seal selection*

Two rotating seal rings are arranged facing away from each other "Back to Back". The lubricating film is generated by the barrier fluid.

### **"Back to Back" arrangement**

The barrier pressure in the case of a "Back to Back" arrangement should be 1.5 up to 2.0 bar above the product pressure in the seal area.



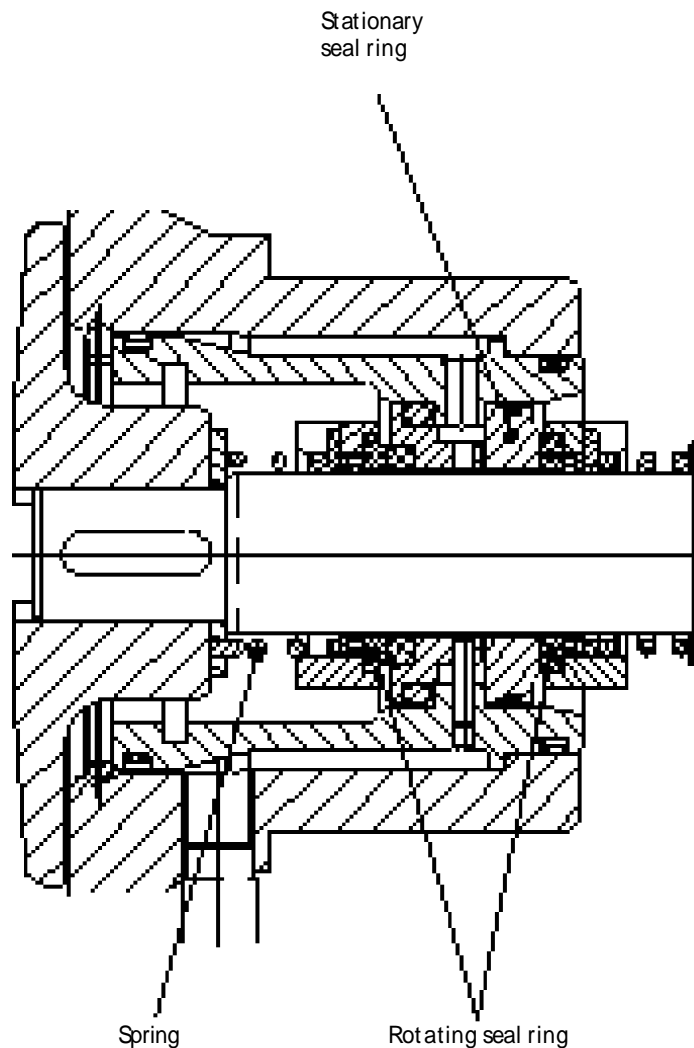
Mechanical seals with a "Back to Back" arrangement are mainly used in the chemical industry. In case of a leakage, the barrier liquid penetrates the product.



*Mechanical seal  
selection*

**“Face to Face”  
arrangement**

The spring loaded rotary seal faces are arranged face to face and slide from the opposite direction to one or two stationary seal part(s).



The mechanical seals with a "Face to Face" arrangement are often used in the food industry in particular for products which tend to stick and for vacuum applications. The barrier pressures are very low (0.2 bar). In the case of leakage the product penetrates the barrier liquid.

In the case of hot products the barrier liquid also acts as a cooling agent for the mechanical seal.

**Fristam** has many years of experience in the manufacture of mechanical seals and is able to provide the best mechanical seal for any application.

Standard mechanical seals in conformity with DIN 24 960 can be mounted without problems.

## **Mechanical seal designs**

## **Seal face materials**

<b>Material</b>	<b>Properties</b>
<b>1. Carbons</b> synthetic resin, impregnated	Good antifrictional properties, high temperature stability. Chemical stability is to be tested.
<b>2. Metals</b> Chromium -Nickel- Molybdenum	Good chemical stability.
<b>3. Metal carbides</b>	
3.1 Tungsten carbide	Low thermal conductivity, but high hardness and wear resistance.
3.2 Silicon carbide	Hardness greater than with tungsten carbide, outstanding chemical stability, good antifrictional properties and thermal conductivity, but very brittle.
<b>4. Ceramics</b>	High quality aluminium oxide, high wear resistance, good chemical stability, low thermal conductivity, sensitive to thermal shocks

## *Mechanical seal selection*

<b>Elastomers</b>	<b>Material</b>	<b>Range of temperatures</b>	<b>Properties</b>
	<b>1. Nitrile</b>	-30 up to + 100°C	Resistant to water, vapour, mineral and vegetable shortening (fat) and oils, alcohol, salt solutions. Not resistant to aromatic and chlorine hydrocarbons, acids and alkaline solutions.
	<b>2. EPDM</b>	- 50 up to + 150°C	Good thermal properties, can be used for alcoholic solutions, diluted acids and concentrated alkaline solutions. Not resistant to mineral and vegetable shortening (fat) and oils, and hydrocarbons.
	<b>3. Viton (FKM)</b>	-25 up to + 200°C	Good thermal resistivity, water resistant, vapour resistant, resistance to mineral and vegetable fat and oils, to alcohol, to acids and alkaline solutions, salt solutions. Not resistant to ketones such as acetone and ester.
	<b>4. PTFE</b>	-20 up to + 200°C	Best chemical and thermal resistivity to all aggressive liquids, elasticity ensured through use of Viton-caoutchouc or EP- core material.

The transfer of hygienic, high quality products requires a clean pump. Therefore at the end of a production process the pumps must be cleaned immediately. The plant needs to be clean and free from germs before starting a new production cycle.

Cleaning is the operation to remove all traces of product from the plant. A properly cleaned surface is free from visible, perceptible or chemically detectable dirt deposits (residue).

The standard cleaning process for plants is the **CIP** - (**C**leaning in **P**lace). This implies cleaning without dismantling of the plant by means of CIP fluids.

In the food industry a CIP process requires the following steps:

- preliminary rinsing with water
- flushing with alkaline solution
- intermediate rinsing with water
- flushing with acid
- rinsing with clean water

To clean the unit efficiently a turbulent flow of the CIP fluid is required. A minimum flow velocity in pipes is usually 2 m/s.

Viscous fluids are often transferred by positive displacement pumps at low flow velocities. In order to obtain the flow rate required for CIP it may be necessary to fit an additional cleaning pump such as a centrifugal pump.

**Fristam** pumps are fully CIP capable. They are characterised by:

- welded and ground joints
- round edges and angles
- smooth joining
- no narrow gaps and dead legs
- O-rings immersed in the pump housing
- smooth, nonporous internals with a high surface finish

### Cleaning

### CIP

### CIP plant cleaning

### CIP compatible design

## *Pump cleaning*

**SIP** After CIP cleaning an additional sterilisation in place process (SIP) may be required when highly sensitive products are handled, inactivating any micro-organisms which might be still present in the pump.

The sterilisation can be carried out by means of chemicals, hot water or steam. In the dairy industry the sterilisation temperature is approximately 145° C.

**Units of measure**

Term	Symbol	Unit used in practice	Coherent unit
Flow rate	Q	m <sup>3</sup> /h	l/h
Total head	H	m	m
NPSH-value	NPSH	m	m
Power consumption	N	kW	Nm/s
Pump efficiency	$\eta$	%	-
Speed	n	1/min	1/s
Pressure	p	Pa	N/m <sup>2</sup>
Density	$\rho$	kg/dm <sup>3</sup>	kg/m <sup>3</sup>
Fluid flow velocity	v	m/s	m/s
Local gravitational acceleration	g	m/s <sup>2</sup>	m/s <sup>2</sup>

Used indices:

- geo = total discharge head
- S = suction side
- D = discharge side
- E = inlet cross section
- A = discharge cross section
- V = loss

**Conversion**

Term	Unit	
Pressure p	Pascal	Pa, 100 kPa=1 bar
Total head	Meter	1 m = 0.1 bar <sup>*)</sup>
Dynamic viscosity	mPa s	1 mPa s = 1 cP

<sup>\*)</sup> valid only for water

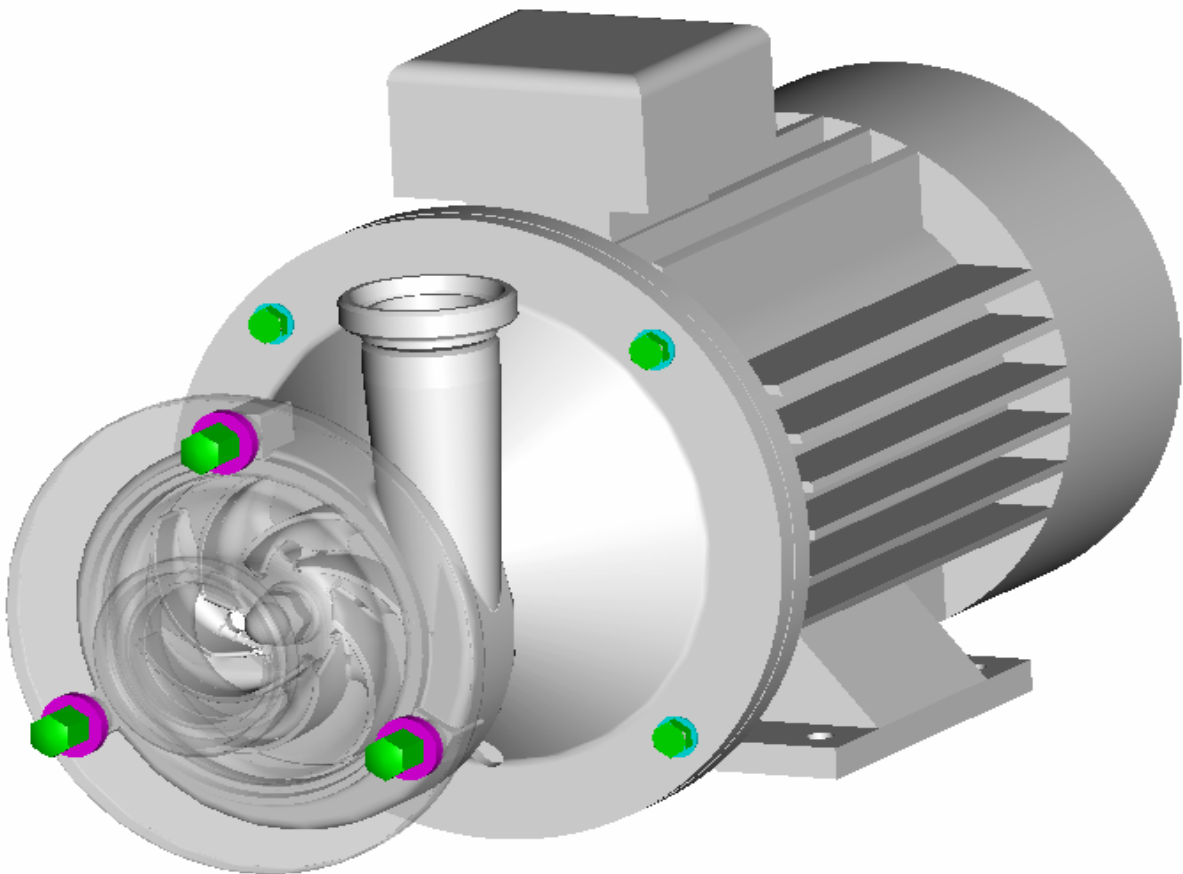
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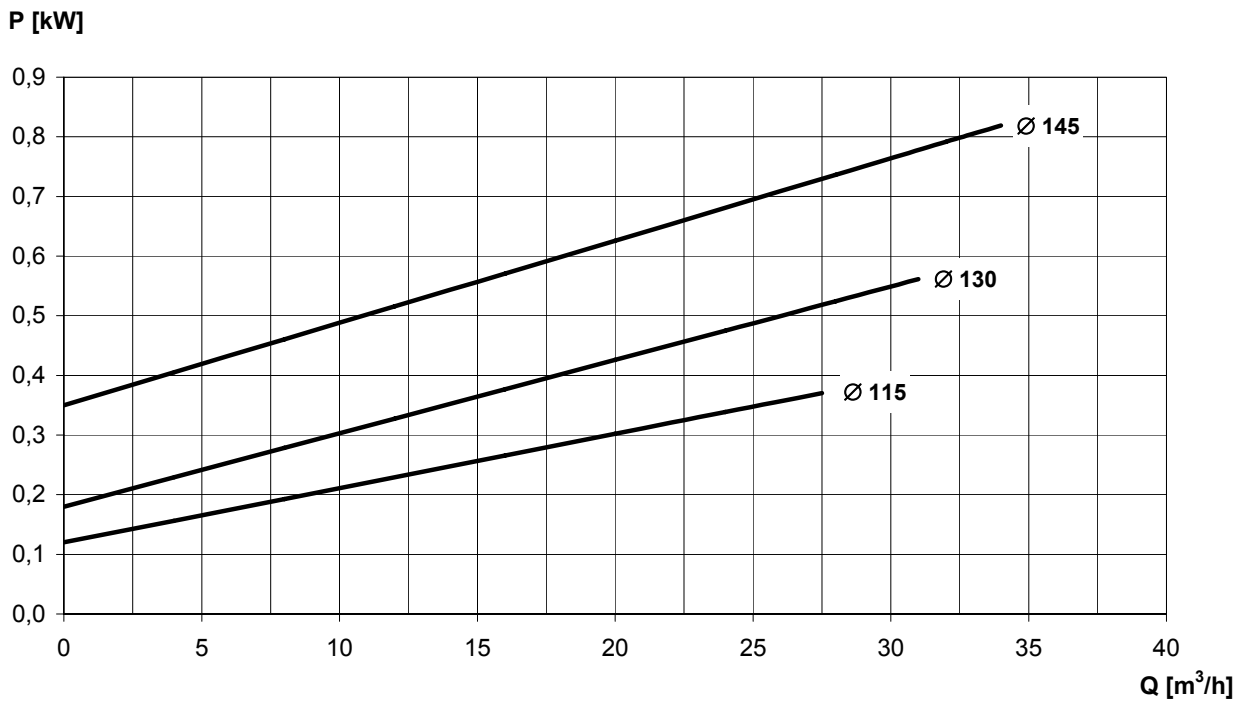
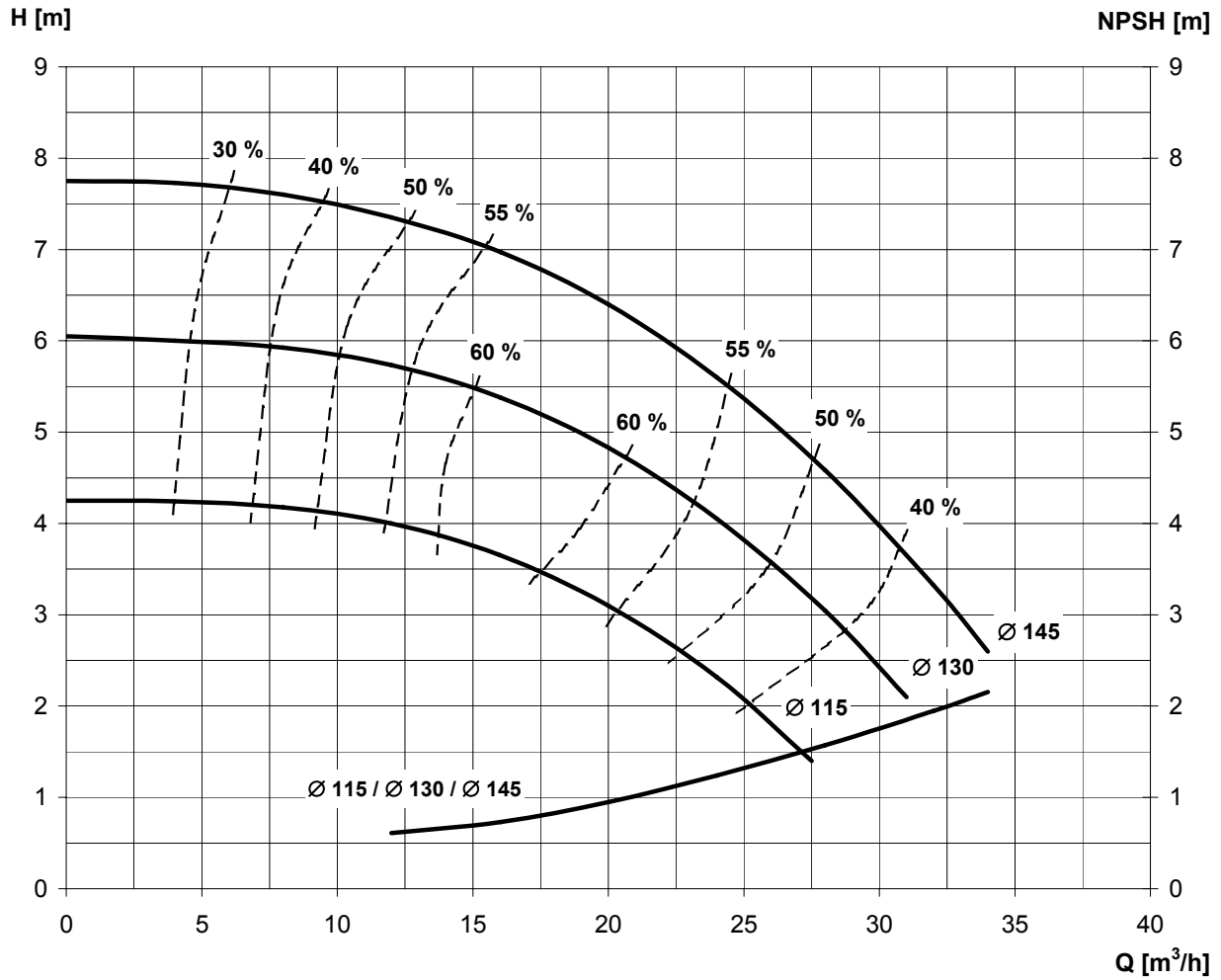


# Kennlinien

## FP 3520







zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

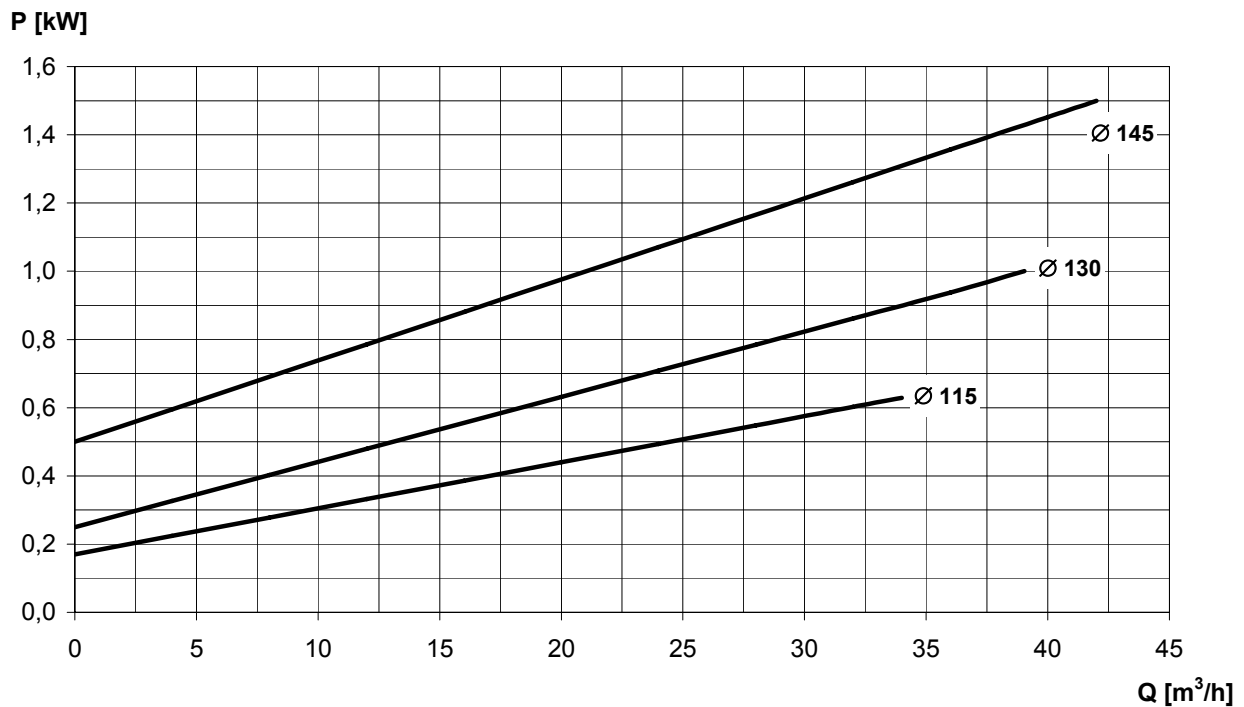
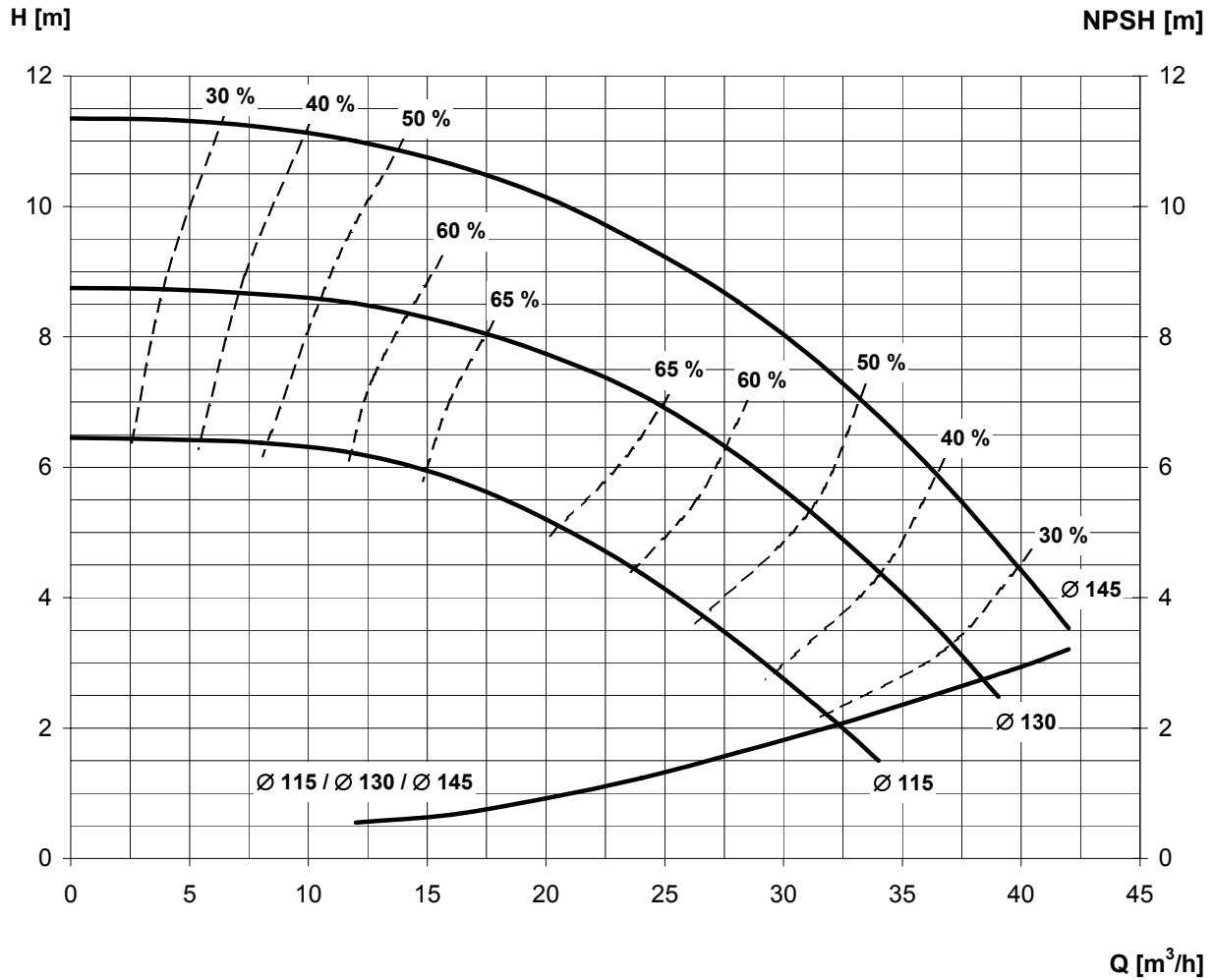
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Datum : 21.01.10

**FP 3521**

**Saugseite : DN 65**  
**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

**0428 81 1001**



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

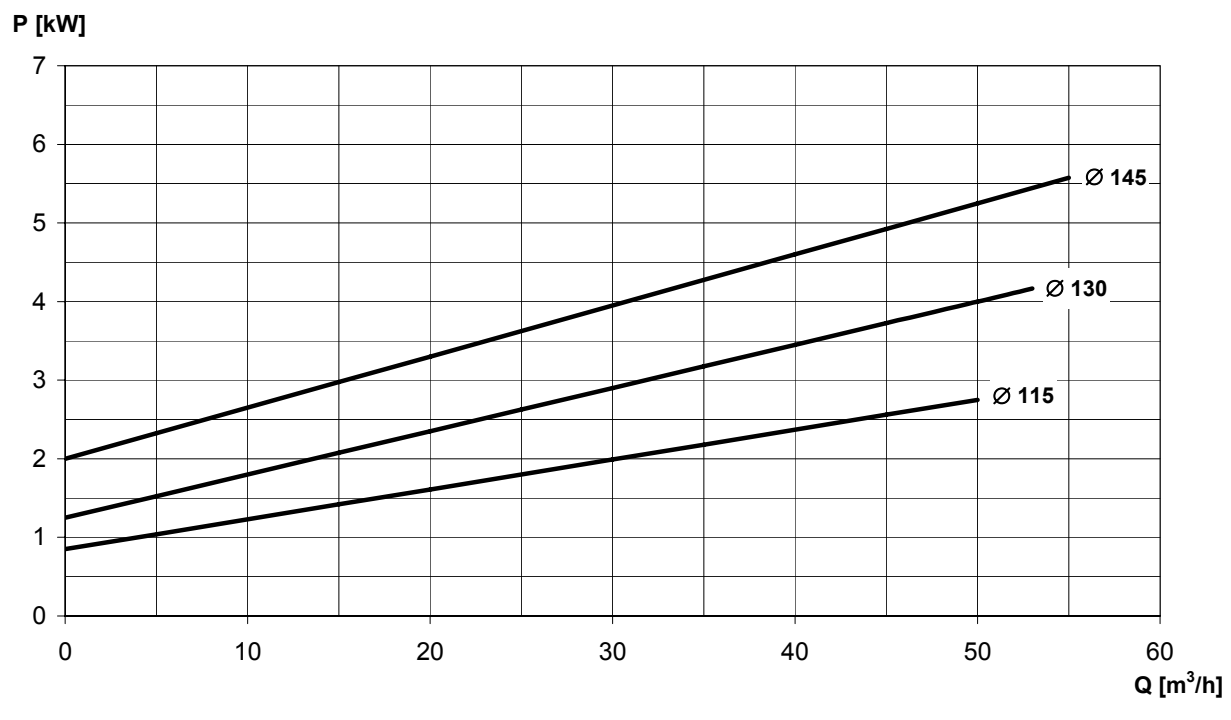
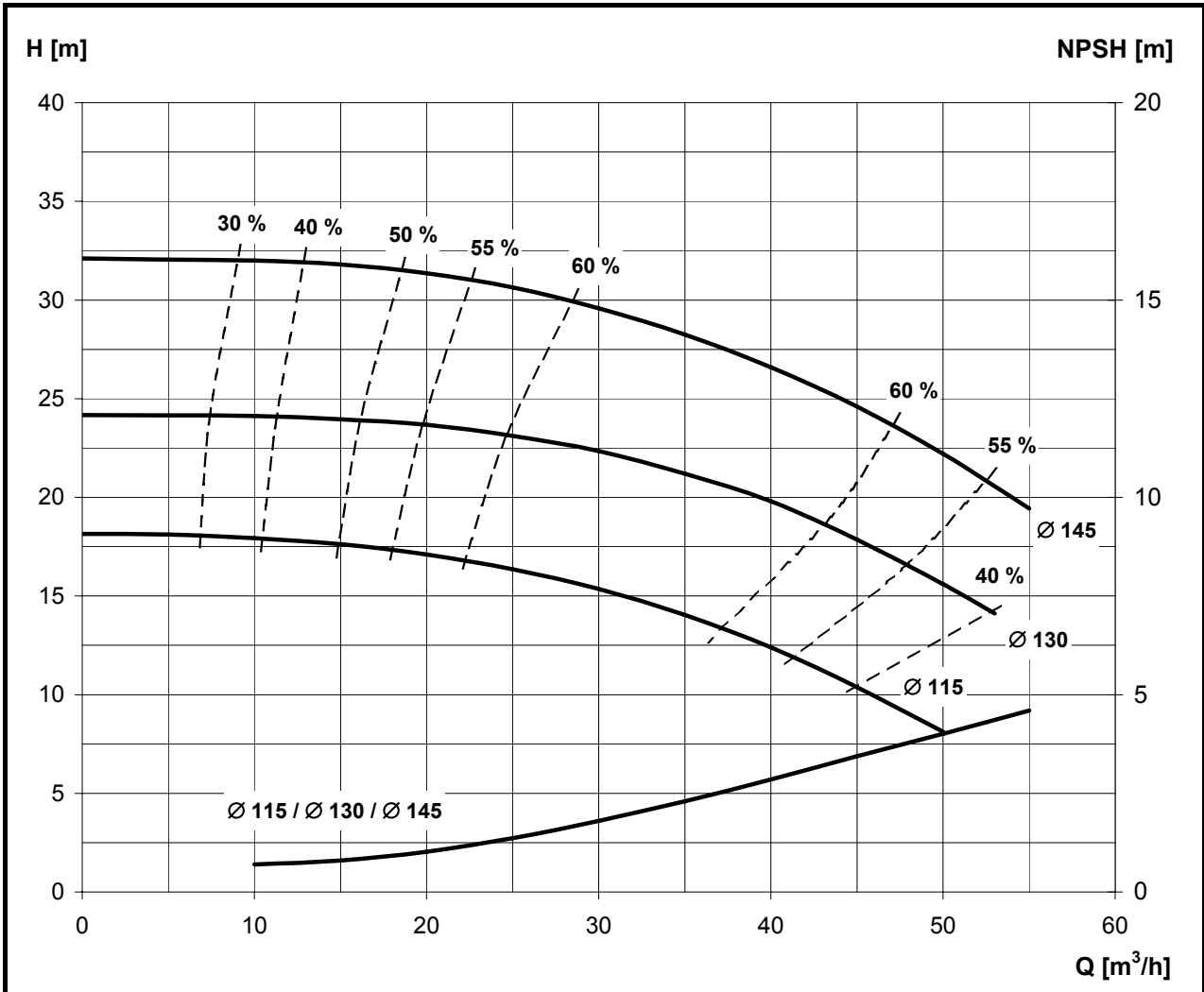
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**FP 3521**

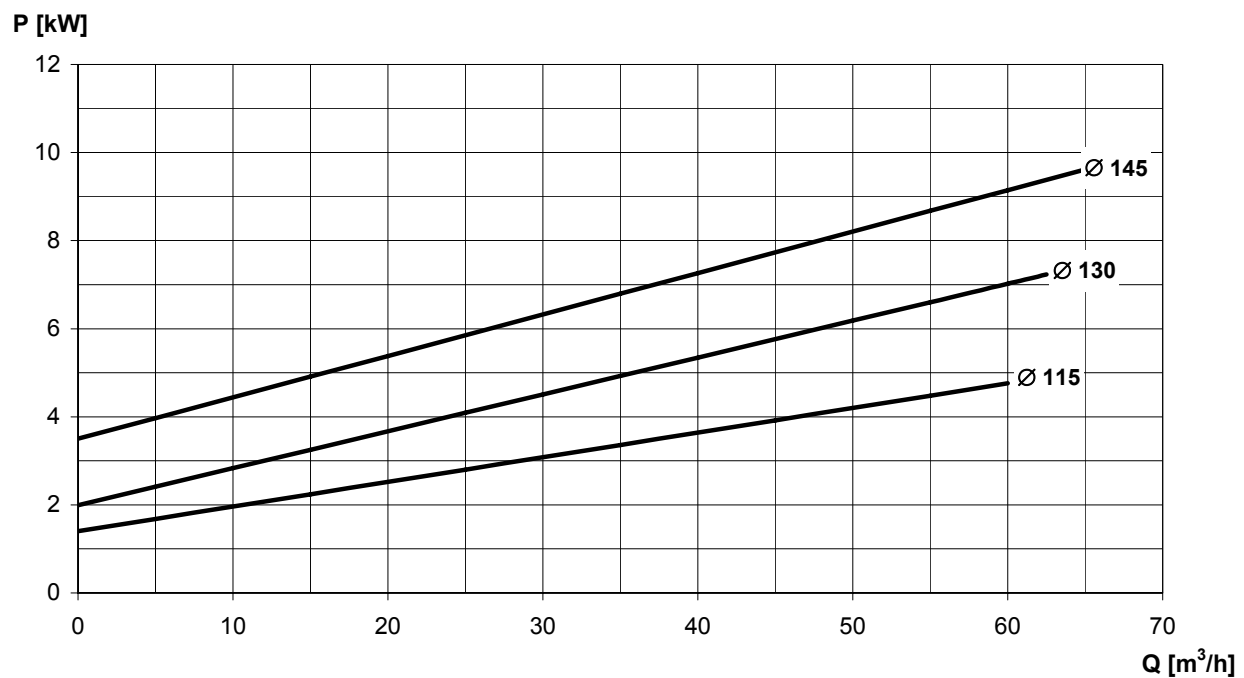
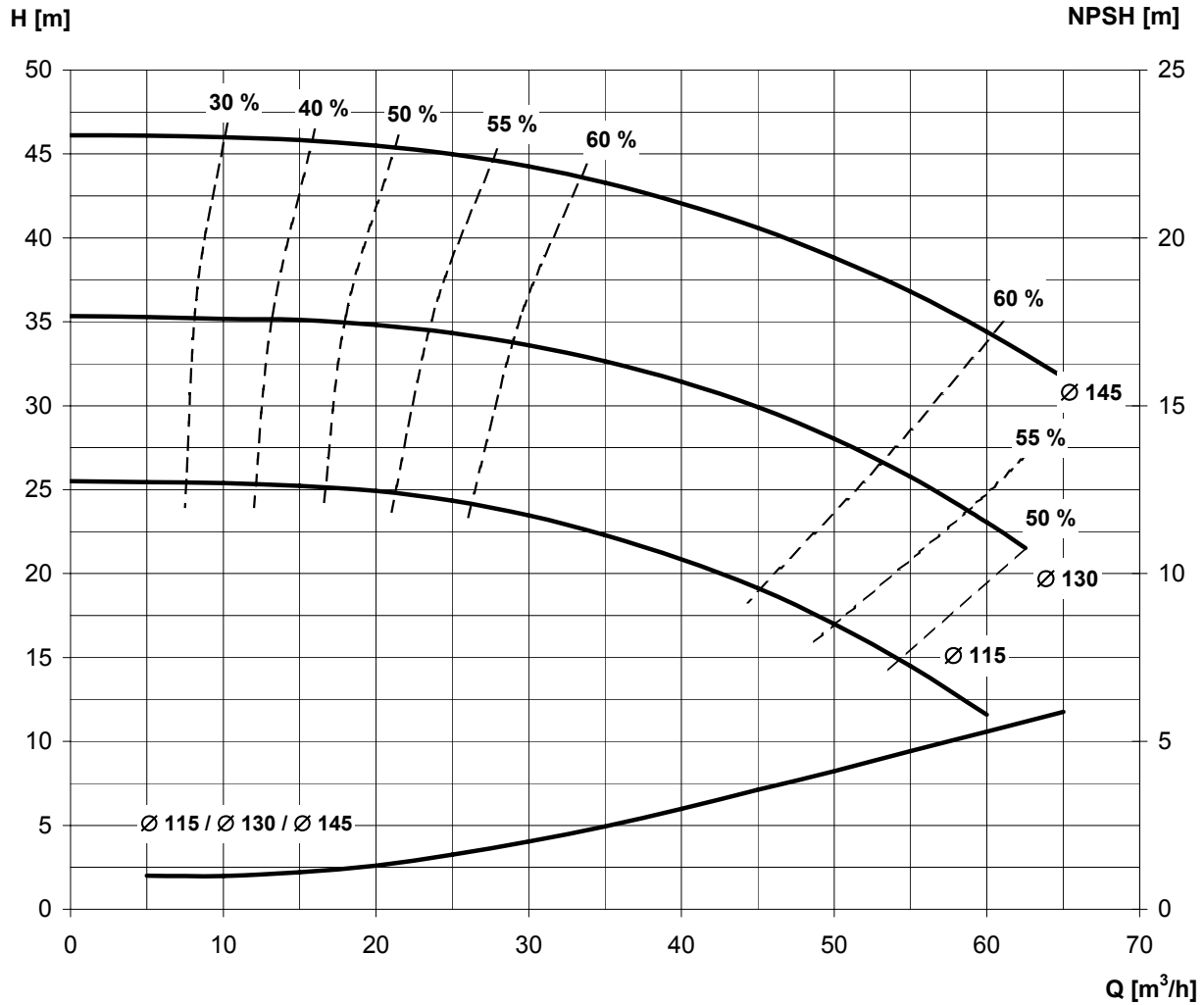
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**n = 1750 min<sup>-1</sup>**

**0428 83 1001**



zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Tho	<b>FP 3522</b>
	Datum : 21.01.10	
<b>Saugseite : DN 65</b> <b>Druckseite : DN 50</b>	<b>n = 2900 min<sup>-1</sup></b>	<b>0428 85 1001</b>



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

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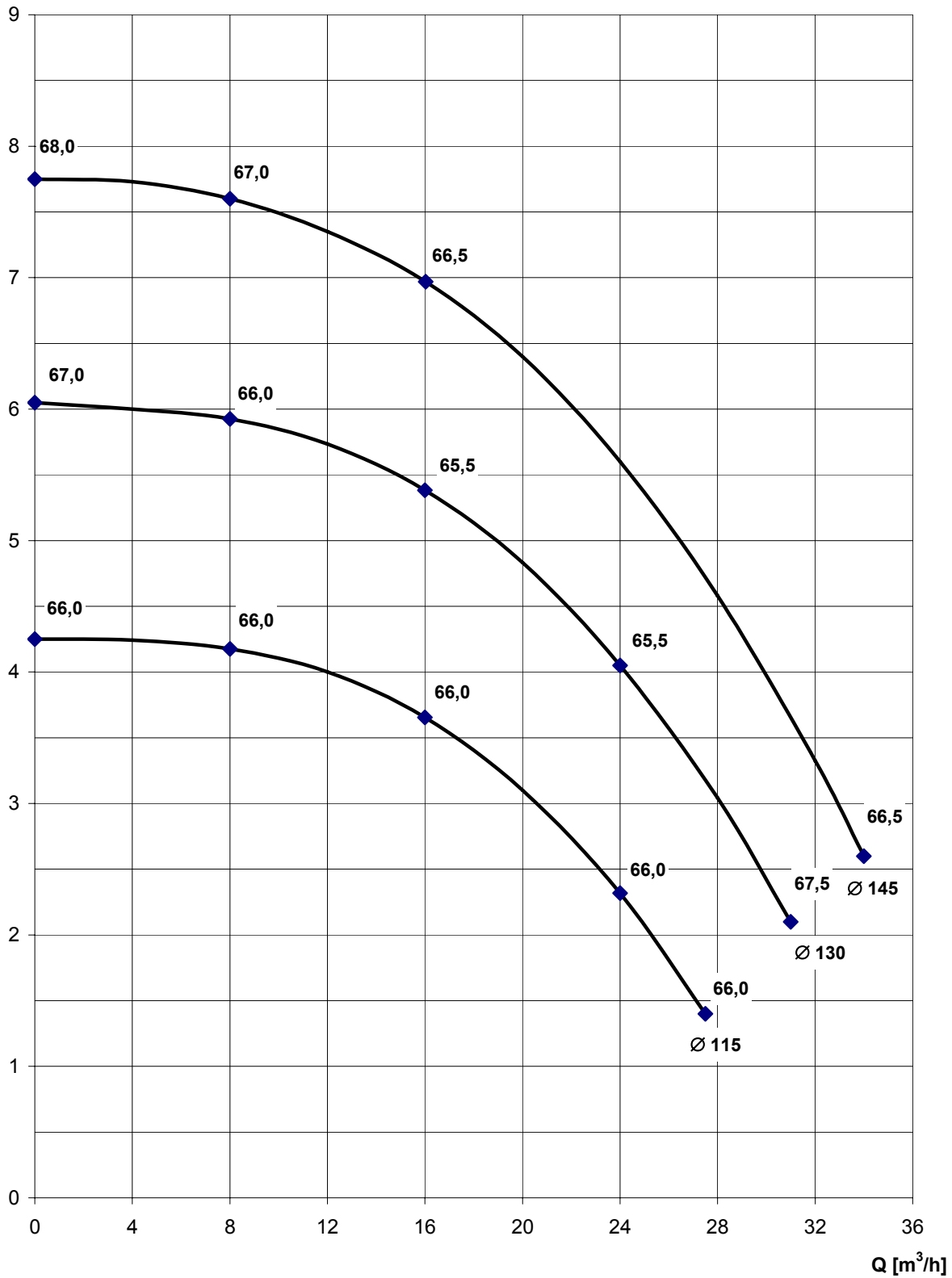
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**Druckseite : DN 50**

**n = 3500 min<sup>-1</sup>**

**0428 87 1001**

H [m]



Schalldruckangaben in [dB (A)]

zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

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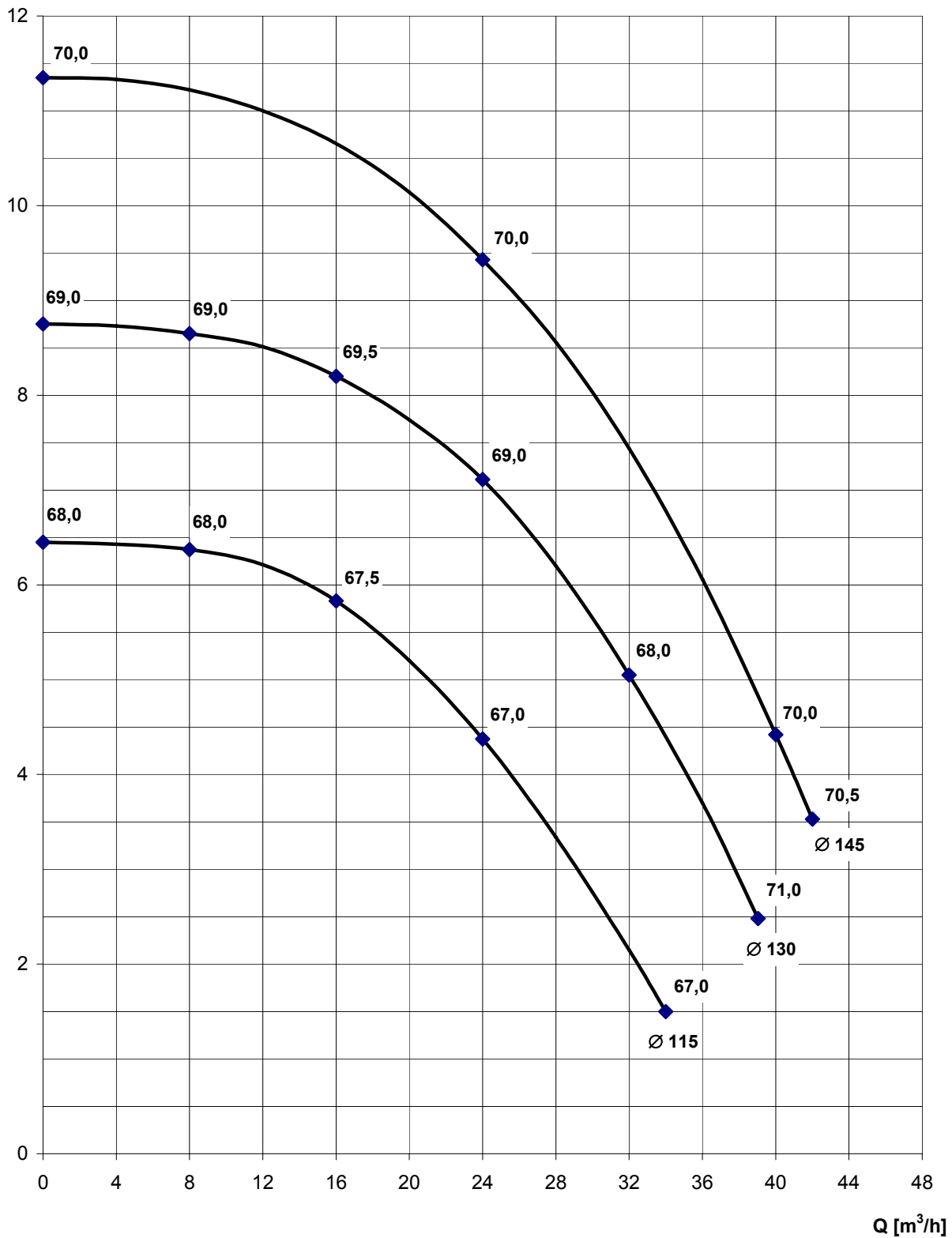
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**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

**0428 81 1002**

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Schalldruckangaben in [dB (A)]

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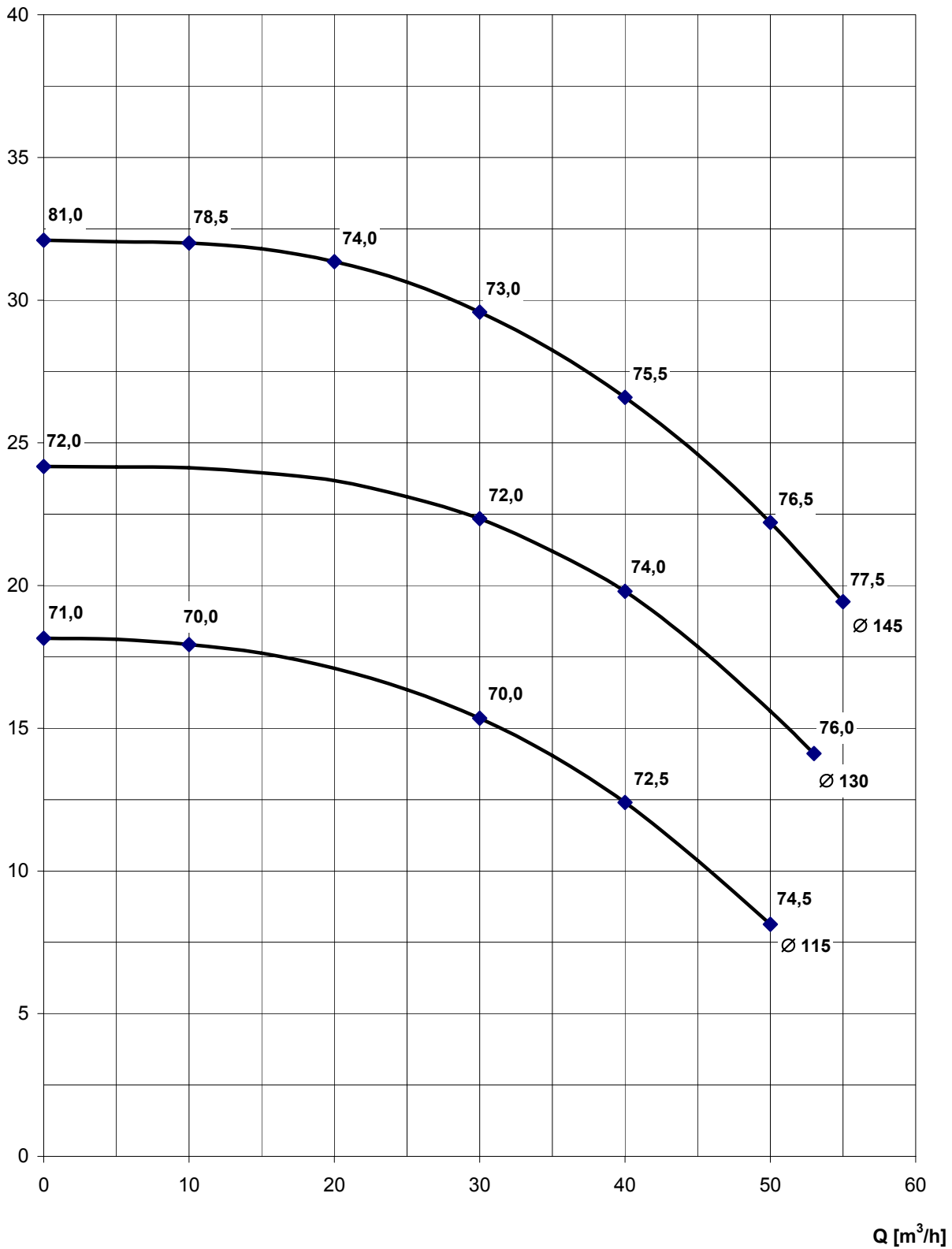
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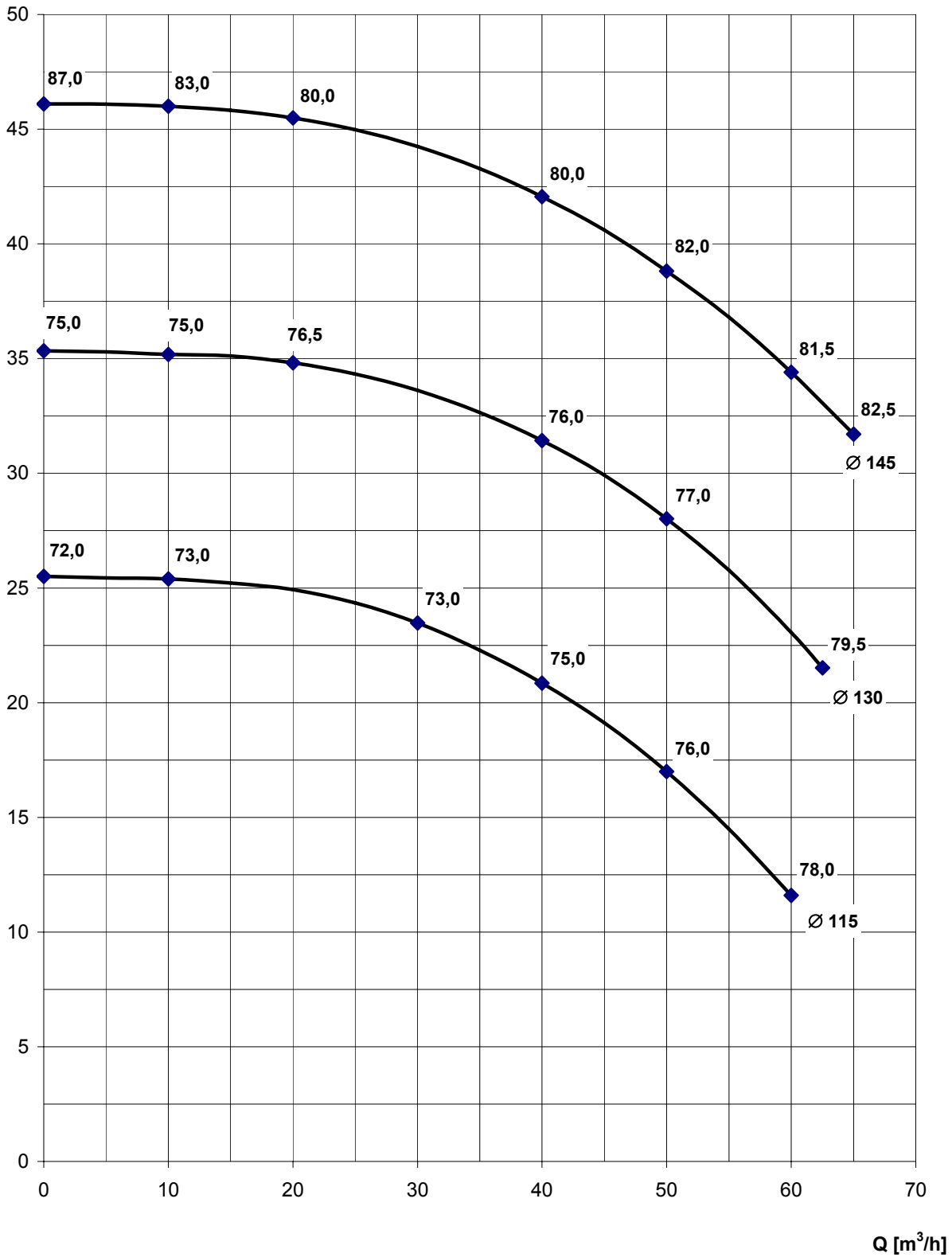
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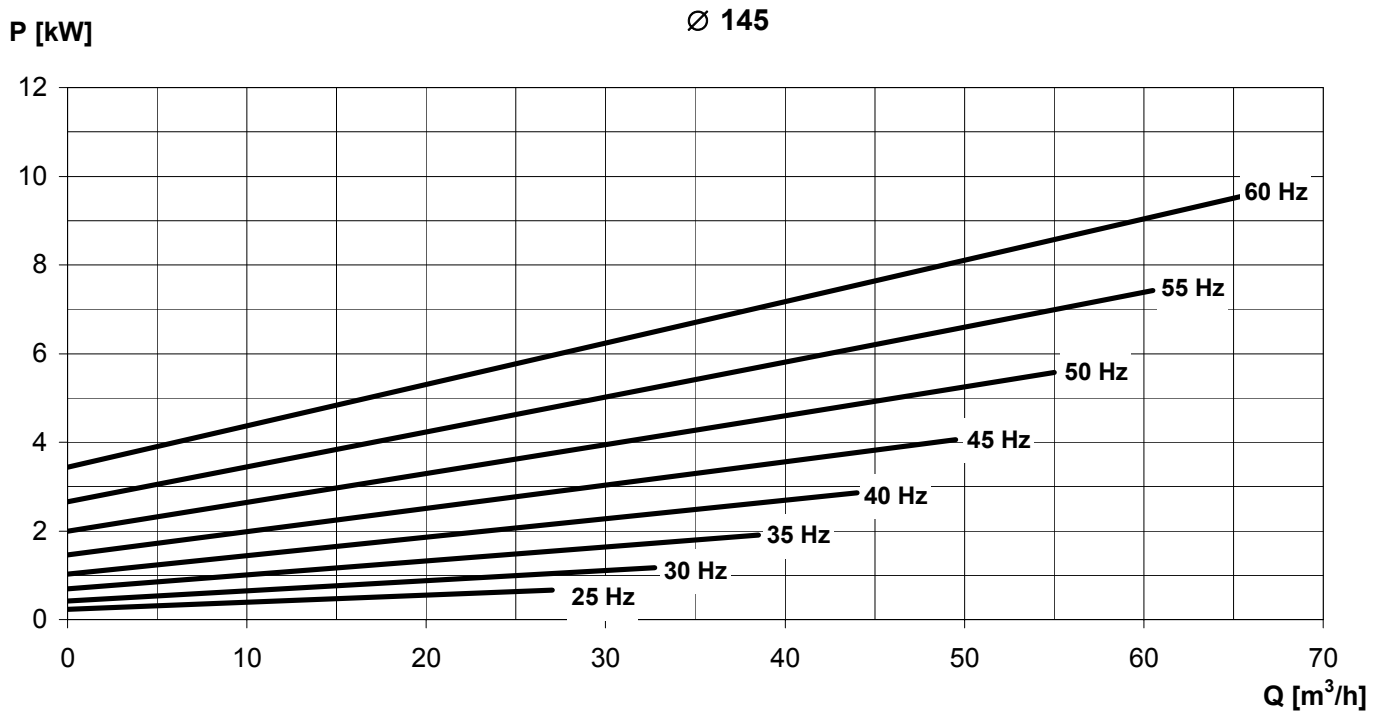
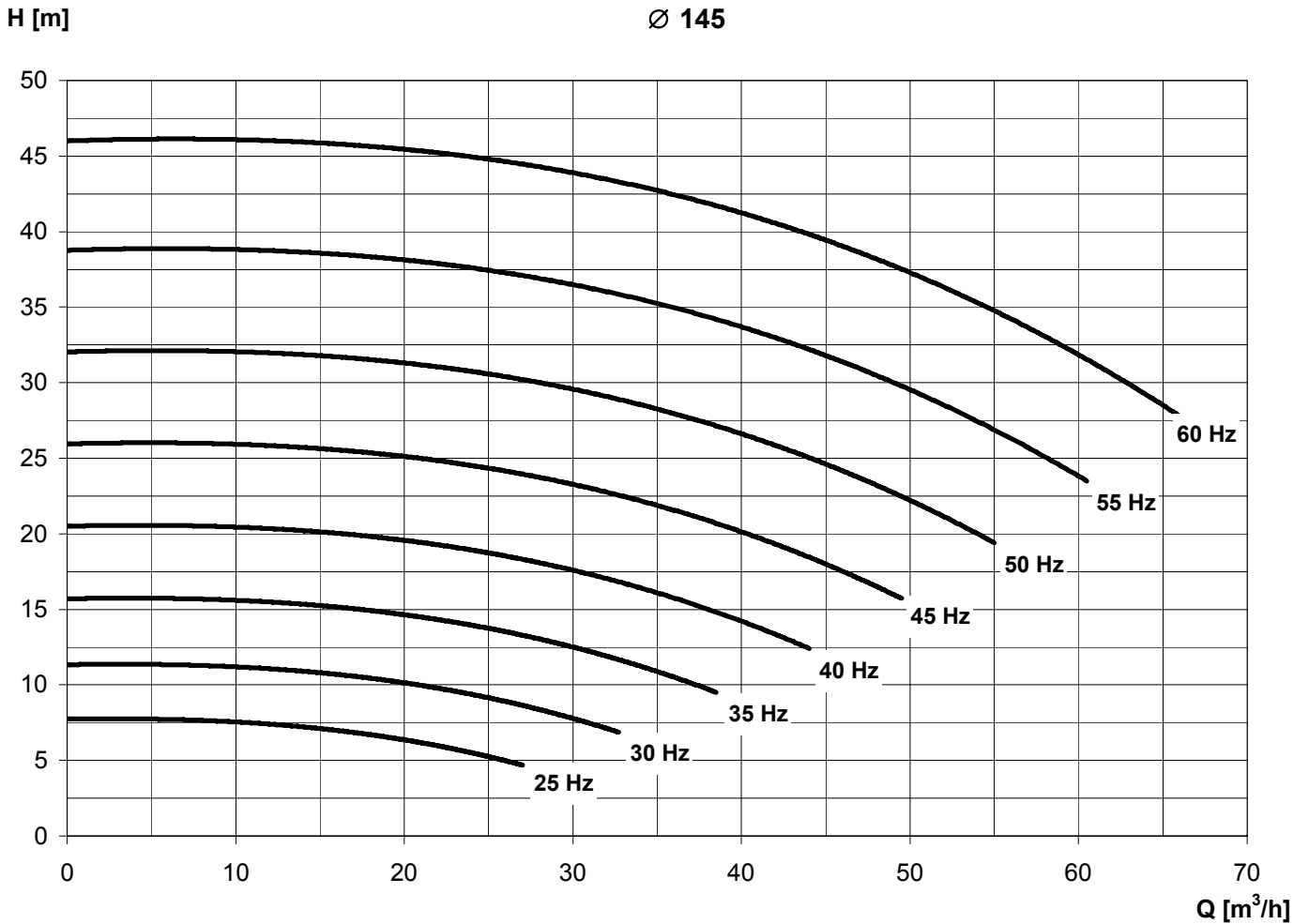
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**n = 3500 min<sup>-1</sup>**

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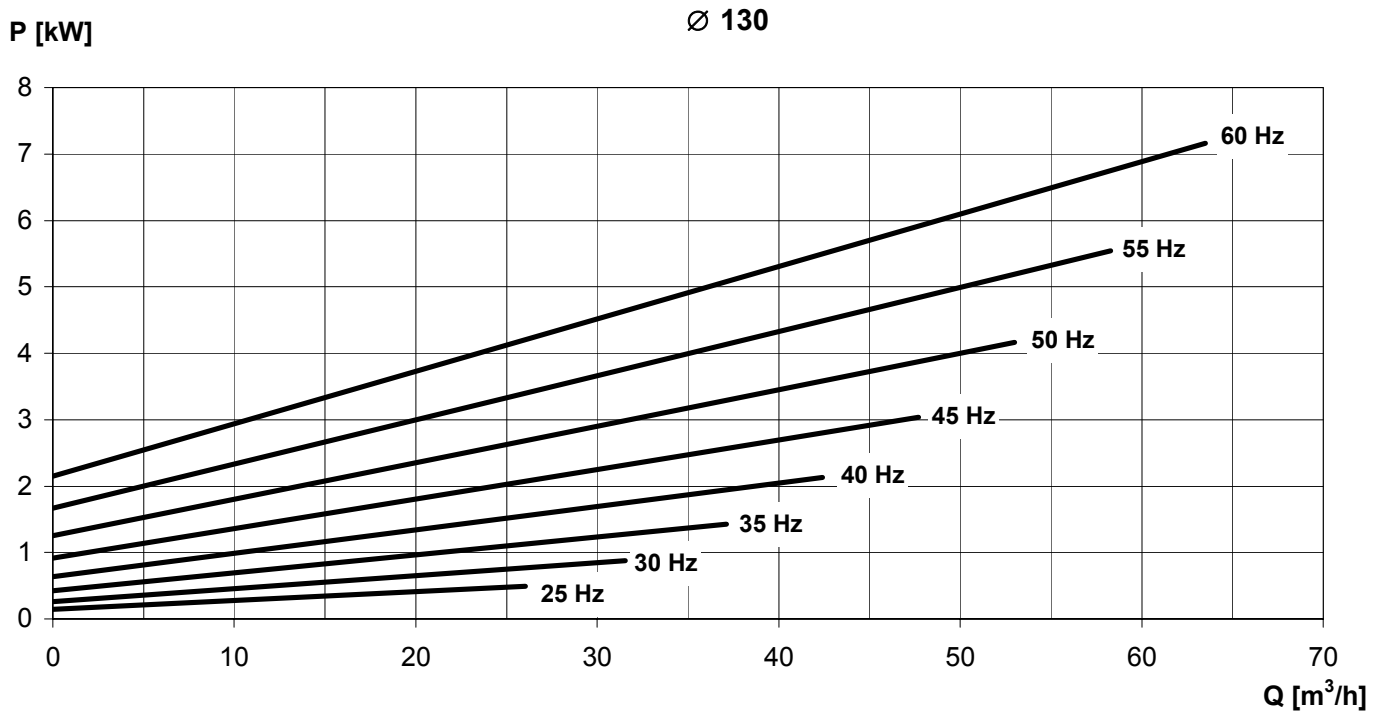
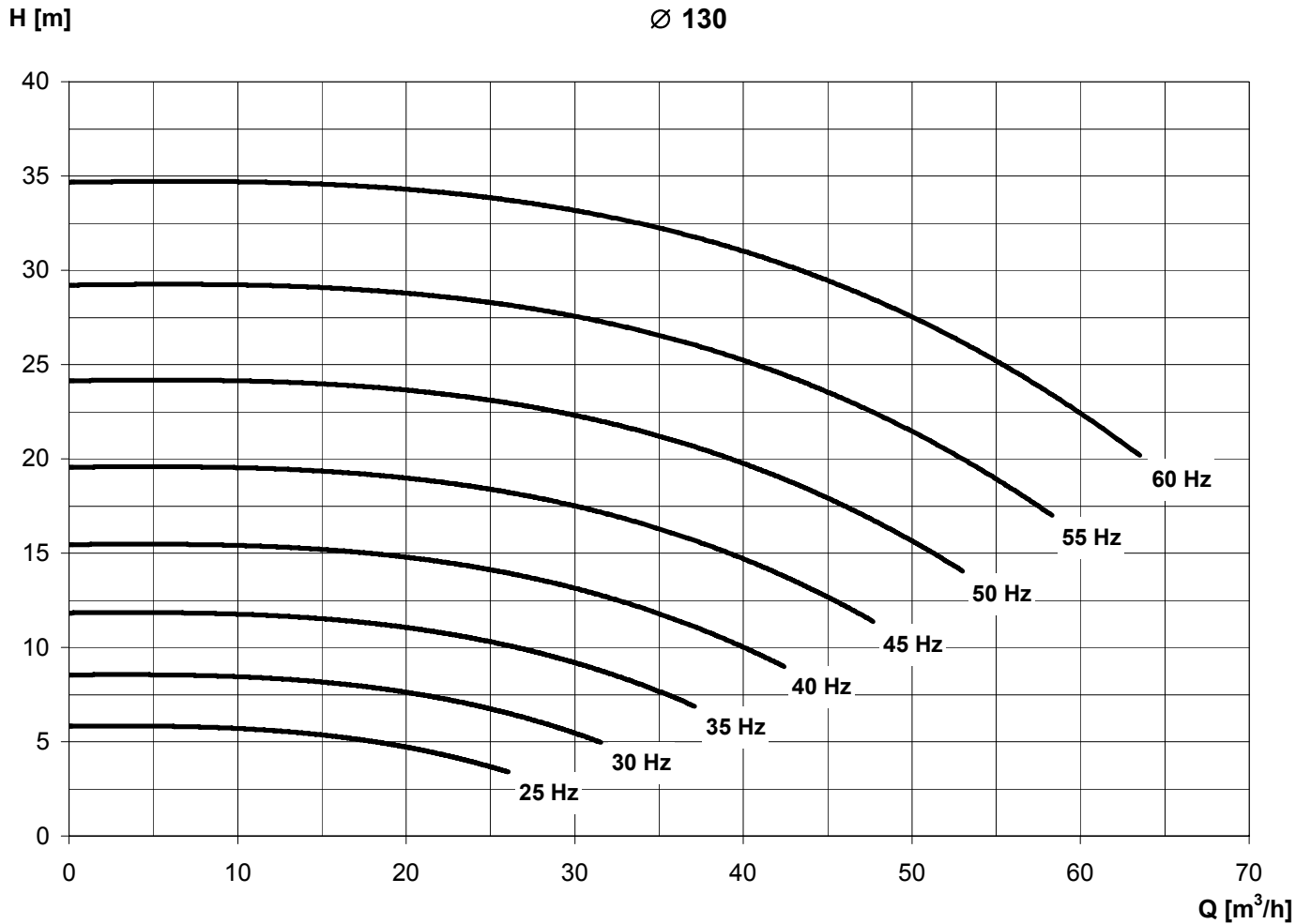
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**FP 3520**

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**Druckseite: DN 50**

**n = 1450 bis 3500 min<sup>-1</sup>**

**0428 89 1001**



zulässige Leistungsschwankungen ± 5%  
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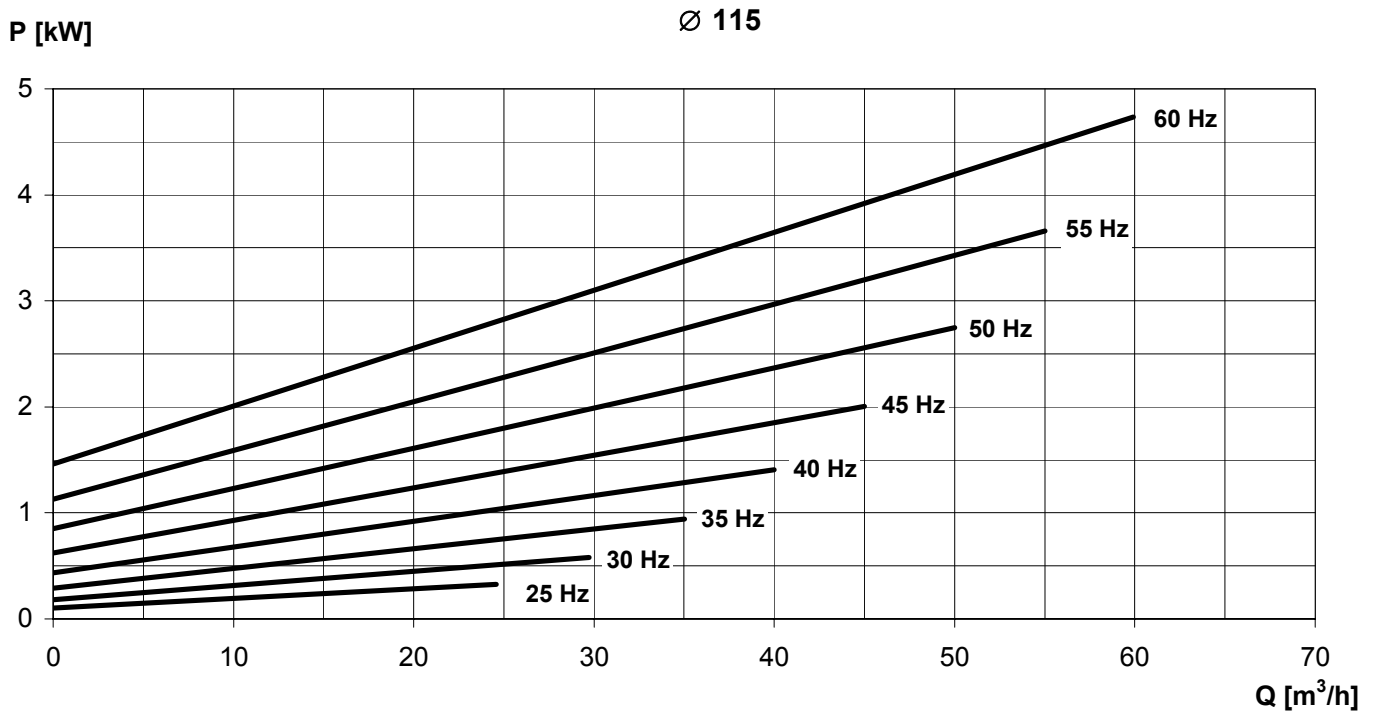
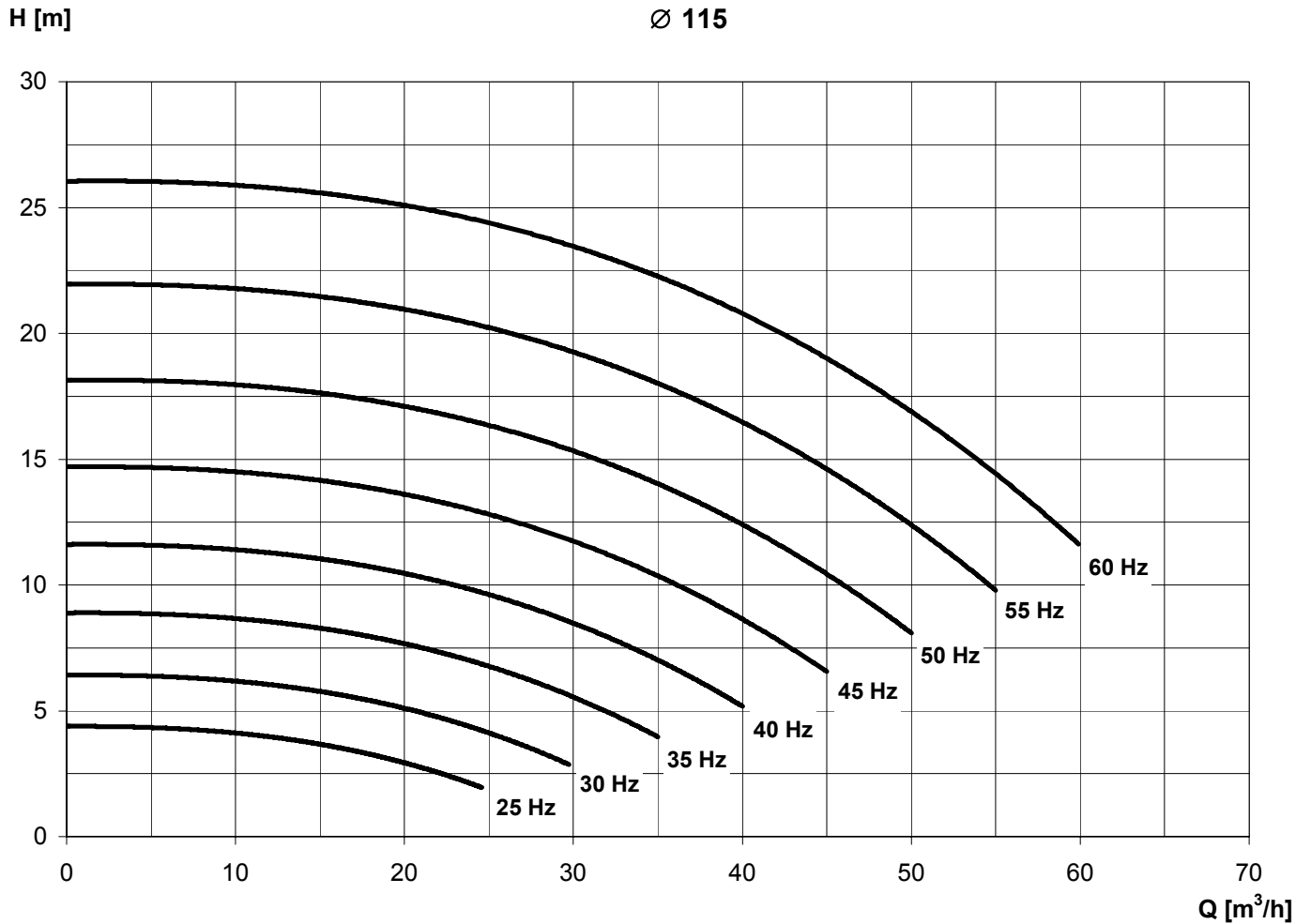
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**n = 1450 bis 3500 min<sup>-1</sup>**

**0428 89 1002**



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

Name : Tho  
Datum : 21.01.10

**FP 3520**

**Saugseite: DN 65**  
**Druckseite: DN 50**

**n = 1450 bis 3500 min<sup>-1</sup>**

**0428 89 1003**

Kreiselpumpe  
centrifugal pump

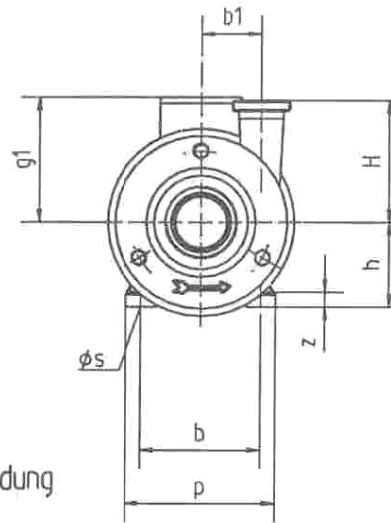
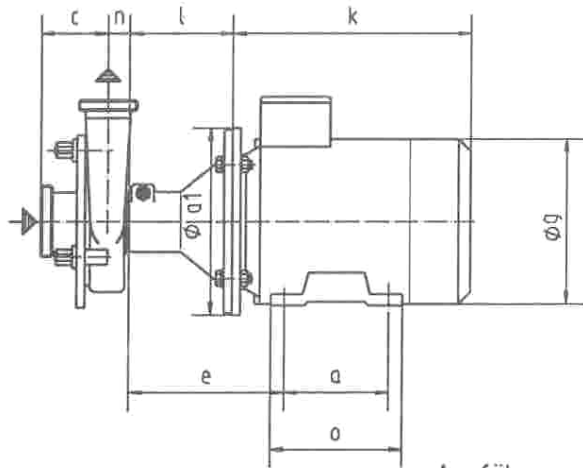
FPE 34 / 35 / 700

B

0,55 kW

bis  
7,5 kW

400 9 0 171 / 02.08



Maße  $\phi g$ ,  $g1$ ,  $k$  und Motor-  
gewichte sind abhängig  
vom Motorfabrikat

Dimensions  $\phi g$ ,  $g1$  and  $k$  and  
motor weights are dependent  
to motor execution

Maße unverbindlich

dimensions without  
obligation

Ausführung B: mit Motorfuß ohne Verkleidung  
execution B: with motor feet without shroud

**Pumpe**  
pump

Typ  
type

Typ type	b1	n	Gewindestutzen DIN 11851 thread DIN 11851 c - DN					H - DN					kg
			40	50	65	80	100	40	50	65	80	100	
FPE 711/712	58	22.5	83	83	83	--	--	147	147	--	--	--	9
FPE 721/722	79	22.5	83	83	74	92	--	150	160	--	--	--	14
FPE 741/742	96	28.5	--	72	72	108	110	--	195	212	--	--	22
FPE 3401/3402	55	23	64	100	--	--	--	120	156	--	--	--	7
FPE 3451/3452	141	33	--	--	85	95	112	--	182	200	240	--	24
<b>FPE 3521/3522</b>	<b>80</b>	<b>29</b>	<b>--</b>	<b>--</b>	<b>89</b>	<b>100</b>	<b>127</b>	<b>--</b>	<b>162</b>	<b>180</b>	<b>190</b>	<b>243</b>	<b>14</b>
FPE 3531/3532	95	31.5	--	--	87	105	124	--	162	180	190	243	15
FPE 3541/3542	115	33	--	--	89	99	99	--	218	182	200	220	19
FPE 3551	138	38	--	--	90	100	117	--	238	202	220	240	26

**Motor**  
motor

P [kW]  
n [1/min]

IEC  
Baugr.  
frame

P [kW]	n [1/min]	IEC Baugr. frame	a	$\phi a1$	b	e	$\phi g$	$g1$	h	k	l	o	p	$\phi s$	z	kg
1450	2900	80	100	200	125	178	159	129	80	255	125	153	9	10	9	
1750	3500	80	100	200	125	178	159	129	80	255	128	125	153	9	10	
0,55	0,75	80	100	200	125	178	159	129	80	255	128	125	153	9	10	
0,75	1,1	80	100	200	125	178	159	129	80	255	128	125	153	9	10	
1,1	1,5	90 S	100	200	140	184	176	148	90	244	130	170	9	11	13	
1,5	2,2	90 L	125	200	140	184	176	148	90	269	130	170	9	11	16	
2,2	3,0	100 L	140	250	160	201	196	155	100	303	176	195	12	13	23	
3,0	--	100 L	140	250	160	201	196	155	100	303	138	176	195	12	13	
<b>4,0</b>	<b>4,0</b>	<b>112 M</b>	<b>140</b>	<b>250</b>	<b>190</b>	<b>208</b>	<b>220</b>	<b>168</b>	<b>112</b>	<b>320</b>	<b>176</b>	<b>225</b>	<b>12</b>	<b>15</b>	<b>30</b>	
5,5	5,5	132 S	140	300	216	247	246	193	132	405	158	218	256	12	18	
--	7,5	132 S	140	300	216	247	246	193	132	405	158	218	256	12	18	
7,5	--	132 M	178	300	216	247	246	193	132	405	158	218	256	12	18	

## CENTRIFUGAL PUMPS FPE/FP...V Series



**Model:**

**Model No.:**



<b>1.</b>	<b>Disassembly</b>	<b>2</b>
1.1	General	2
1.2	Impeller	2
1.3	Complete disassembly	2
<b>2.</b>	<b>Assembly</b>	<b>2</b>
2.1	General	2
2.1.1	Setting the gap	2
2.1.2	Screw tightening torque	3
2.2	FPE assembly	3
2.3	FPE with double shaft seal	3

## 1. Disassembly

### 1.1 General



- Disconnect the pump from the power supply so that it is de-energised.
- If fitted, close the shut-off valve in the suction pipe and discharge pipe.
- Undo the suction/discharge connections and remove the pump from the system.



- In the case of dangerous pumping media, legal and works safety directions must be observed.



#### For highly polished surfaces:

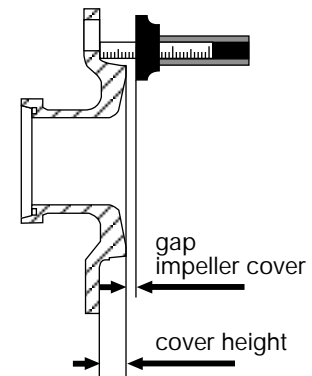
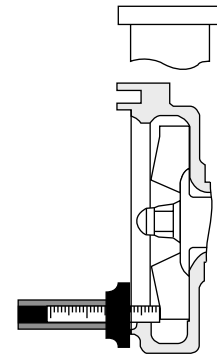
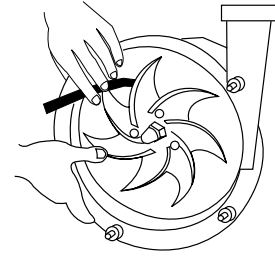
When tightening or untightening the impeller nut please use softer material tool inlets (copper sheet) in order to prevent surface damage.

### 1.2 Impeller and shaft seal

- Unscrew the cover and drain the pump, clean it, if necessary.
- Undo the impeller nut.
- Pull off the impeller from the shaft and remove the feather key.
- Carefully dismantle the shaft seal parts in accordance with the order-related documentation.

### 1.3 Complete disassembly

- Undo the clamping screw resp. hex-screws between casing and lantern (only for 1051/2, 1151/2, 1231/2, 1251/2, 101/102-200, 101/102-250).
- Pull off the casing.
- Undo the screws between the motor flange and clamping disc/lantern.
- Pull off the clamping disc/lantern.
- Undo the screws of the shrink-fit ring.
- Release the tensioning rings from the clamping ring.
- Pull off the pump's hollow shaft from the motor shaft.
- Pull off the shrink-fit ring from the pump's hollow shaft.



## 2. Assembly

### 2.1 General

Before assembling the pump, the following has to be done:

- The parts have to be cleaned.
- The sealing area has to be cleaned.
- All parts have to be checked for precision fit and, if necessary, reworked, with the exception of the sliding surfaces of the shaft seal.
- Worn parts have to be replaced.
- O-rings and gaskets always have to be replaced before assembly.

#### 2.1.1 Setting the gap

The gap size of the pump must be reset in accordance with Tab 1.

Pump Type	Axial gap	
	Impeller/cover	Impeller/casing
711/712	0.5 mm	
721/722		
741/742		
3401/3402		
3521/3522		
3531/3532	0.5 mm	1.0 mm
3541/3542	1.0 mm	
3451/3552		
3551/3552		
751/752		
1051/1052	0.7 mm	0.6 mm
1151/1152	2.0 mm	
1231/1232	1.0 mm	1.5 mm
1251/1252		
101/102-200	0.5 mm	1.2 mm
101/102-250		

Tab. 1: Gap sizes



## 2.1.2 Screw tightening torque

The screw tightening torque in the tables below must be complied with.

	M6	M8	M10	M12	M16	M20
Nm	10	25	49	85	210	420

Tab. 2: Class 8.8 steel screws

	M6	M8	M10	M12	M16	M20
Nm	7,3	17,5	35	60	144	281

Tab. 3: Stainless steel screws  
A2-70 and A4-70

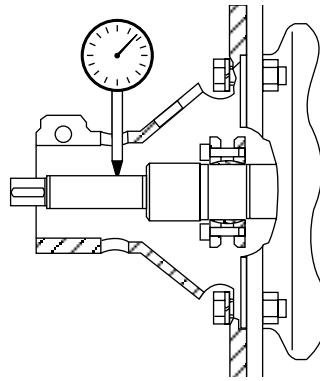
## 2.2 Pump assembly

1. Remove the feather key from the motor shaft.
2. Degrease the motor shaft and bore of the hollow shaft.
3. Insert half feather key into the motor shaft (only for bigger motors above > 30 kW).
4. Seal the motor shaft around the shaft shoulder with a sealing gel (e.g. Stucarit sealing gel 309).
5. Push the hollow shaft with shrink-fit ring onto the motor shaft up to the shaft shoulder.
6. Tighten the hexagon socket screws of the shrink-fit ring in diagonally opposite sequence (see Tab. 4).

Hexagon socket screw	Tightening torque
M5	6 Nm
M6	12 Nm

Tab. 4: Tightening torque for the fastening screws of the shrink-fit ring

7. Check the hollow shaft for concentricity and align.  
**Concentricity tolerance:**  
**max. 0,06 mm for motors below 30 kW**  
**max. 0,08 mm for motors above 30 kW**



8. Screw the clamping disc/lantern to the motor flange.
9. Insert the shaft seal housing or stationary ring with O-ring into the pump casing and secure (in accordance with the order-related documentation).
10. Screw pump casing and clamping disc/lantern together so as to be fingertight.
11. Fit the front seal set of the shaft seal. Cut the Nylon lock ring and put it into the prepared groove behind the thread of the shaft.
12. Insert the O-ring into the impeller nut. Push the impeller on to the pump shaft. Secure the impeller against twisting and tighten the impeller nut with 100 Nm.
13. Set the gap size of the cover, impeller and casing by shifting the pump casing within the clamped joint, resp. measure the gap size and adjust by fitting shims between casing and lantern (only for 1051/2, 1151/2, 1231/2, 1251/2, 101/102-200, 101/102-250) (see Tab. 1: Gap sizes).
14. Tighten the clamping screw with the following torque:
  - M 10 with 45 Nm
  - M 12 with 75 Nm
 or hex-screws with torque specified.
15. Place the cover with O-ring onto the casing and tighten.

## 2.3 Pumps with double shaft seal

1. Remove the feather key from the motor shaft.
2. Degrease the motor shaft and bore of the hollow shaft.



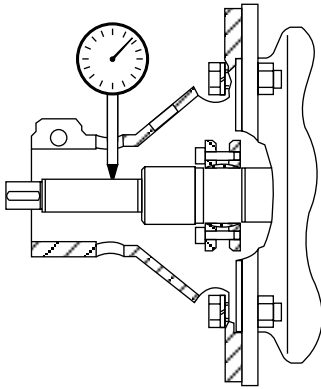
For pumps in FPE execution radial gasket needs to be fitted onto a speedy – sleeve.

3. Use a piece of pipe (length between 120 to 150 mm) to push the sleeve onto the shaft. Inner diameter of pipe 23 mm (for 22 mm shaft), 36 mm (for 35 mm shaft).



**For pumps in FPE execution with 22 mm shaft only:** Sealing cover with radial gasket to be fitted to pump housing. Flushing pipes in vertical direction, then threaded pins to be fixed manually.

4. Insert half feather key into the motor shaft (only for bigger motors above 30 kW).
5. Seal the motor shaft around the shaft shoulder with sealing gel (e.g. Stucarit sealing gel 309).
6. Push the hollow shaft with shrink-fit ring onto the motor shaft up the shaft shoulder.
7. Tighten the hexagon socket screws of the shrink-fit ring in diagonally opposite sequence (see Tab. 4).
8. Check the hollow shaft for concentricity and align.  
**Concentricity tolerance:**  
**max. 0,06 mm for motors below 30 kW**  
**max. 0,08 mm for motors above 30 kW**



9. Screw the clamping disc/lantern to the motor flange.

**For pumps in FP...V execution only:** Push rear mechanical seal unit onto the shaft (according to the order-related documentation).

10. Insert the shaft seal housing or stationary ring with O-ring into the pump casing and secure (in accordance with the order-related documentation).
11. Screw pump casing and clamping disc/lantern together so as to be fingertight.
12. Flushing pipes to screw into the sealing cover to be sealed with sealing paste.
13. Fit the front seal set of the shaft seal. Cut the Nylon lock ring and put it into the prepared groove behind the thread of the shaft.
14. Insert the O-ring into the impeller nut. Push the impeller on to the pump shaft. Secure the impeller against twisting and tighten the impeller nut with 100 Nm.
15. Set the gap size of the cover, impeller and casing by shifting the pump casing within the clamped joint, resp. measure the gap size and adjust by fitting shims between casing and lantern (only for 1051/2, 1151/2, 1231/2, 1251/2, 101/102-200, 101/102-250) (see Tab. 1: Gap sizes).

16. Tighten the clamping screw with the following tightening torque:
- M 10 with 45 Nm
  - M 12 with 75 Nm
- or hex-screws with torque specified.

17. Place the cover with O-ring onto the casing and tighten.



Each time the impeller is assembled, a check must be made to ensure that it does not chafe at any point, and the Nylon lock ring has to be replaced.





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## Australia

Fristam Australia Pty. Ltd.  
Bayswater, VIC

## Austria

Fristam Pumpen GmbH  
Vienna

## Belgium

**Luxembourg**  
Fristam N.V.  
Aartselaar

## France

Pompes Fristam S.A.  
Noisy-le-Sec

## Great Britain

Fristam Pumps (UK) Ltd.  
Hailsham

## India

Fristam Pumps (I) Pvt. Ltd.  
Pune

## Italy

Fristam Italia S.r.l.  
Borgo Ticino (NO)

## Japan

Stamp Pumps of Japan  
Ltd.  
Tokio

## Netherlands

Fristam B.V.  
De Meern

## New Zealand

Fristam Pumps Ltd.  
Cambridge

## Poland

Fristam Polska Sp.z.o.o.  
Warsaw

## Russian Federation

Fristam Pumpen R.A.  
Moskow

## Scandinavia

Fristam Pumper A/S  
Saeby

## South/East Asia

Fristam Pumpen (S.E.A.)  
Pte.Ltd.  
Singapore

## Ukraine

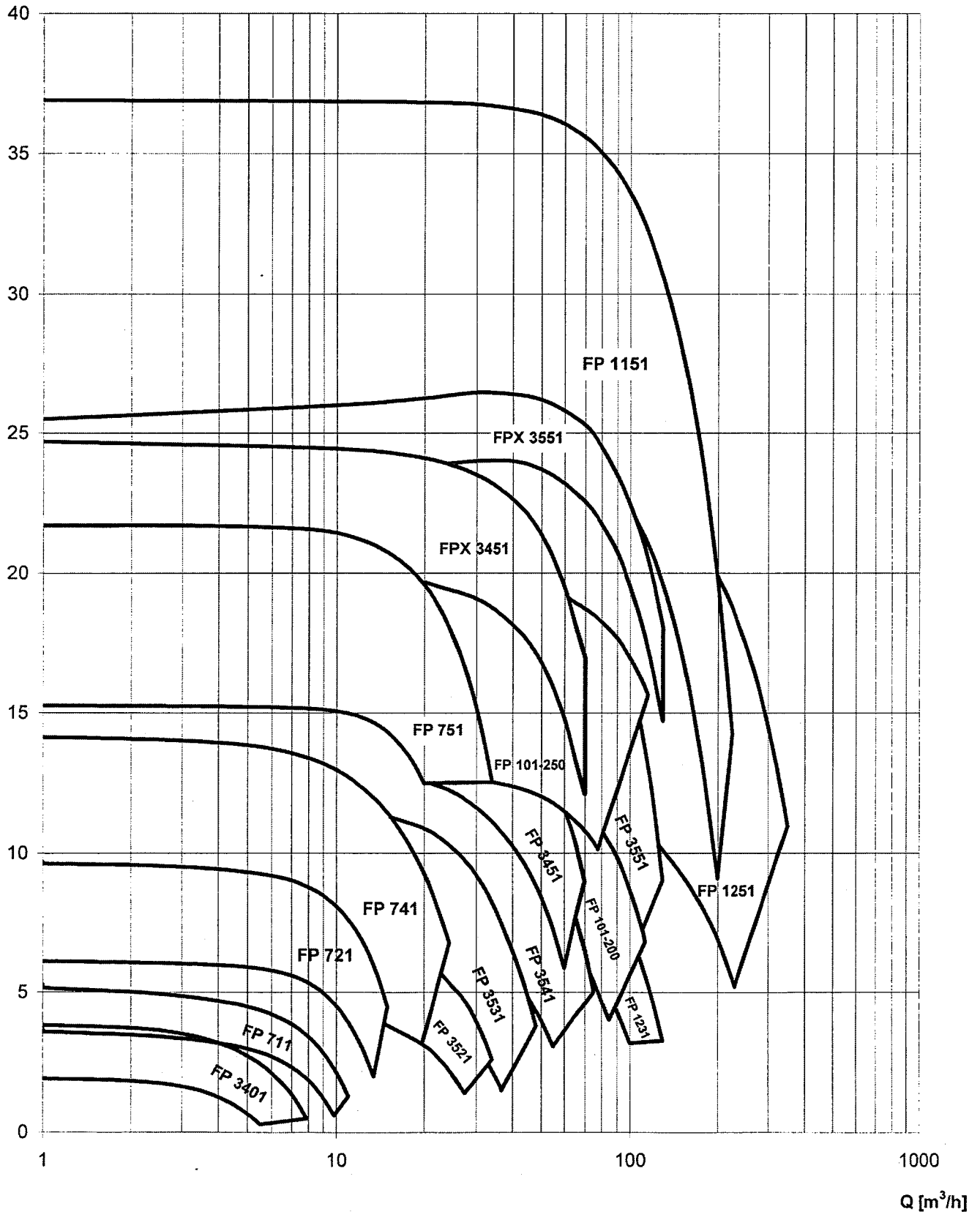
Fristam Kiev Ltd.  
Kiev

## USA/Canada

**Mexico**  
**South America**  
Fristam Pumps, Inc.  
Middleton, WI

## Kreiselpumpen FP / Centrifugal Pumps FP n=1450 min<sup>-1</sup>

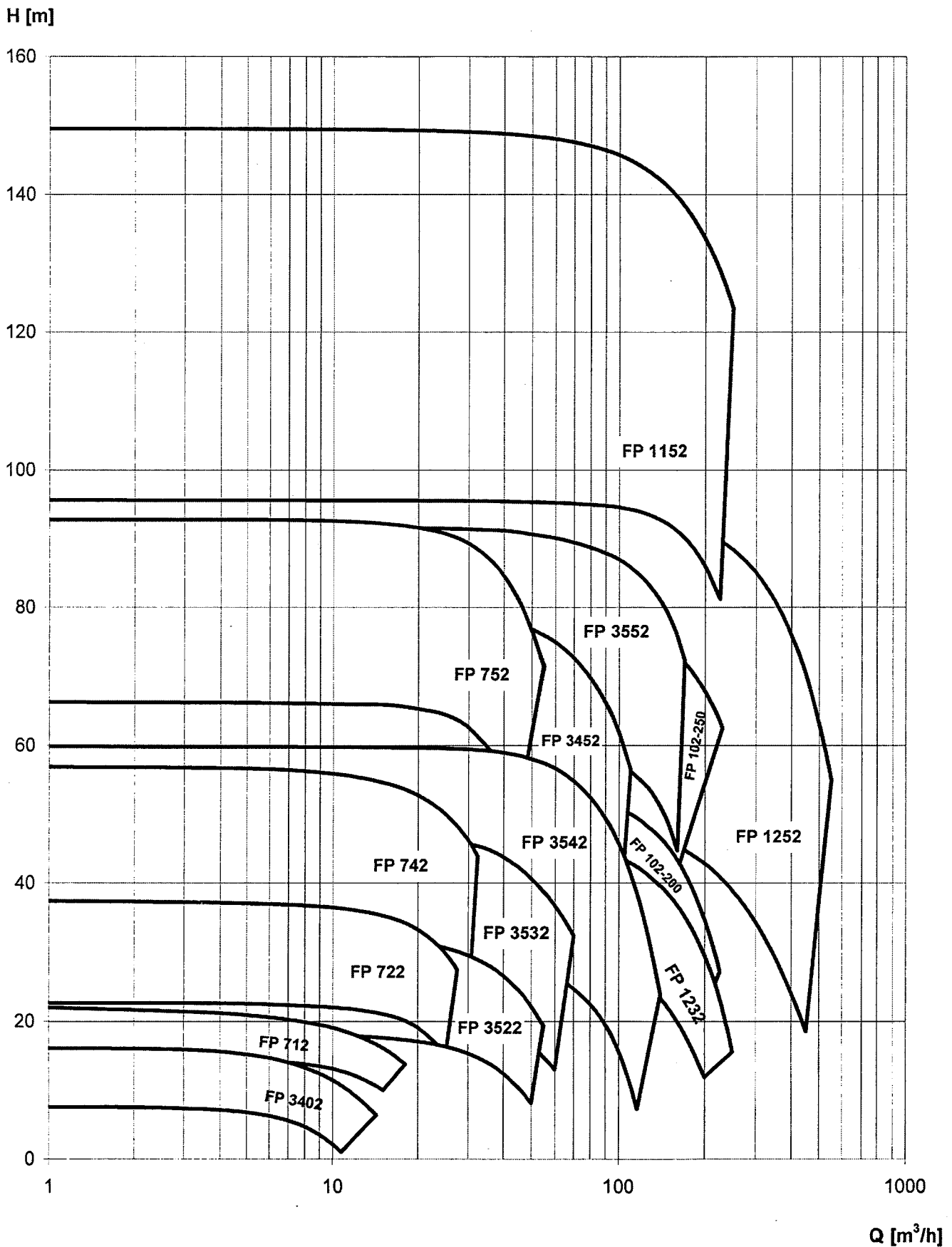
H [m]



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

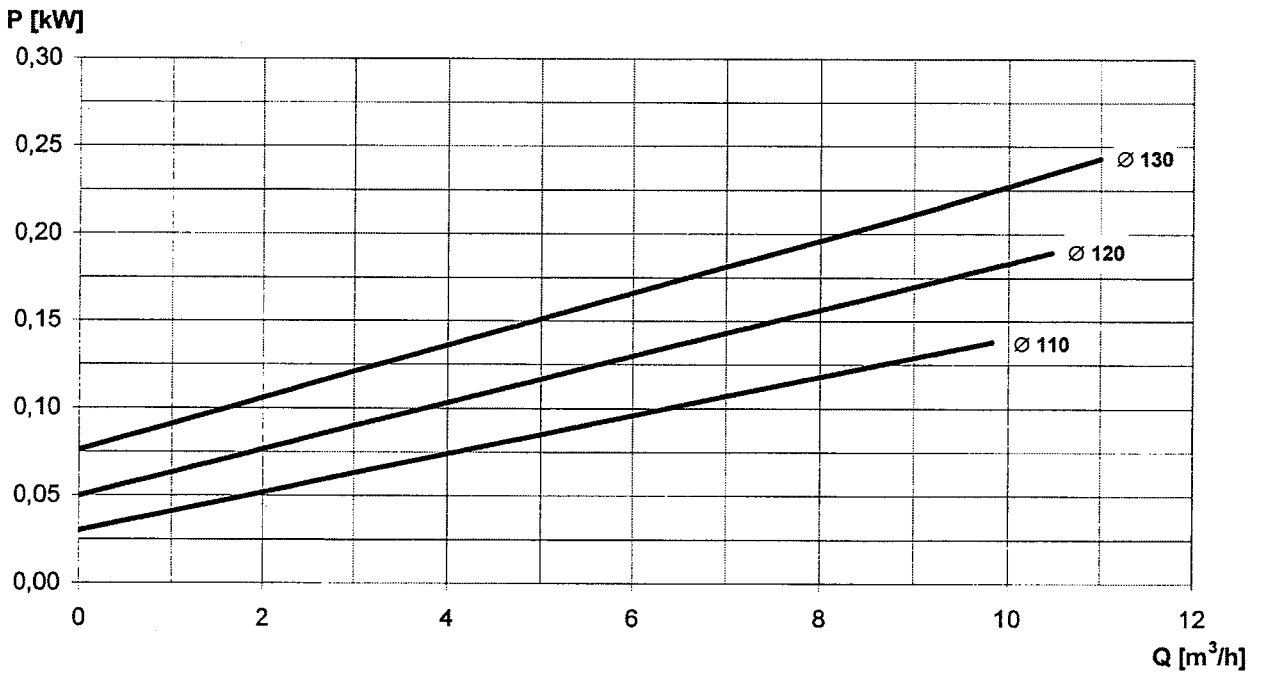
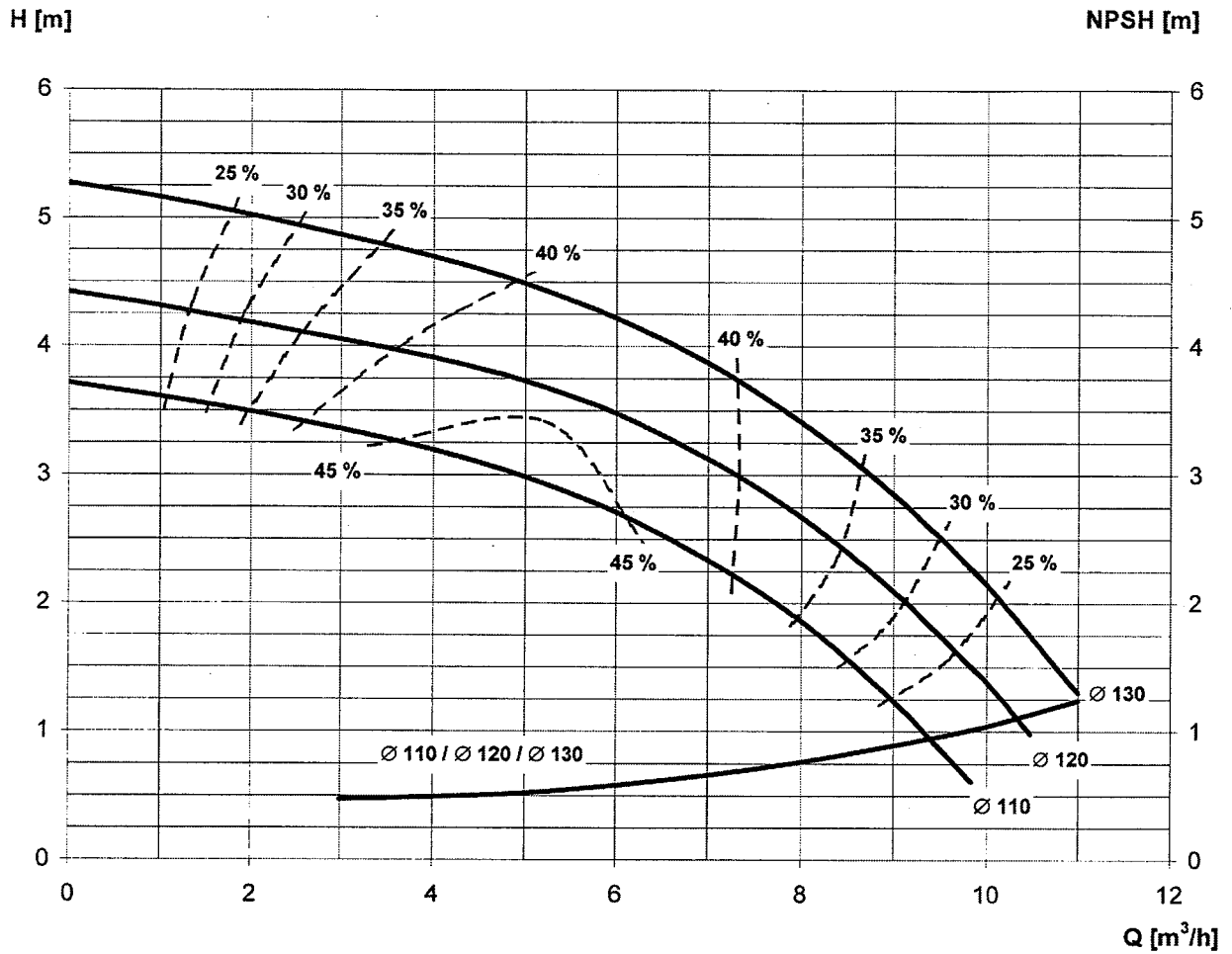
0400 71 1002 / 07.03

## Kreiselpumpen FP / Centrifugal Pumps FP n=2900 min<sup>-1</sup>



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

0400 75 1002 / 07.03



zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei 20°C

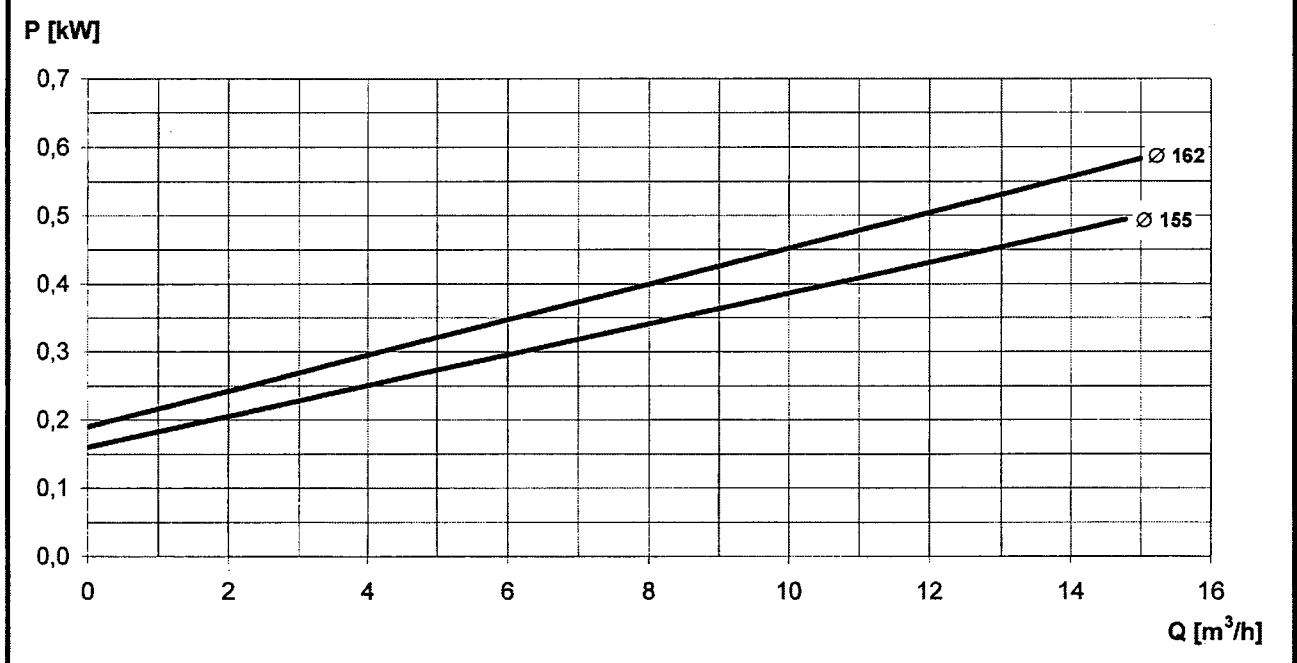
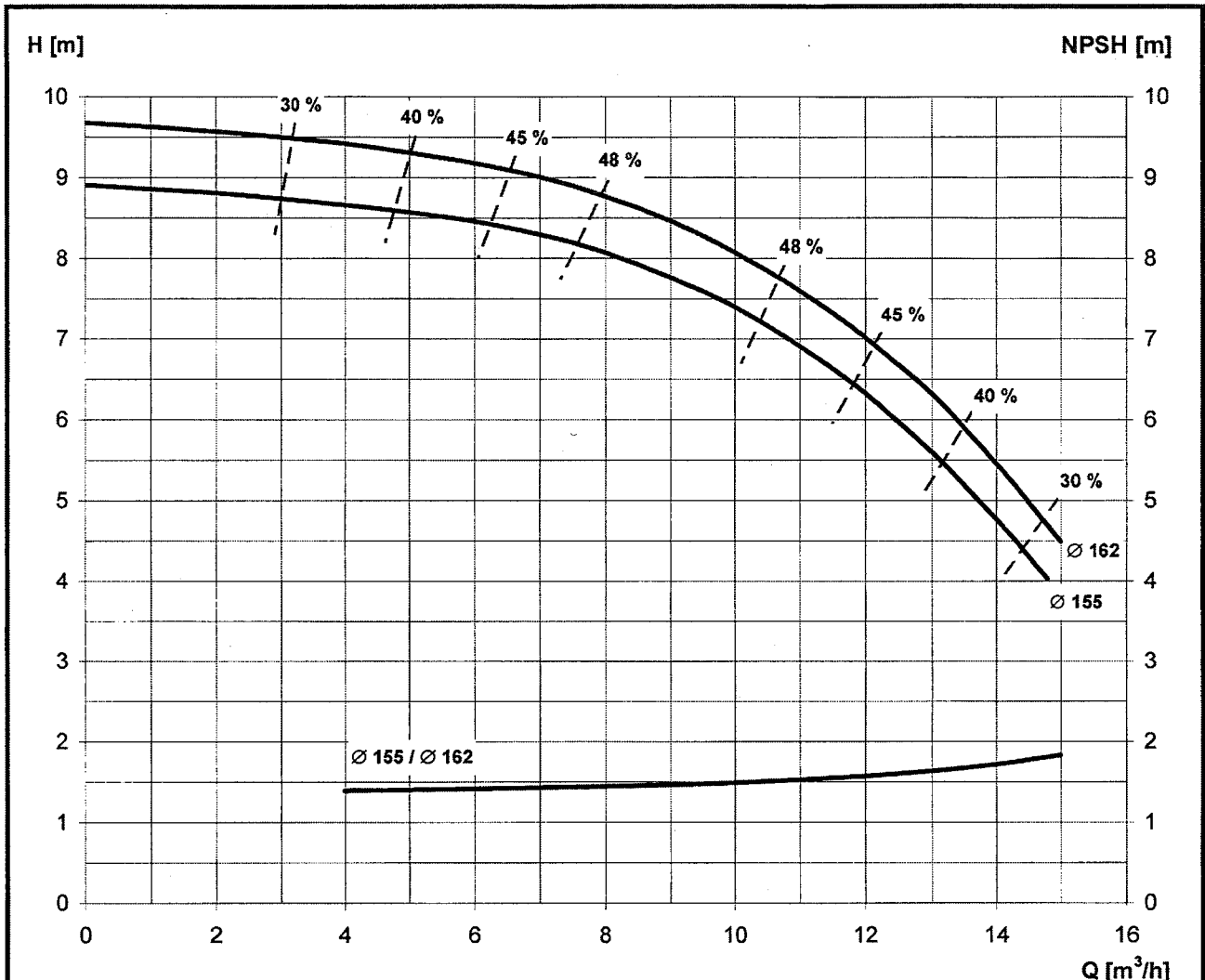
Name : Thomsen  
 Datum : 27.04.00

**FP 711**

**Saugseite : DN 40**  
**Druckseite : DN 40**

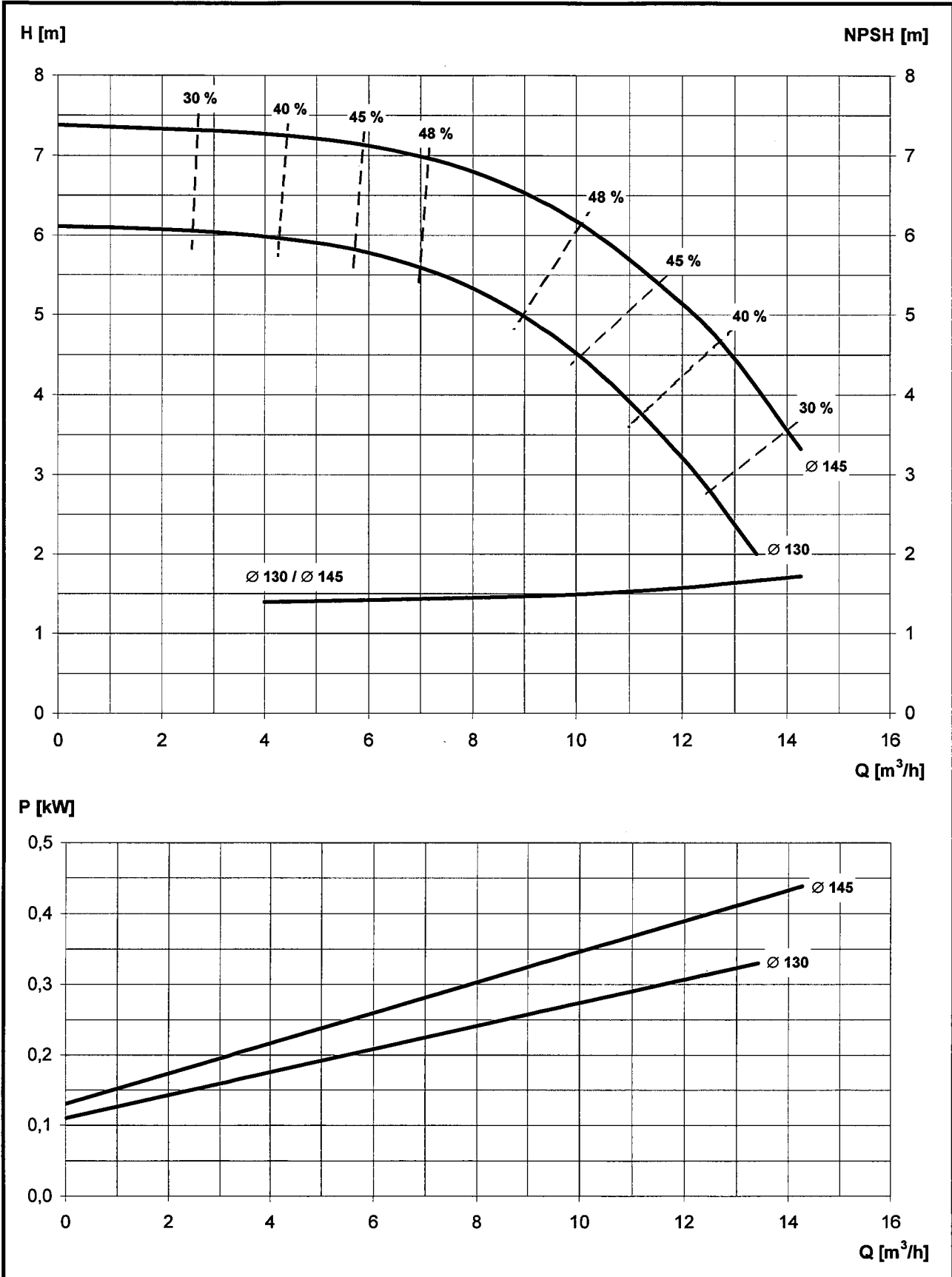
$n = 1450 \text{ min}^{-1}$

**0413 81 1001**

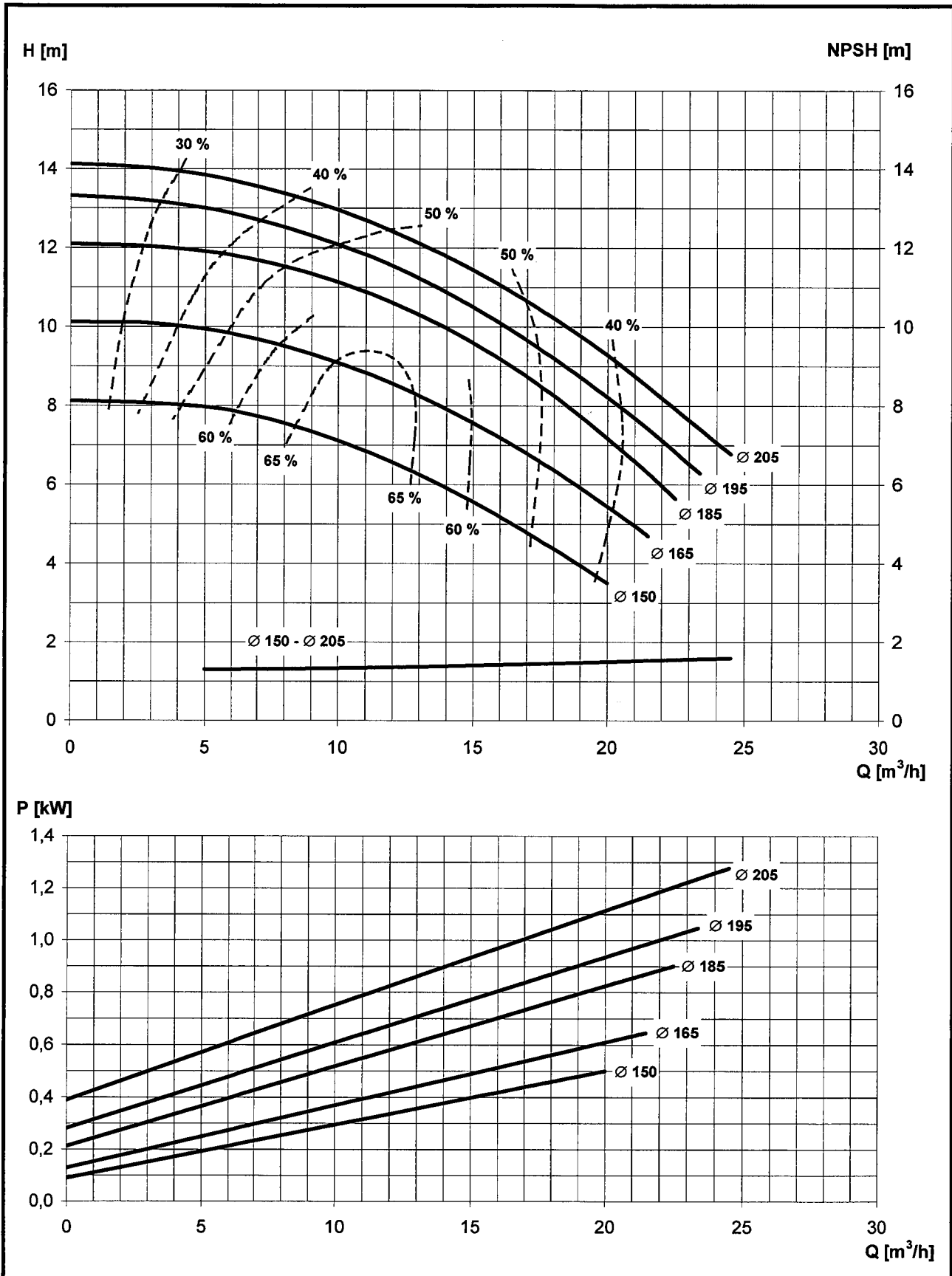


zulässige Leistungsschwankungen $\pm 5\%$ alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 721 - BE</b>
	Datum : 25.07.00	
<b>Saugseite : DN 40</b> <b>Druckseite : DN 40</b>	<b><math>n = 1450 \text{ min}^{-1}</math></b>	<b>0423 81 1001</b>





zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 721</b>
	Datum : 25.07.00	
<b>Saugseite : DN 40</b> <b>Druckseite : DN 40</b>	<b>n = 1450 min<sup>-1</sup></b>	<b>0423 81 1003</b>



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

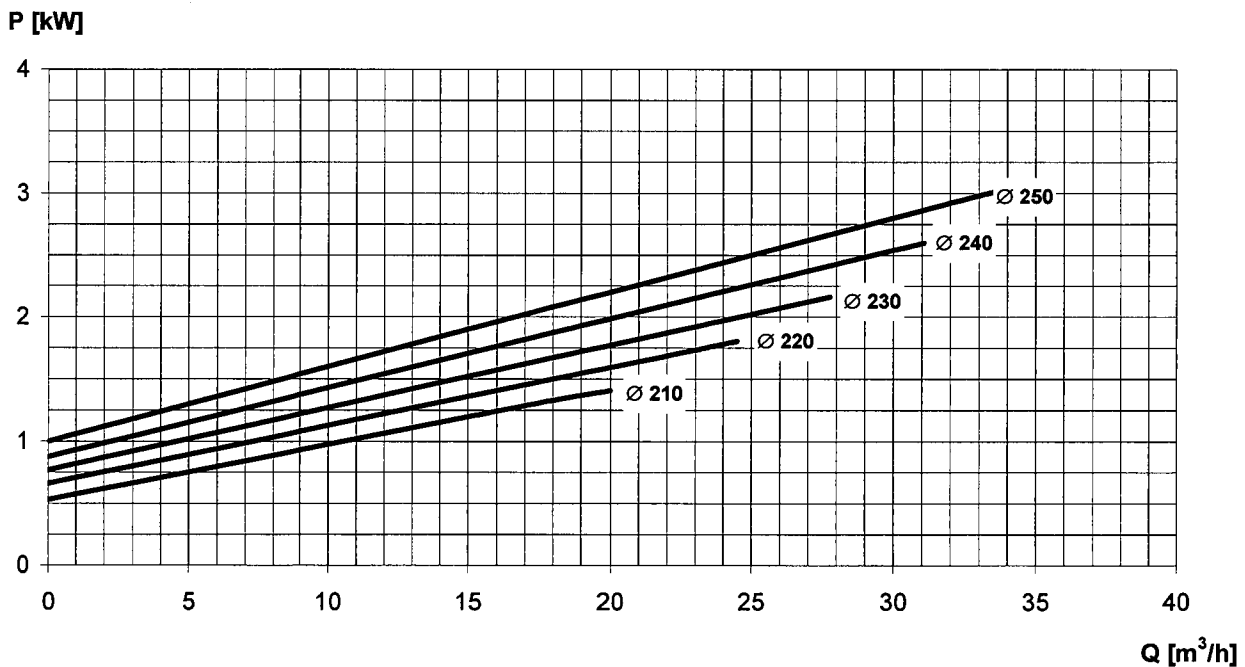
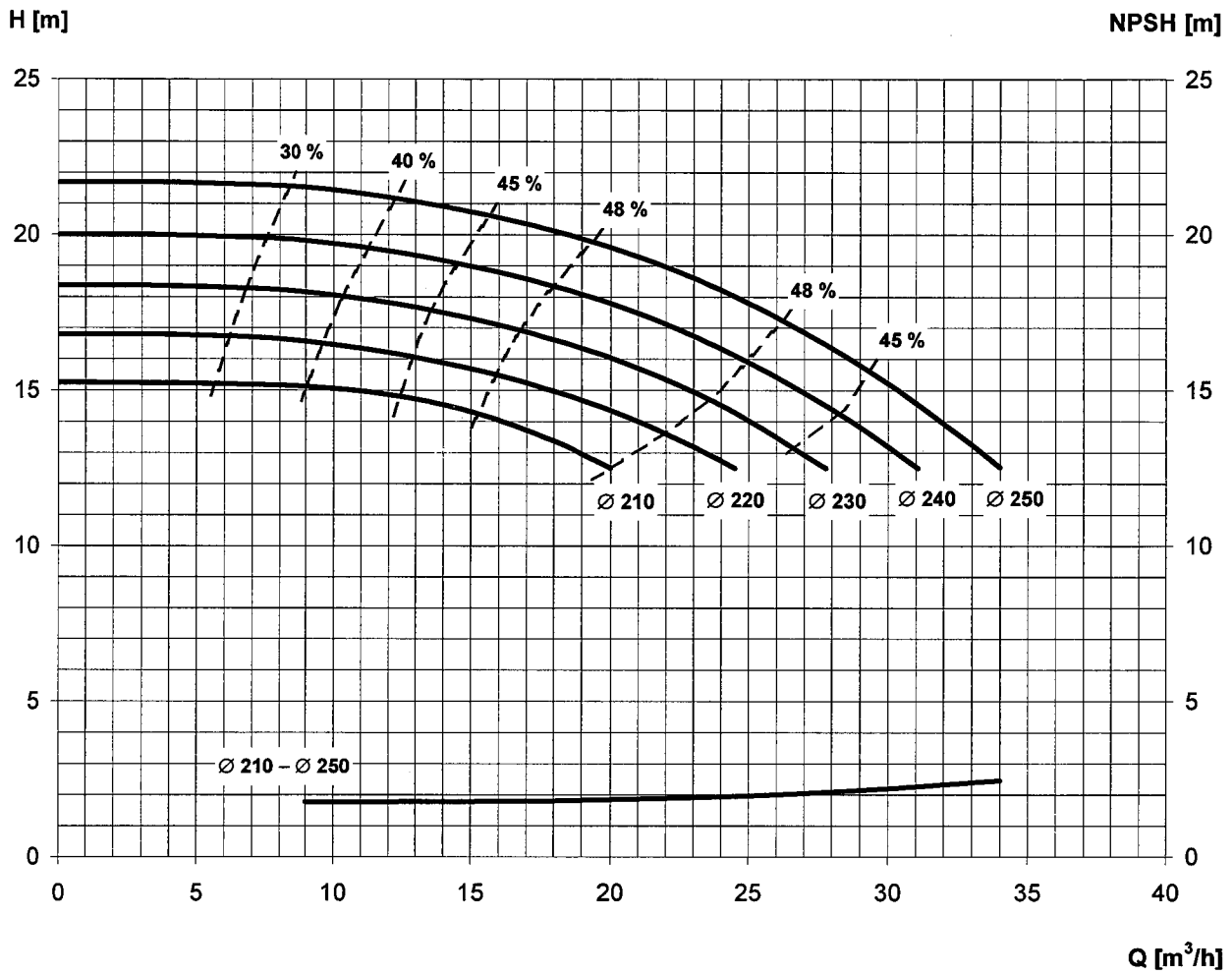
Name : Thomsen  
 Datum : 23.05.00

**FP 741**

**Saugseite : DN 50**  
**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

**0443 81 1001**



zulässige Leistungsschwankungen  $\pm 5\%$   
alle Angaben gelten für Wasser bei  $20^\circ C$

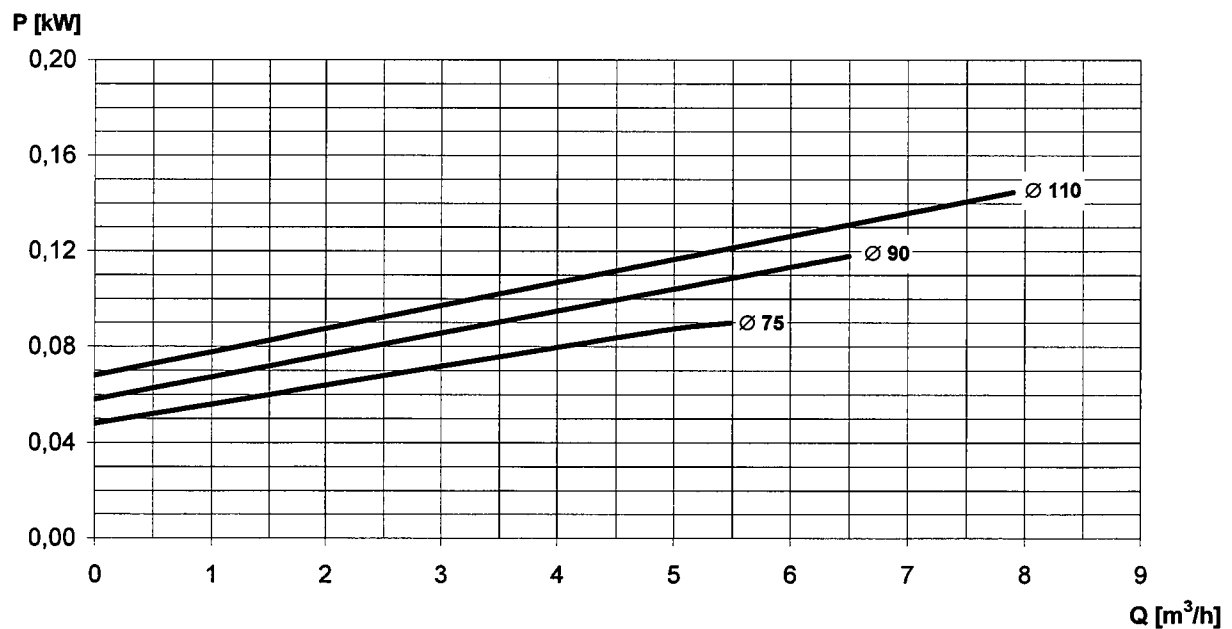
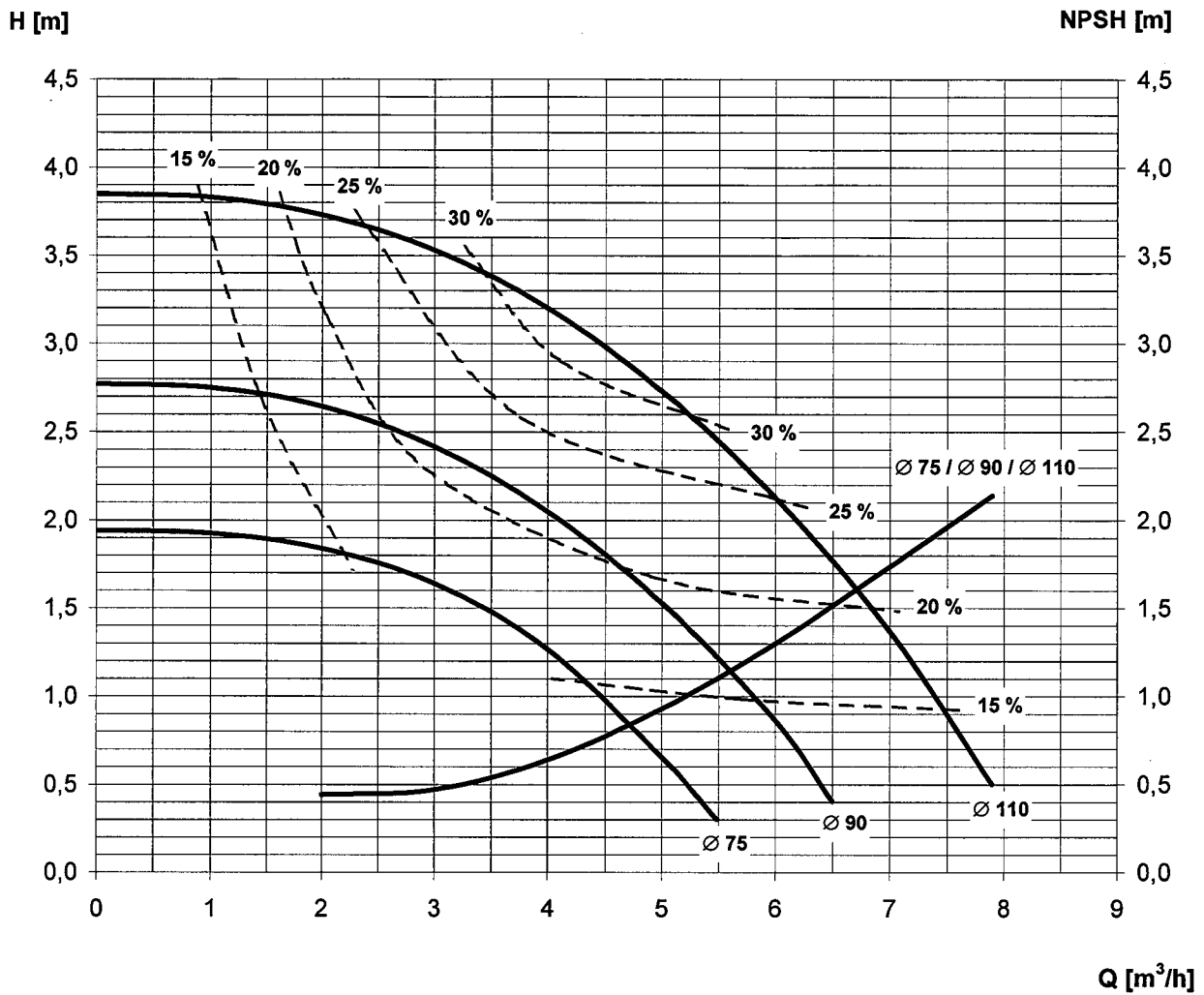
Name : Thomsen  
Datum : 31.03.00

**FP 751**

**Saugseite : DN 80**  
**Druckseite : DN 50**

$n = 1450 \text{ min}^{-1}$

**0482 81 1001**



zulässige Leistungsschwankungen  $\pm 5\%$   
alle Angaben gelten für Wasser bei 20°C

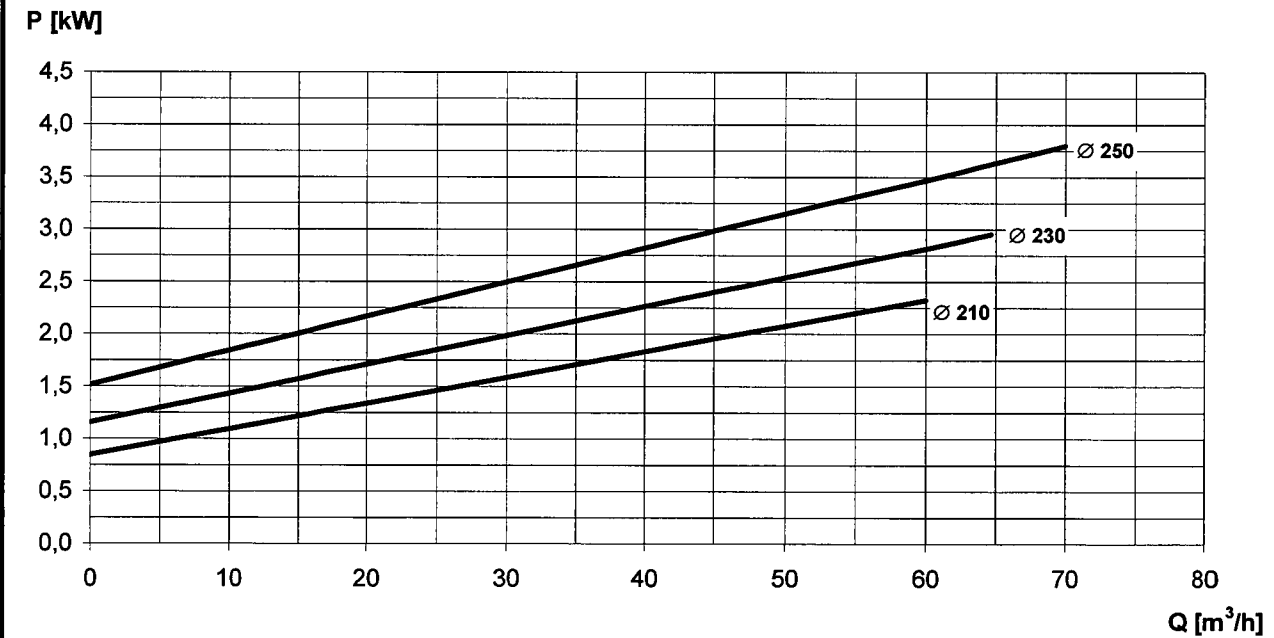
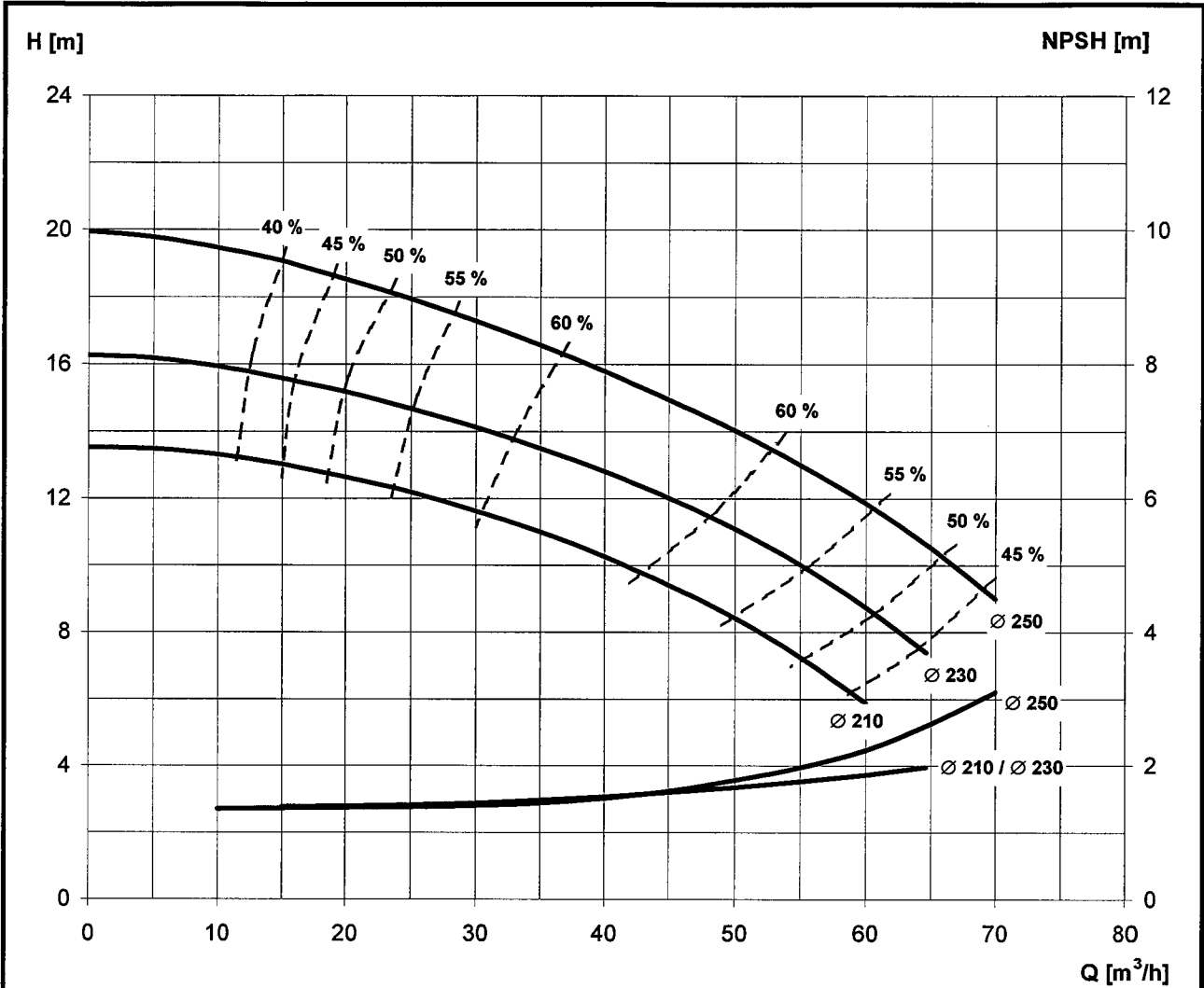
Name : Thomsen  
Datum : 25.05.00

**FP 3401**

**Saugseite : DN 40**  
**Druckseite : DN 40**

$n = 1450 \text{ min}^{-1}$

**0406 81 1001**



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

Name : Thomsen  
 Datum : 16.08.00

**FP 3451**

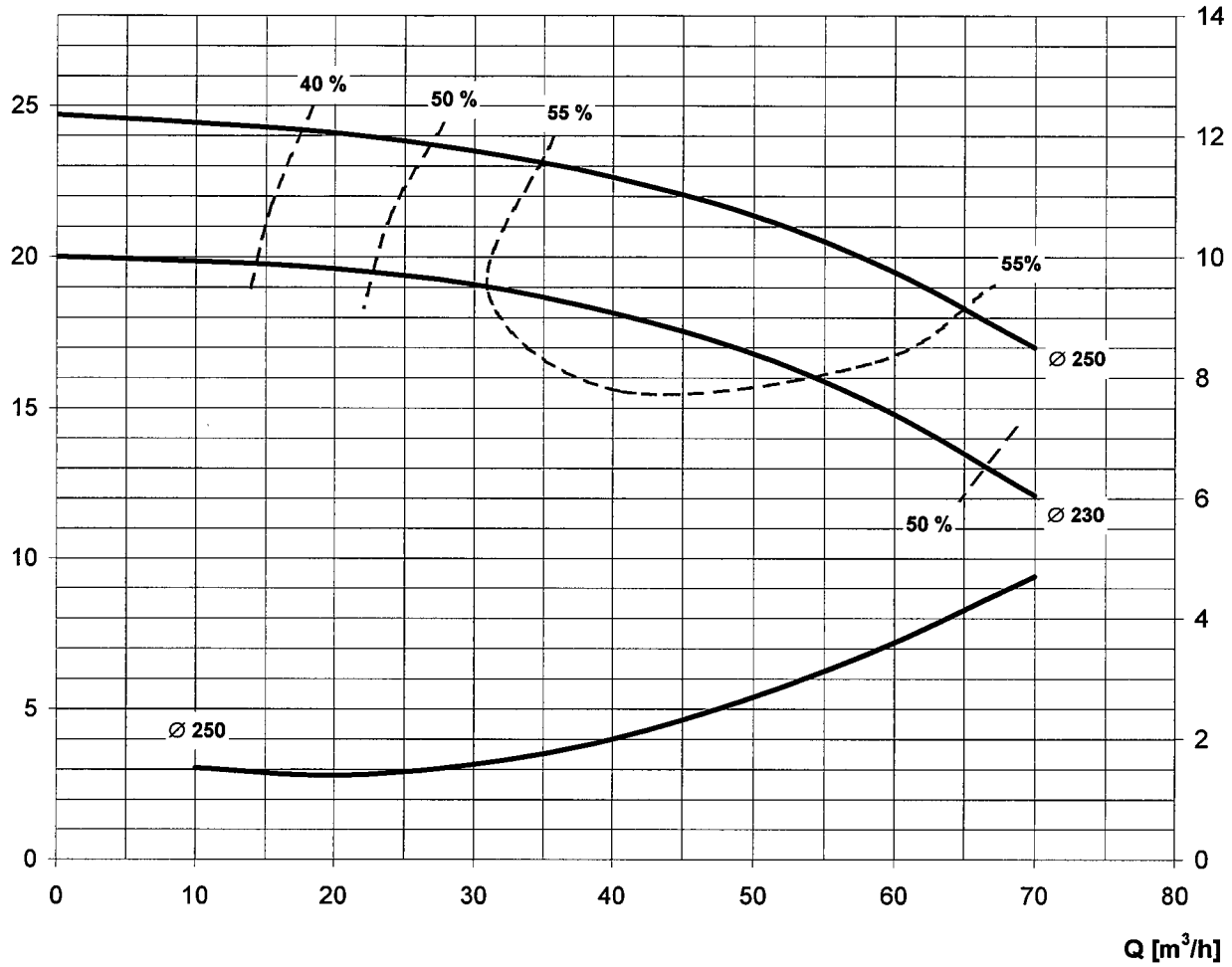
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**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

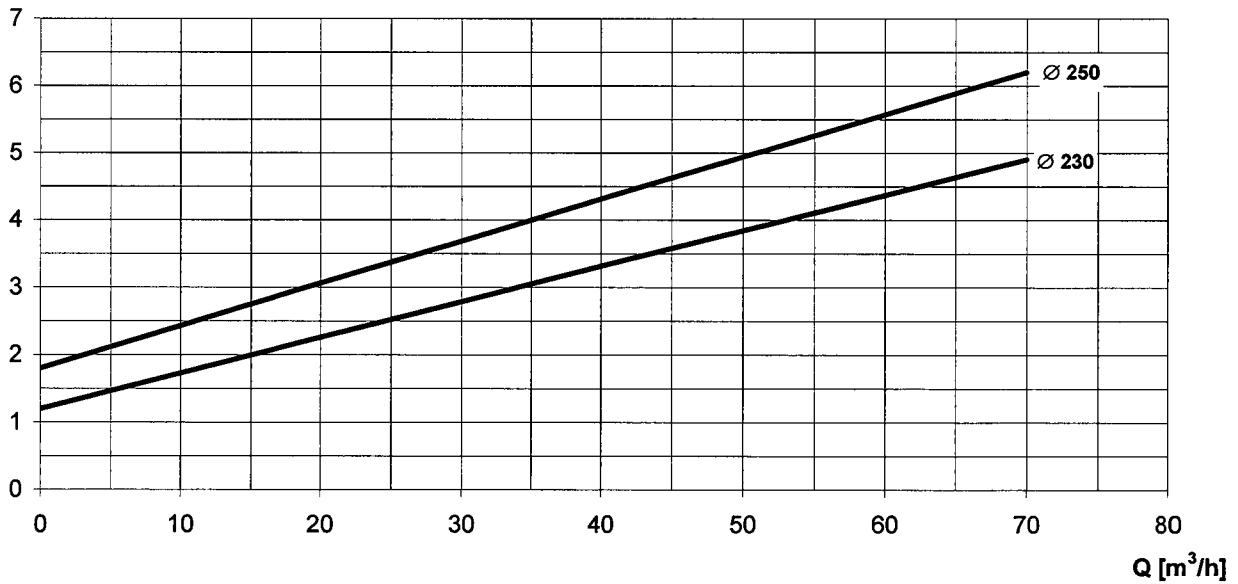
**0456 81 1001**

H [m]

NPSH [m]



P [kW]



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

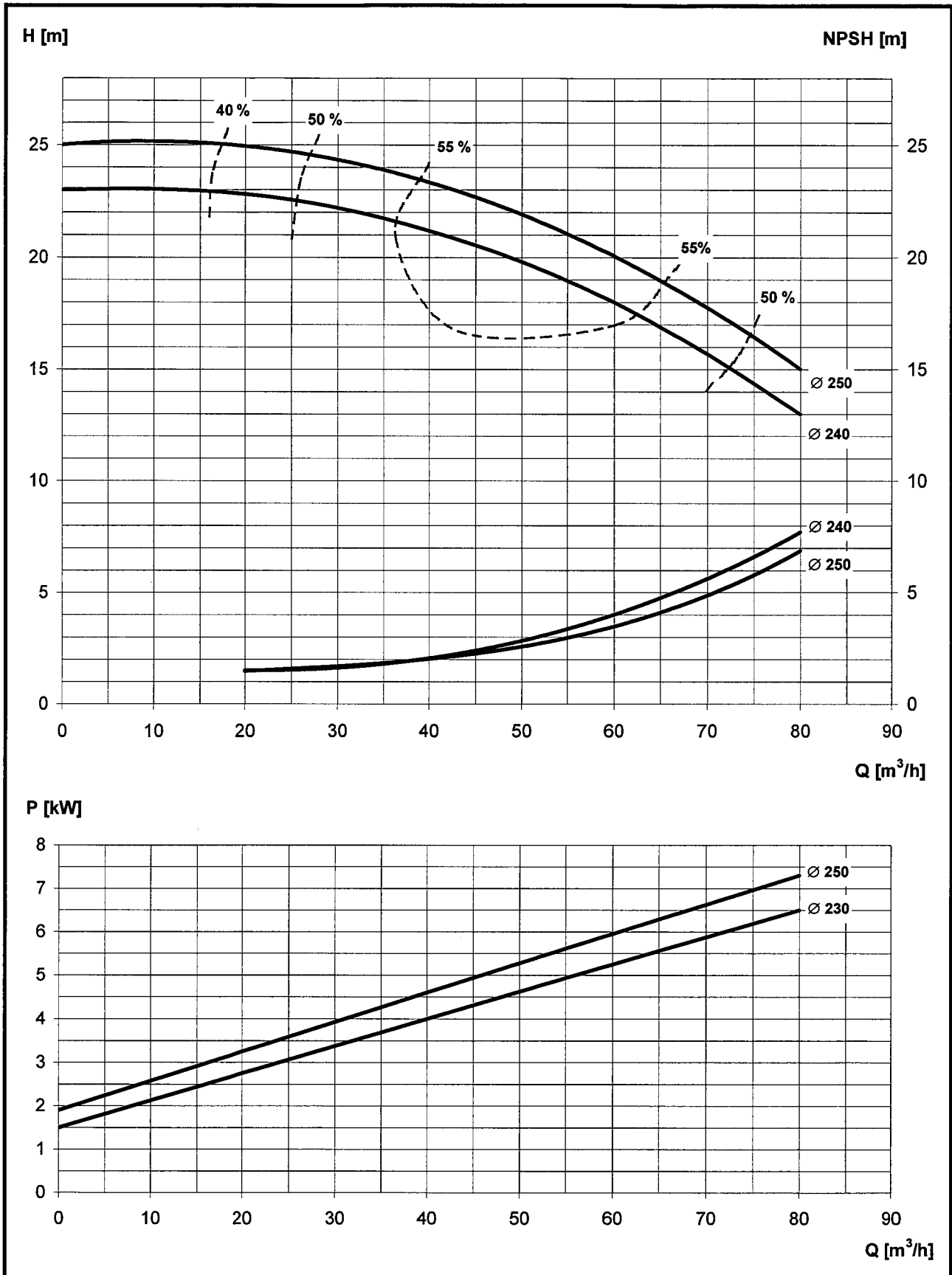
Name : Thomsen  
Datum : 21.07.03

**FPX 3451**

**Saugseite : DN 65**  
**Druckseite : DN 50**

$n = 1450 \text{ min}^{-1}$

**0456 81 3001**



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

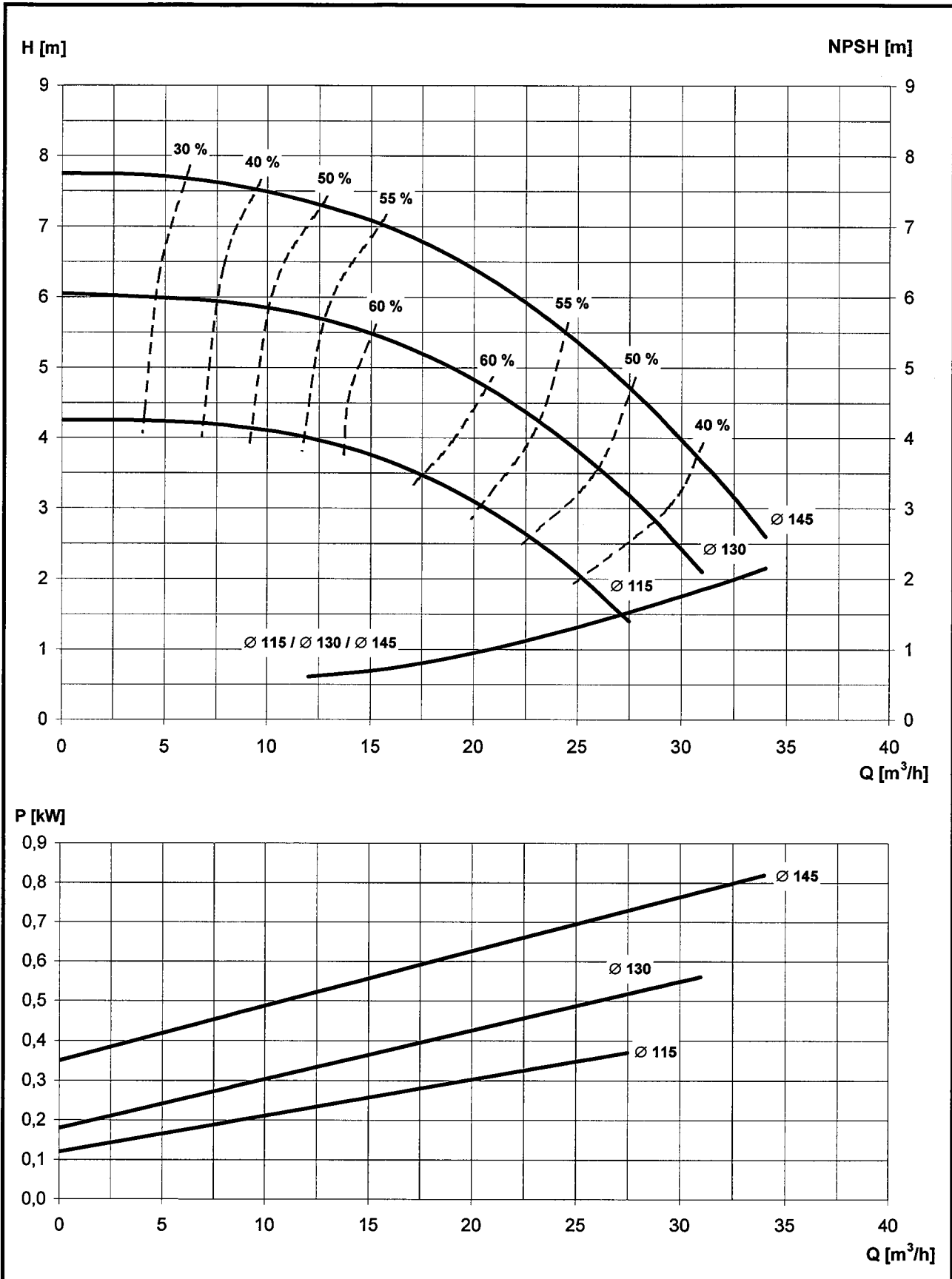
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Datum : 21.07.03

**FPX 3451**

**Saugseite : DN 80**  
**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

**0456 81 3002**



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

Name : Thomsen  
 Datum : 29.05.00

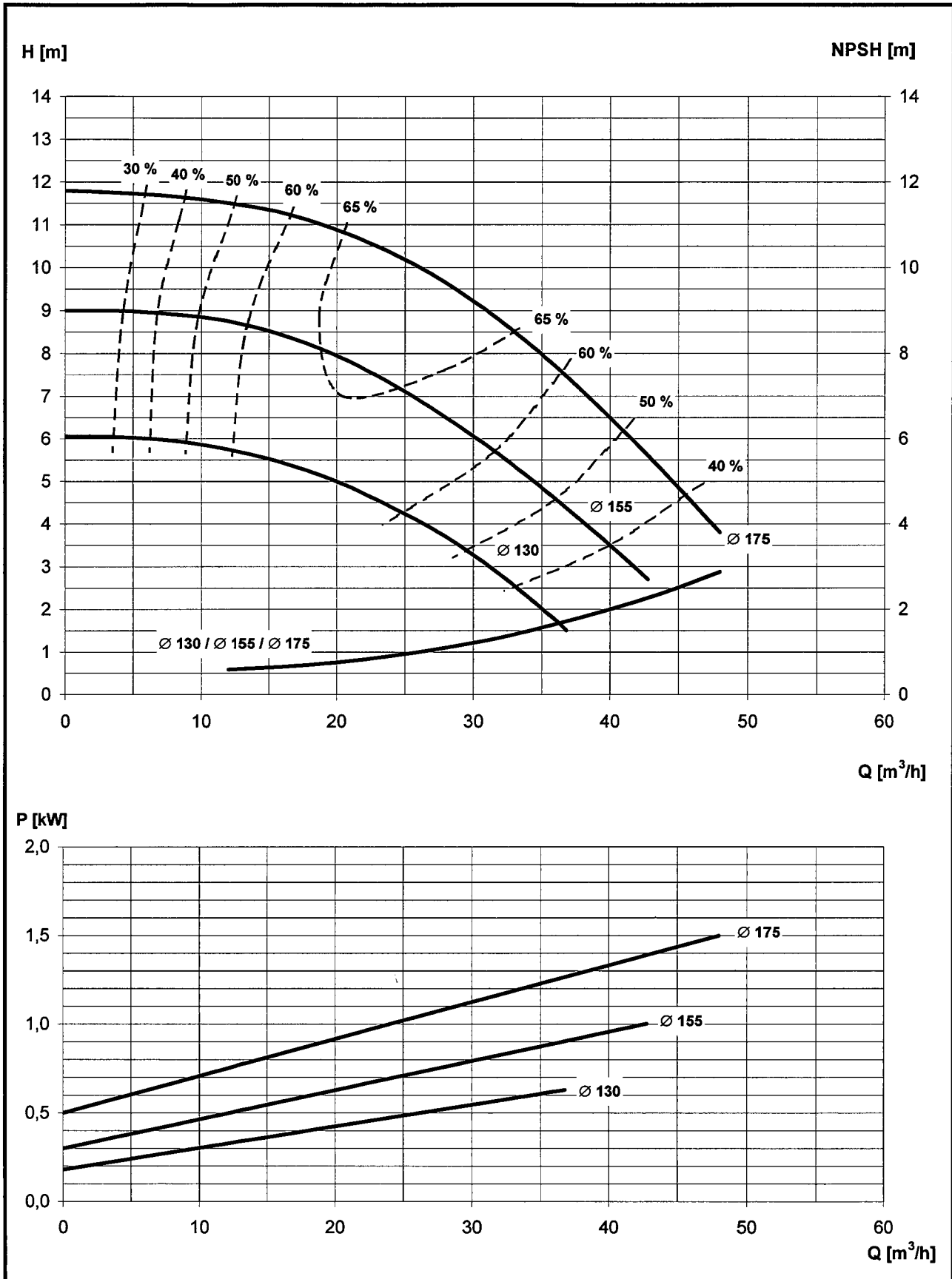
**FP 3521**

**Saugseite : DN 65**  
**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

**0428 81 1001**





zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

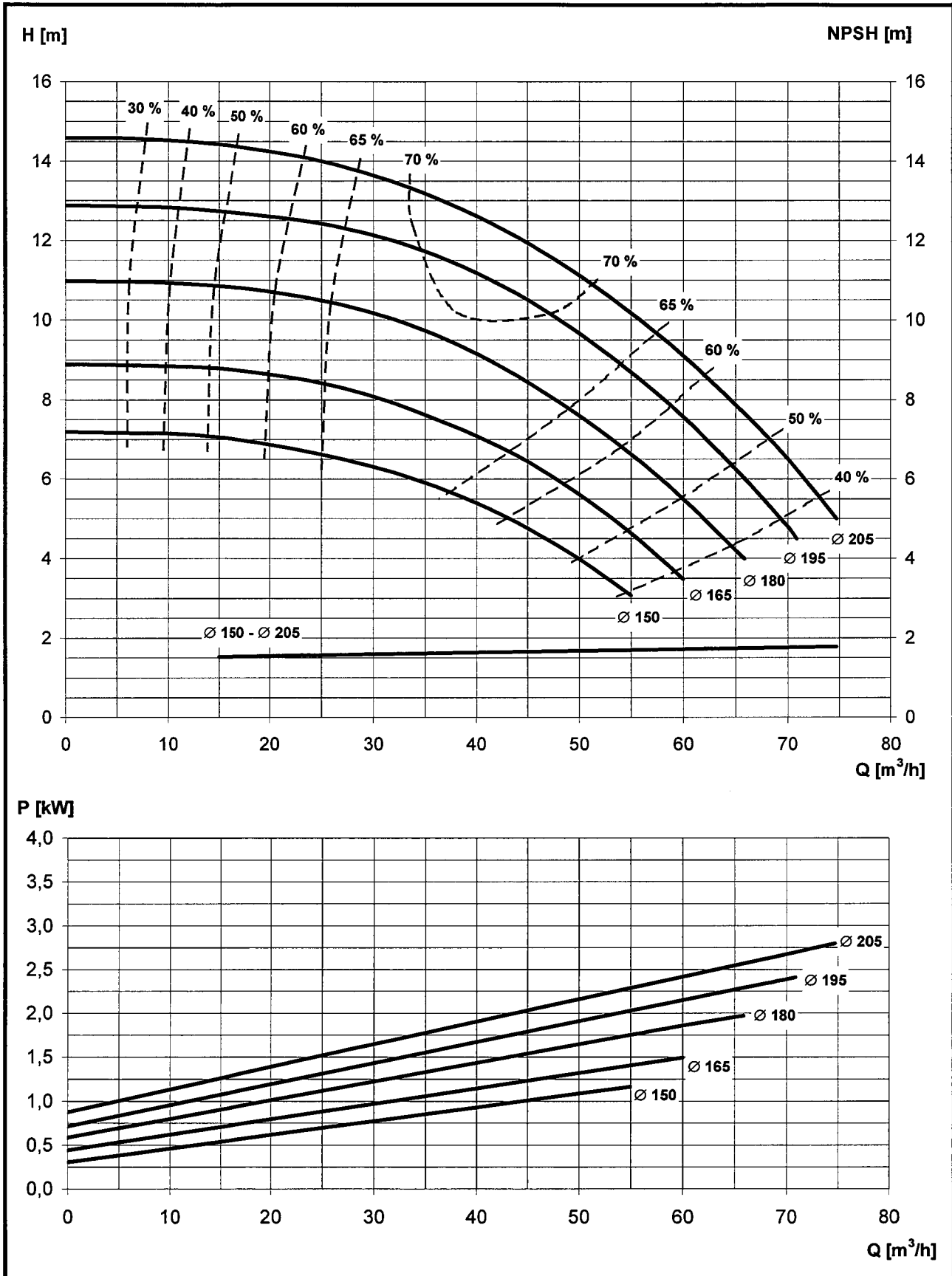
Name : Thomsen  
 Datum : 31.05.00

**FP 3531**

**Saugseite : DN 65**  
**Druckseite : DN 50**

**n = 1450 min<sup>-1</sup>**

**0438 81 1001**



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

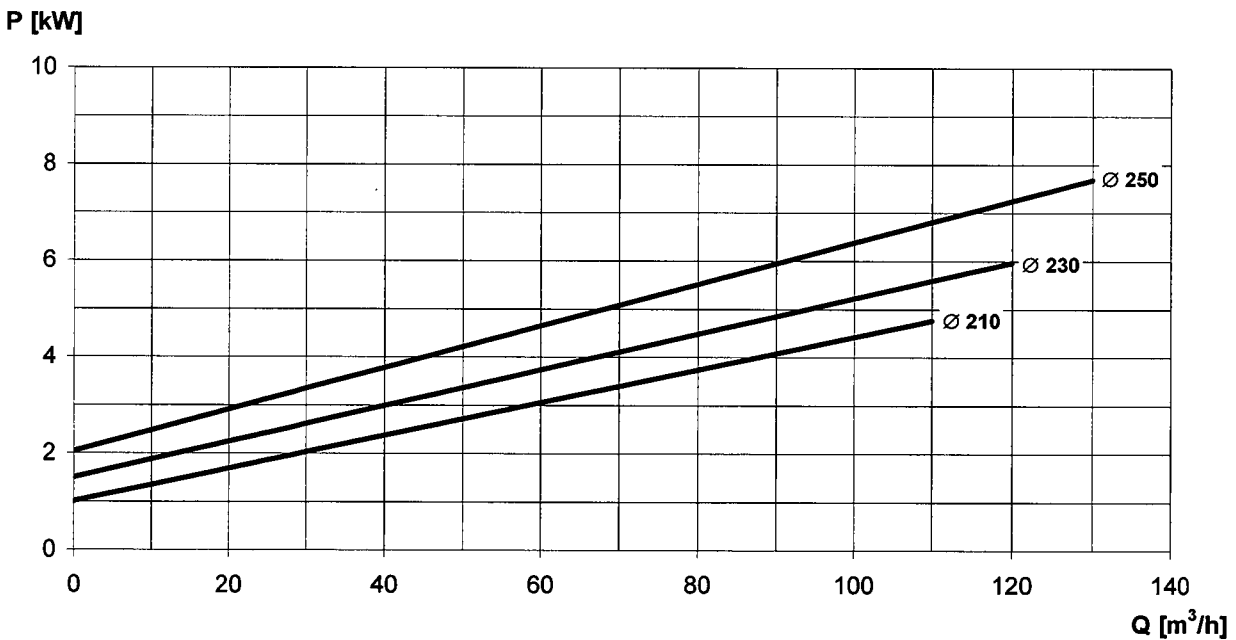
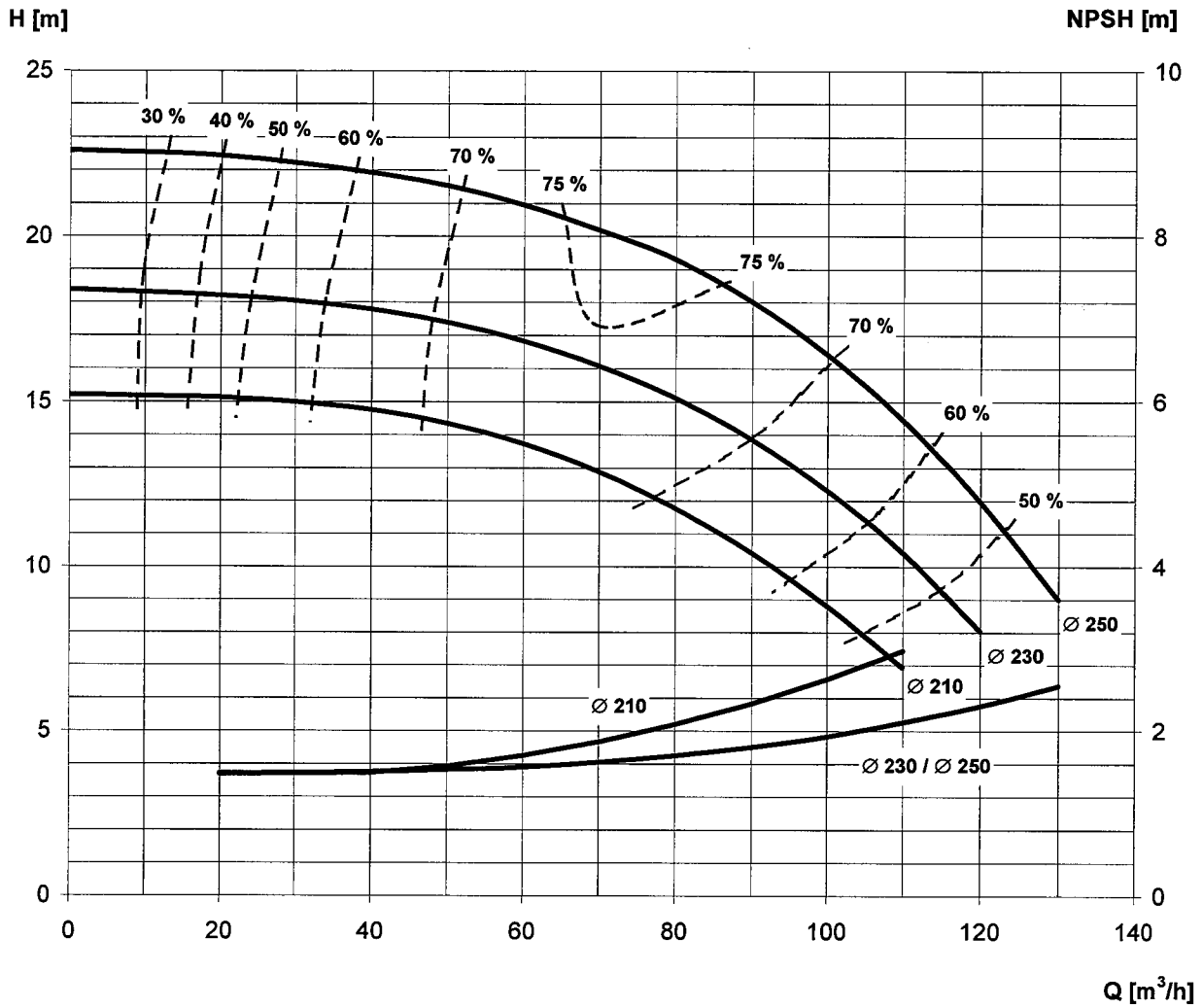
Name : Thomsen  
Datum : 29.08.00

**FP 3541**

**Saugseite : DN 80**  
**Druckseite : DN 65**

$n = 1450 \text{ min}^{-1}$

**0448 81 1001**



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

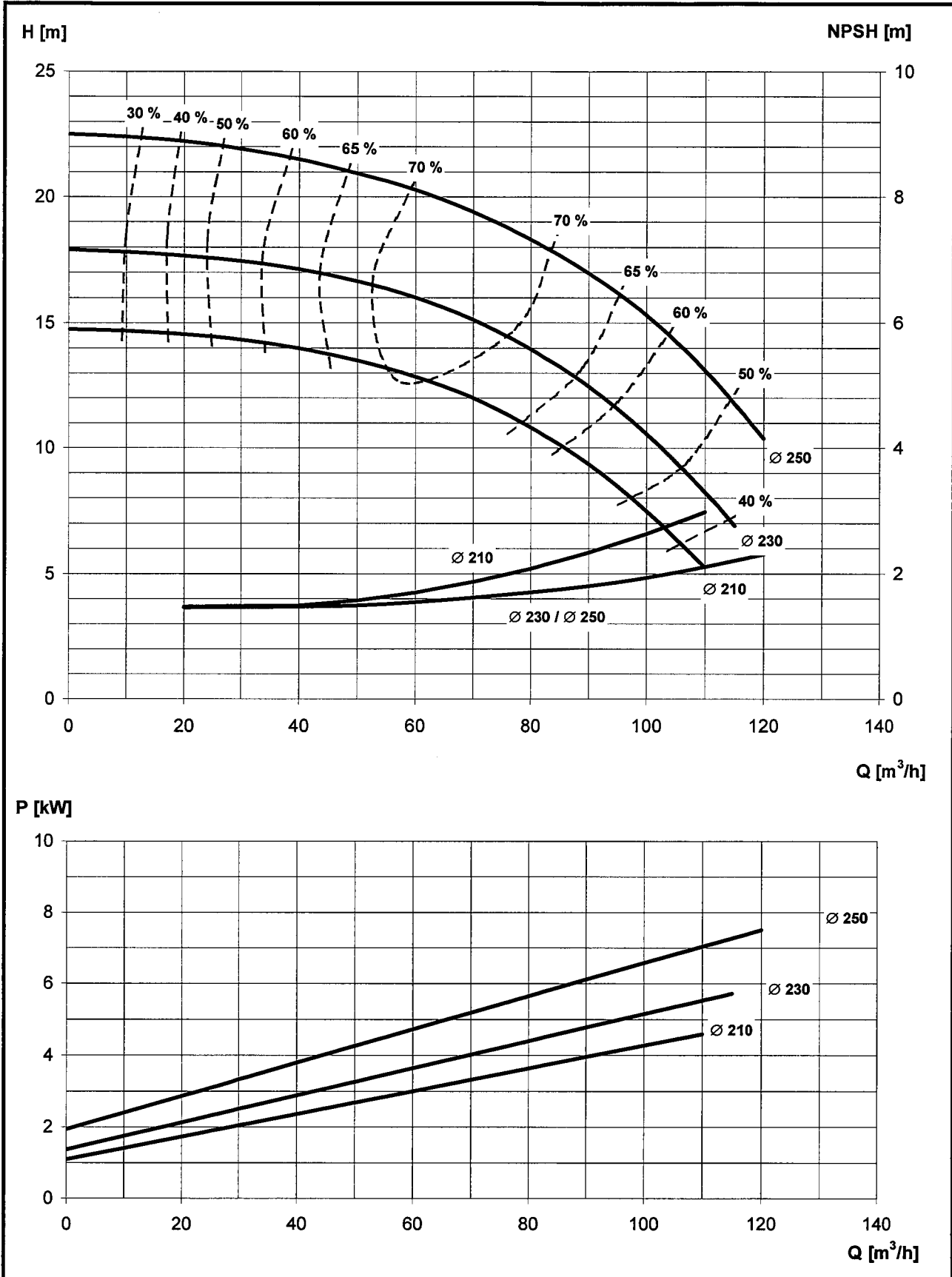
Name : Thomsen  
Datum : 25.09.00

**FP 3551**

**Saugseite : DN 80**  
**Druckseite : DN 65**

$n = 1450 \text{ min}^{-1}$

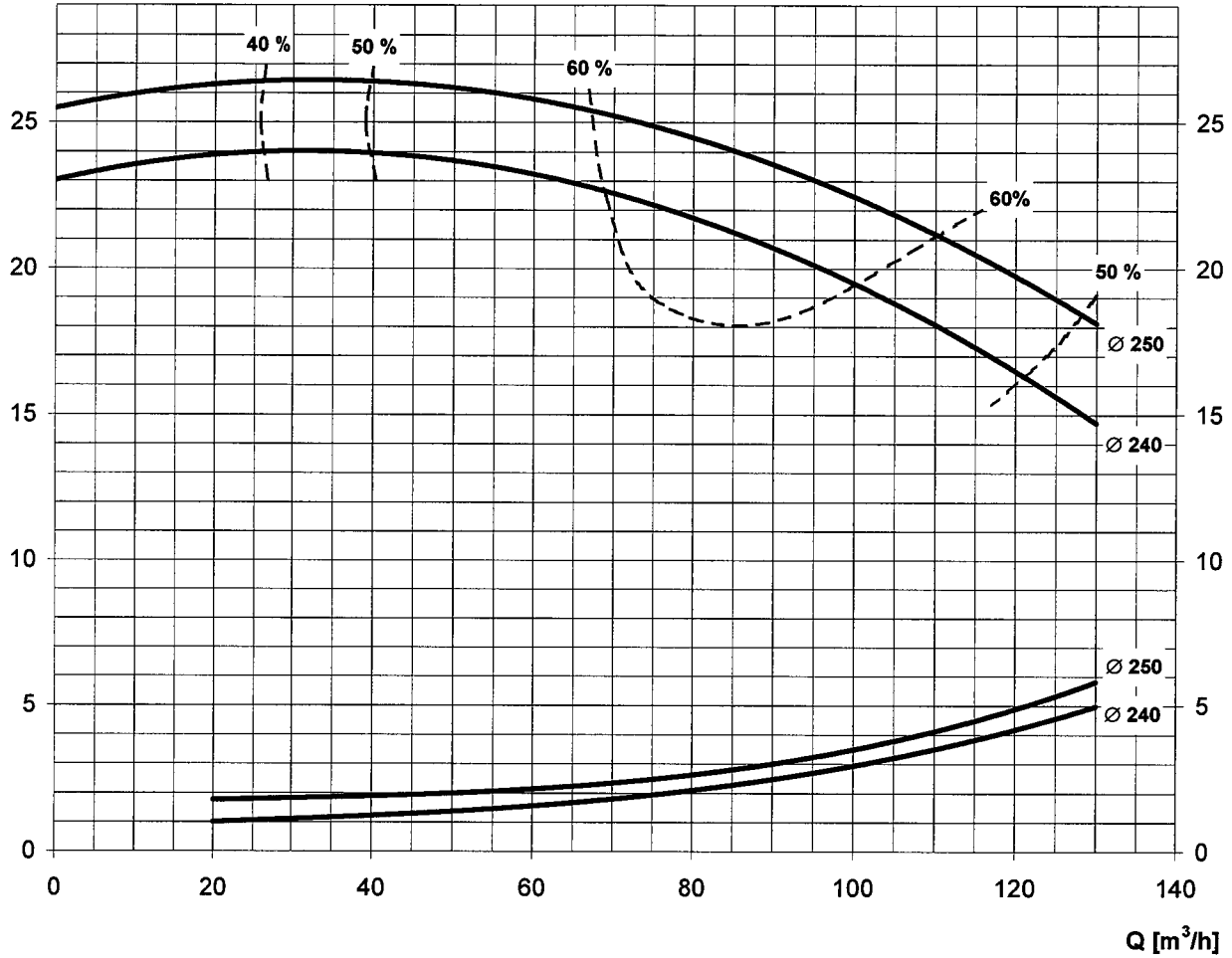
**0458 81 1001**



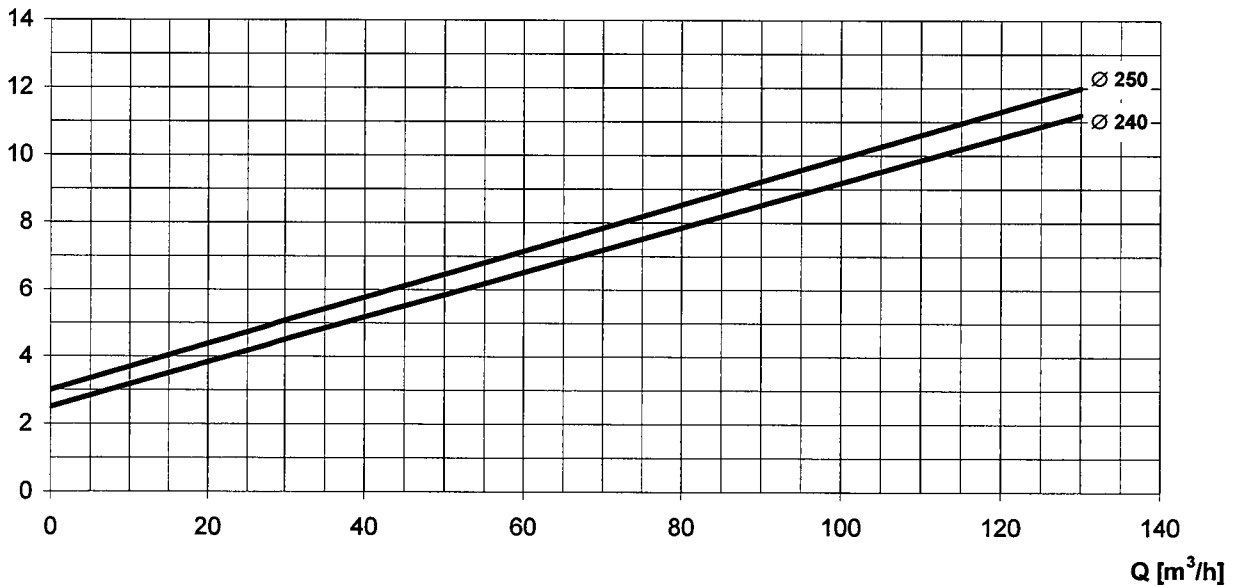
zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen Datum : 25.09.00	<b>FP 3551</b>
<b>Saugseite : DN 100</b> <b>Druckseite : DN 65</b>	<b>n = 1450 min<sup>-1</sup></b>	<b>0458 81 1002</b>

H [m]

NPSH [m]



P [kW]



zulässige Leistungsschwankungen  $\pm 5\%$   
alle Angaben gelten für Wasser bei 20°C

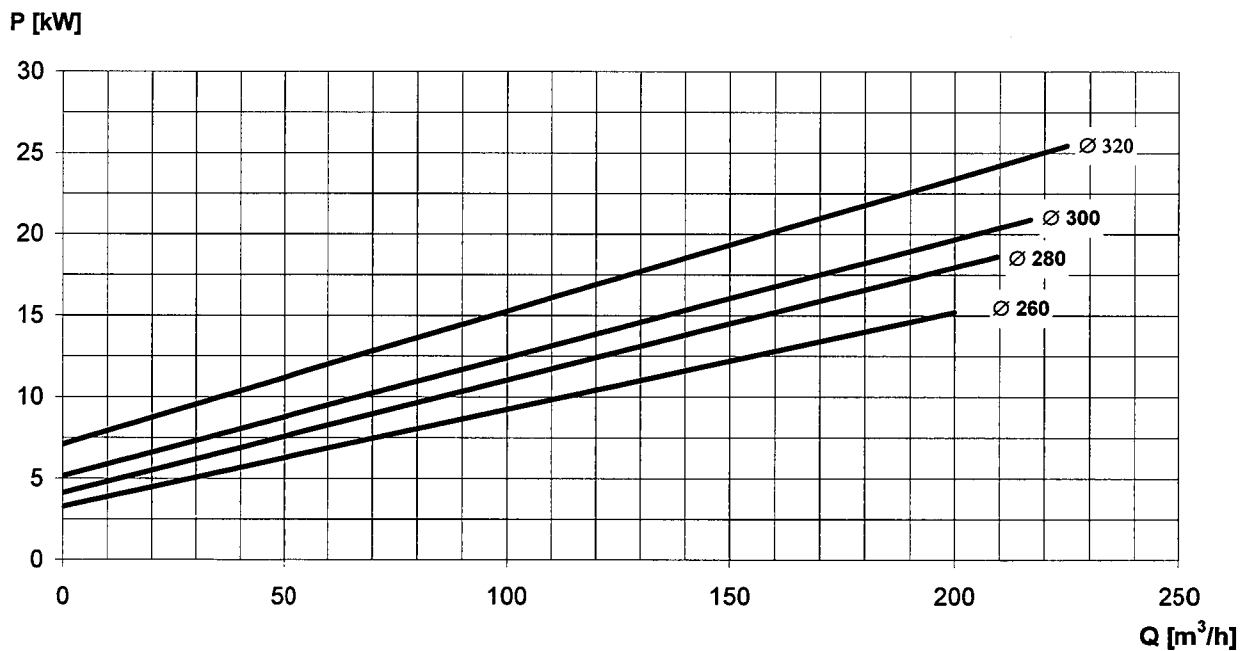
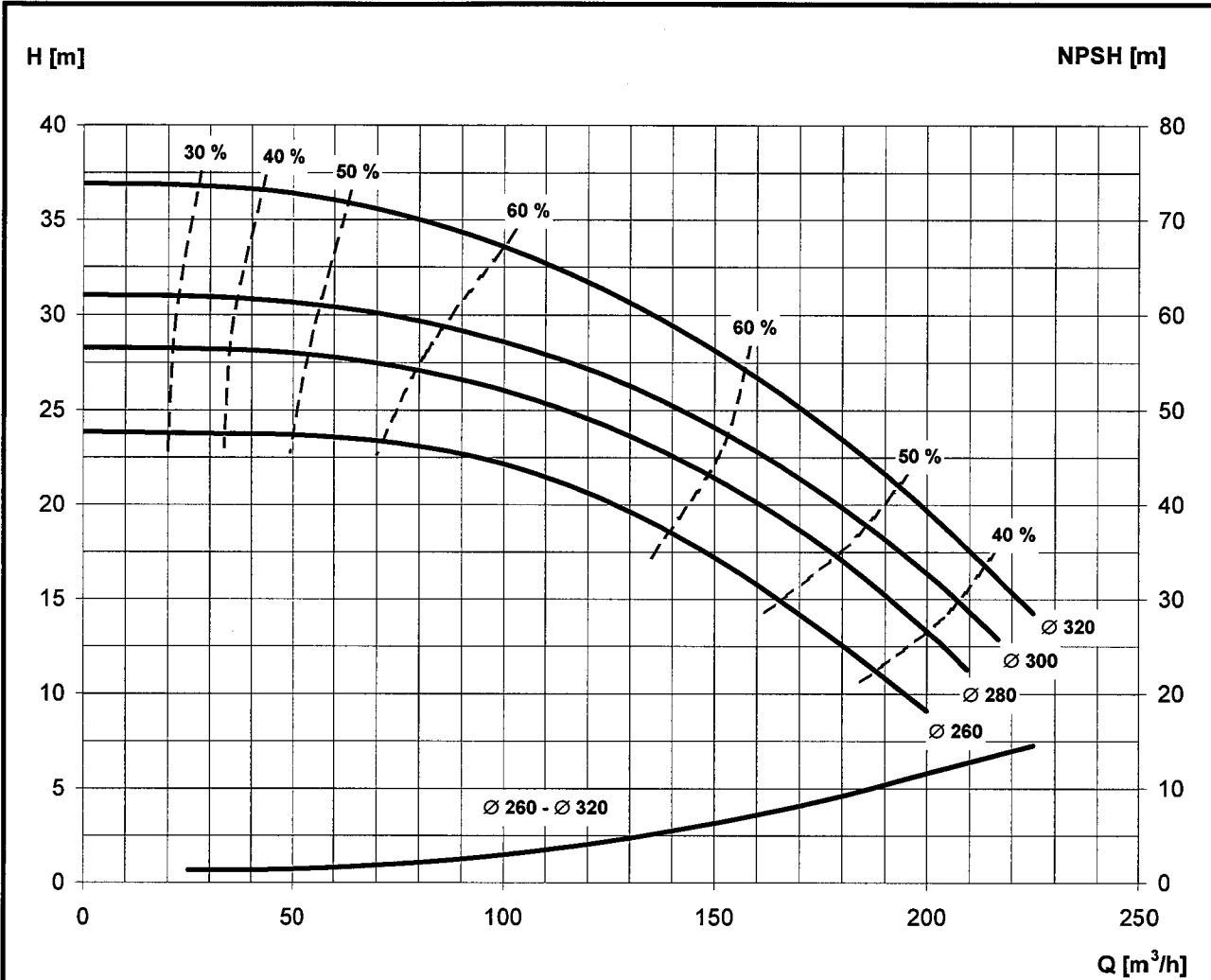
Name : Thomsen  
Datum : 22.07.03

**FPX 3551**

**Saugseite : DN 80 u. 100**  
**Druckseite : DN 65**

$n = 1450 \text{ min}^{-1}$

**0458 81 3001**



zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei  $20^\circ C$

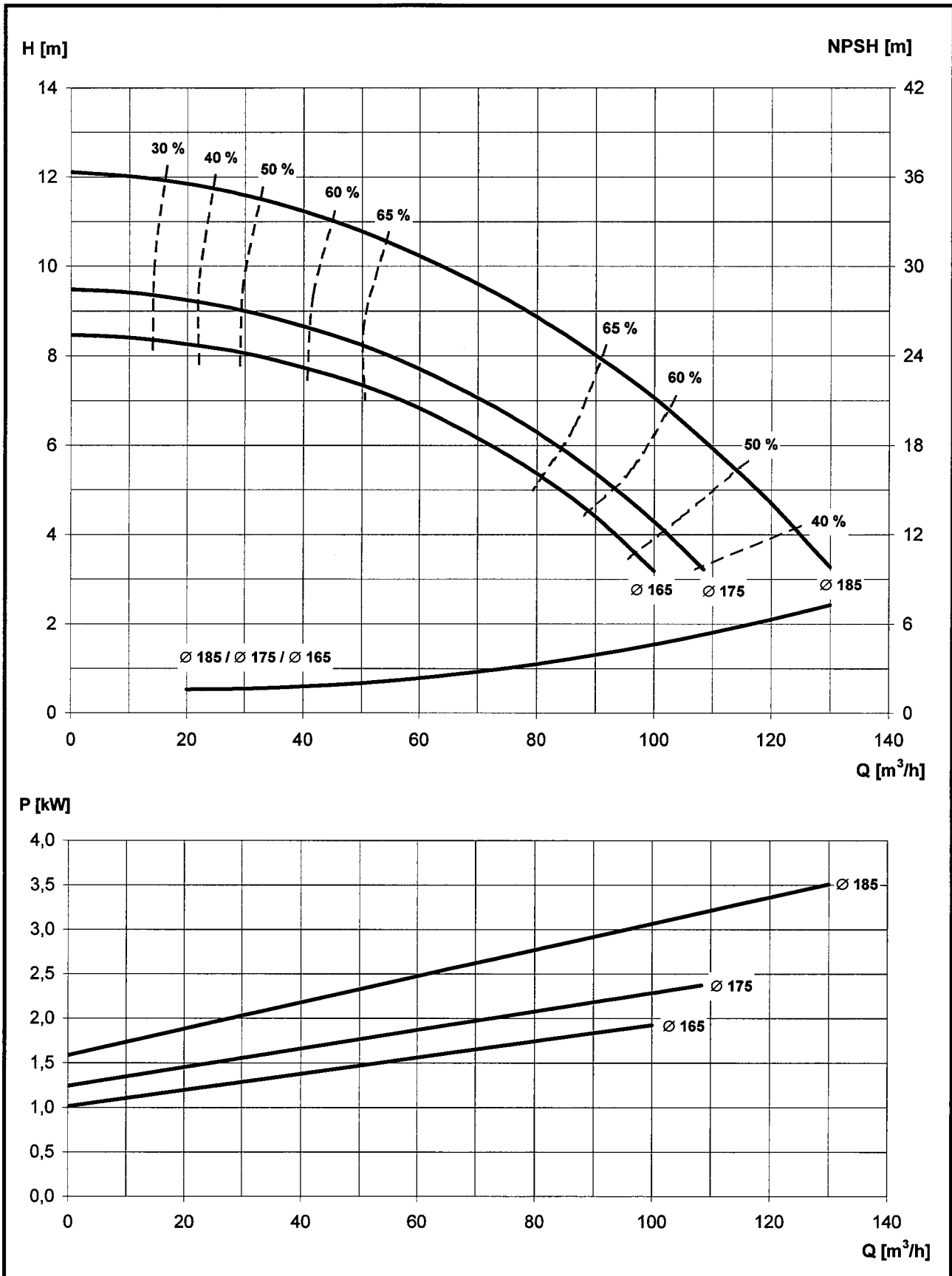
Name : Thomsen  
 Datum : 02.11.00

**FP 1151**

**Saugseite : DN 125**  
**Druckseite : DN 100**

$n = 1450 \text{ min}^{-1}$

**0473 81 1001**



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

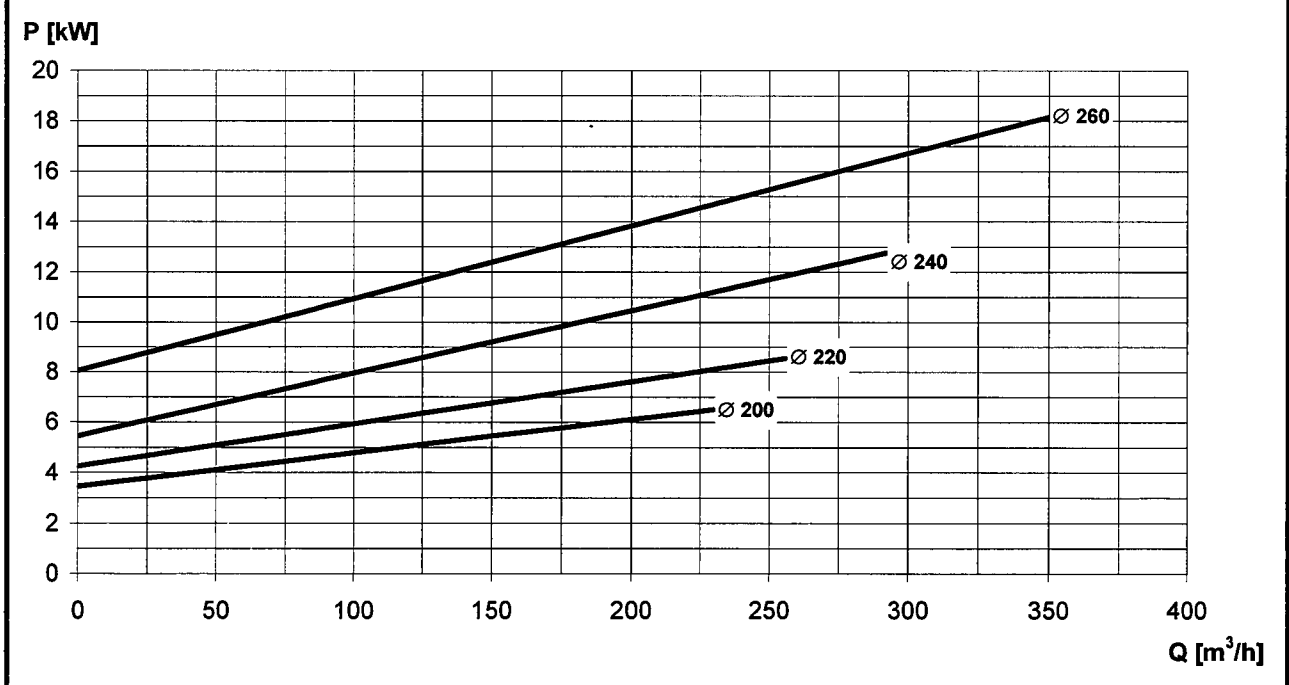
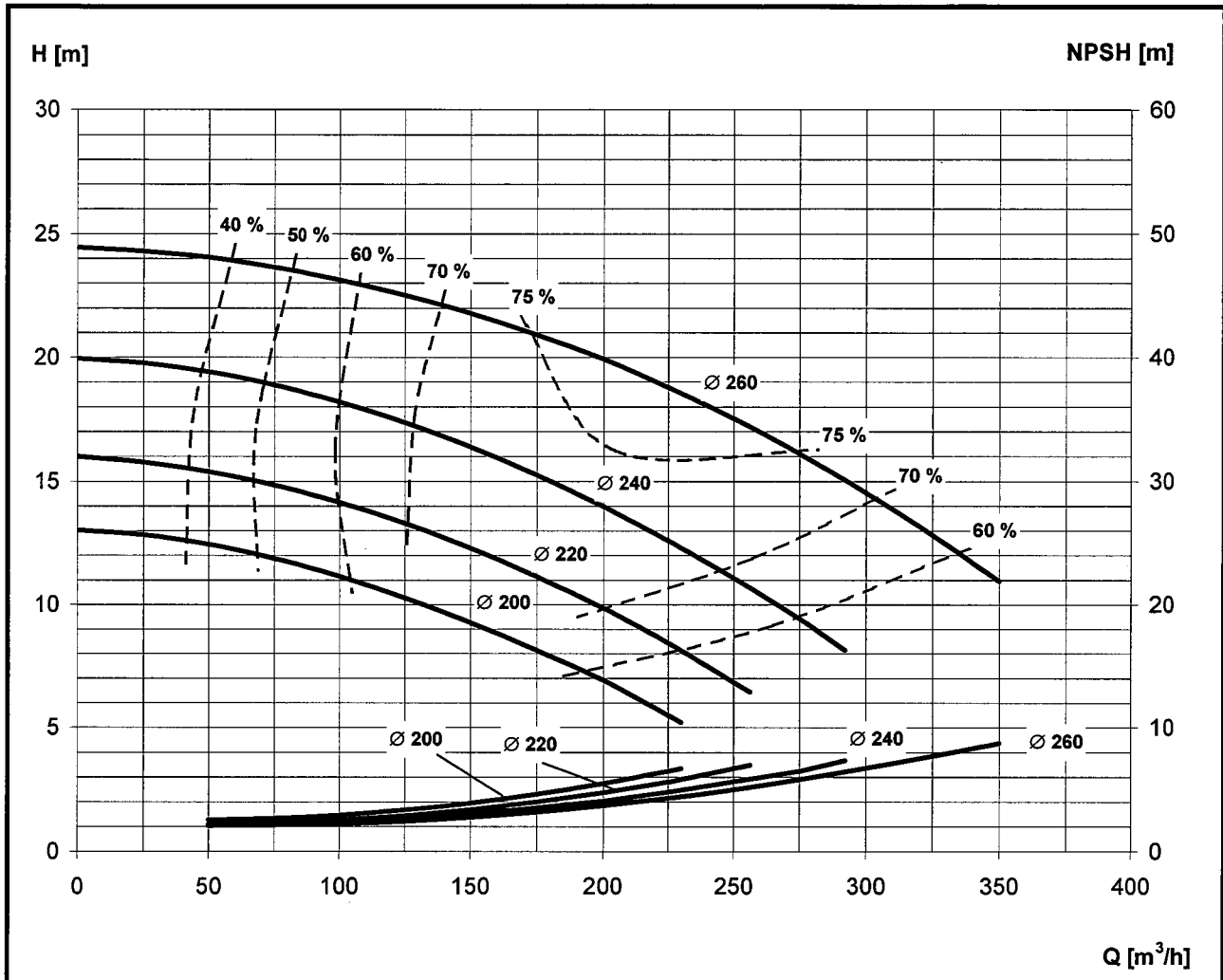
Name : Thomsen  
 Datum : 17.10.00

**FP 1231**

**Saugseite : DN 100**  
**Druckseite : DN 80**

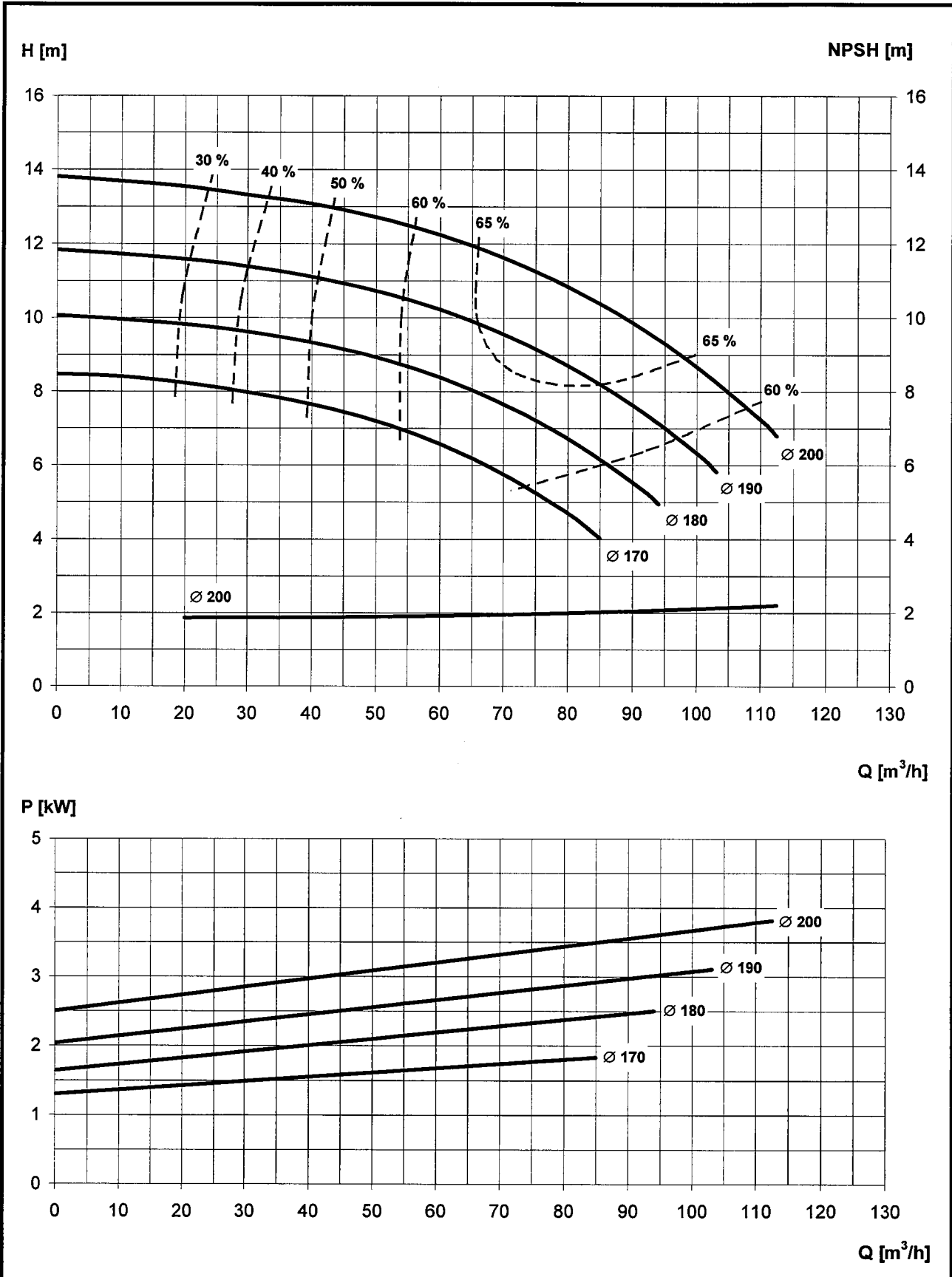
**n = 1450 min<sup>-1</sup>**

**0474 81 1001**



zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 1251</b>
	Datum : 13.12.00	
<b>Saugseite : DN 150</b> <b>Druckseite : DN 125</b>	<b>n = 1450 min<sup>-1</sup></b>	<b>0475 81 1003</b>





zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei  $20^\circ C$

Name : Thomsen  
 Datum : 15.11.00

**FP 101-200**

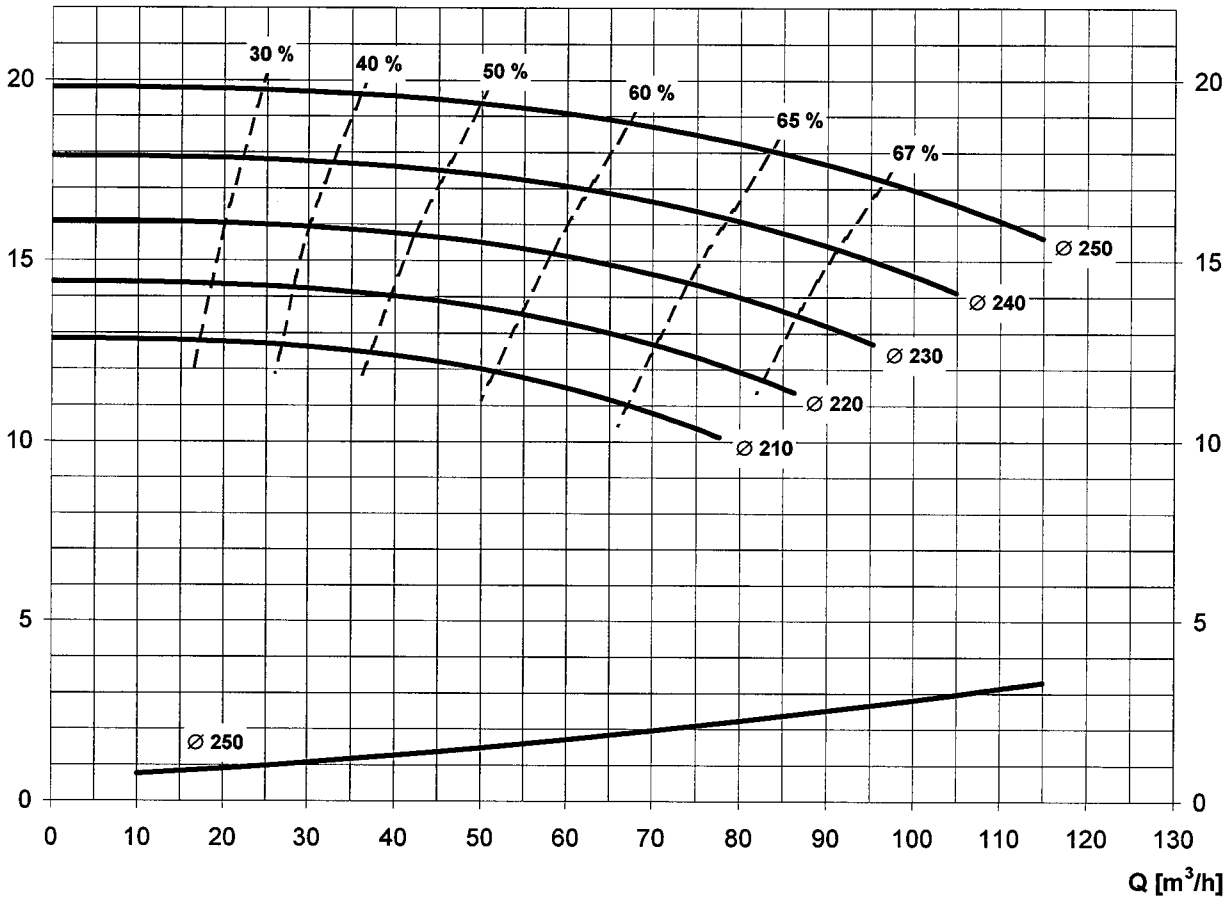
**Saugseite : DN 125**  
**Druckseite : DN 100**

$n = 1450 \text{ min}^{-1}$

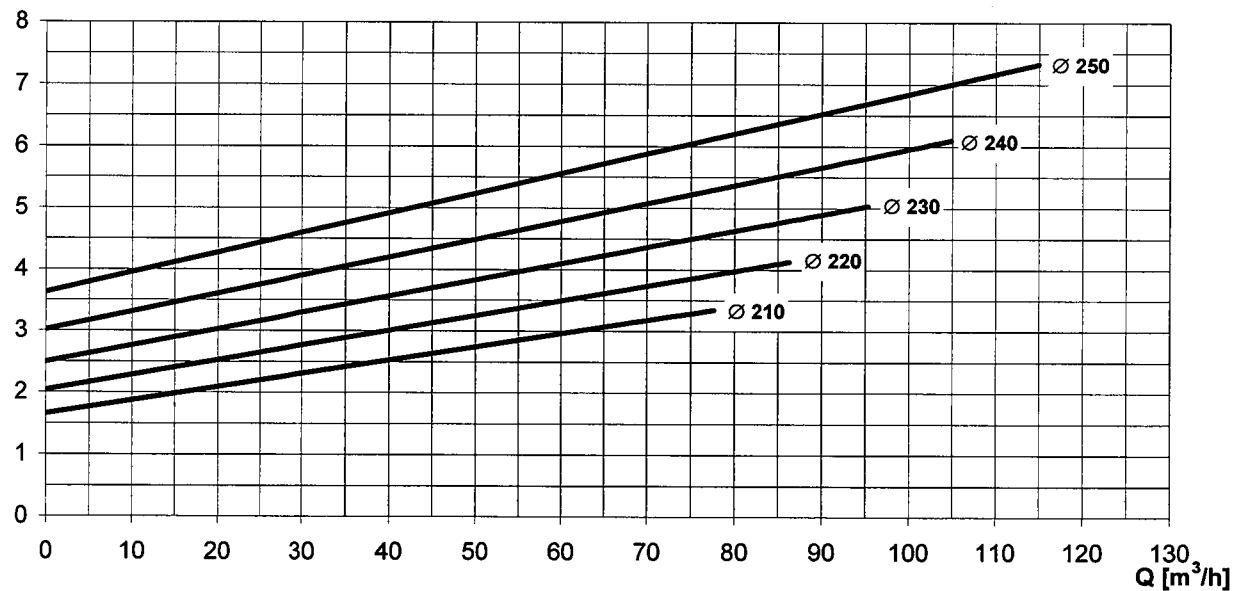
**0466 81 1001**

H [m]

NPSH [m]



P [kW]



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

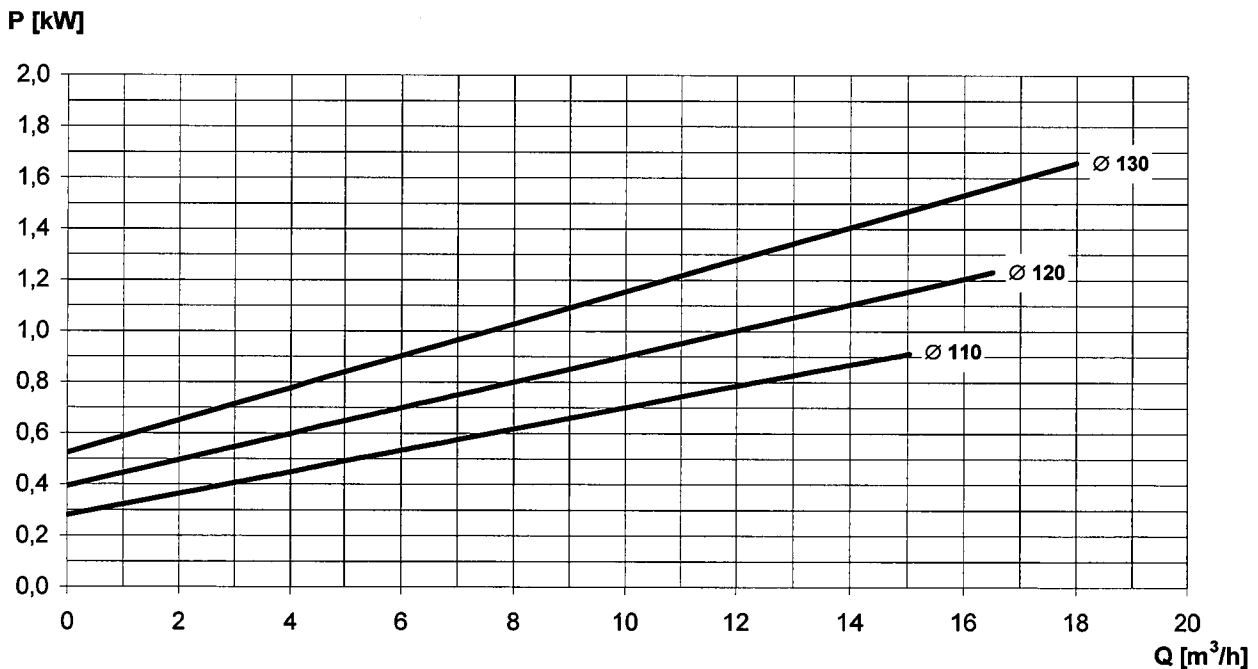
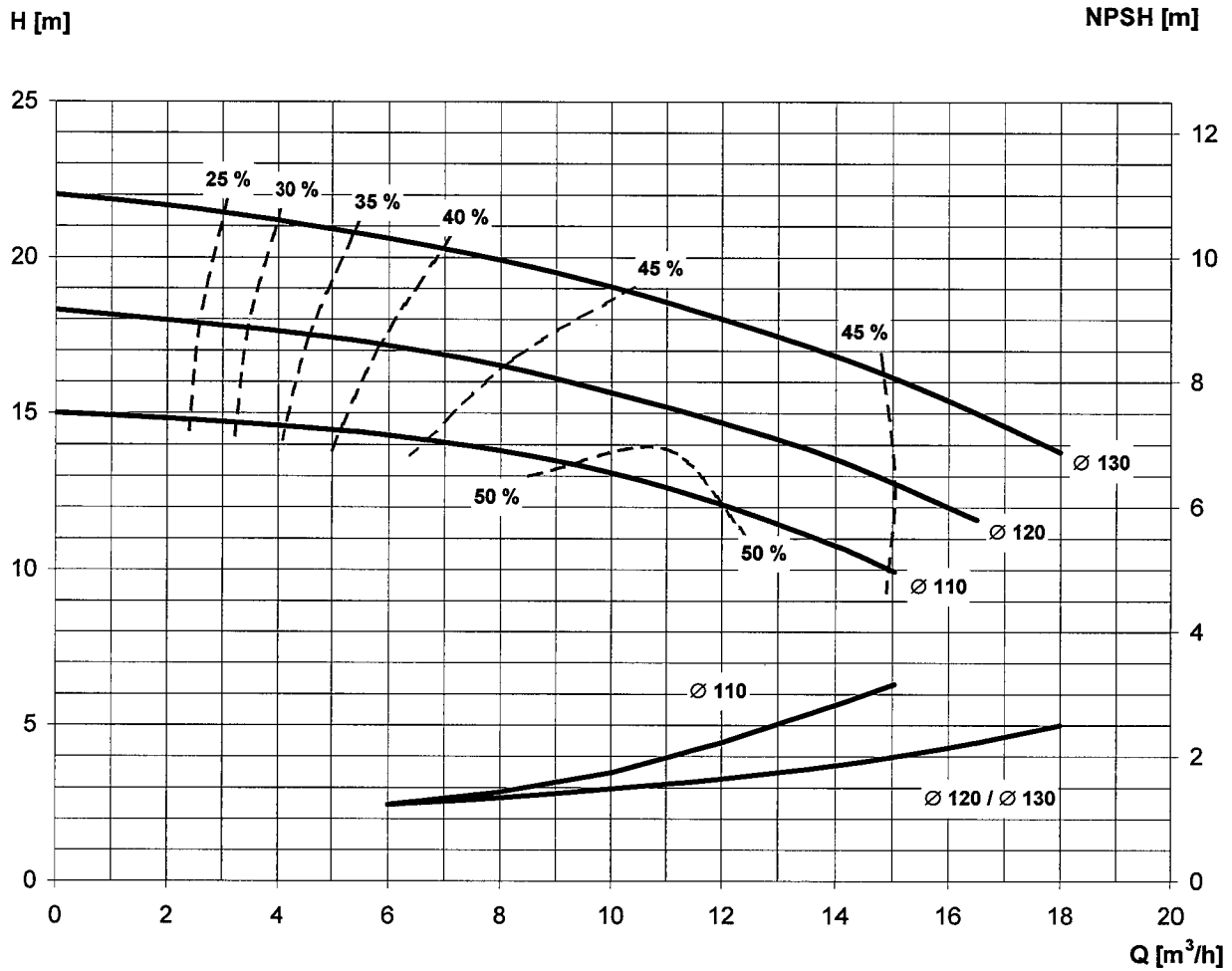
Name : Thomsen  
Datum : 15.11.00

**FP 101-250**

**Saugseite : DN 125**  
**Druckseite : DN 100**

**n = 1450 min<sup>-1</sup>**

**0468 81 1001**



zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei 20°C

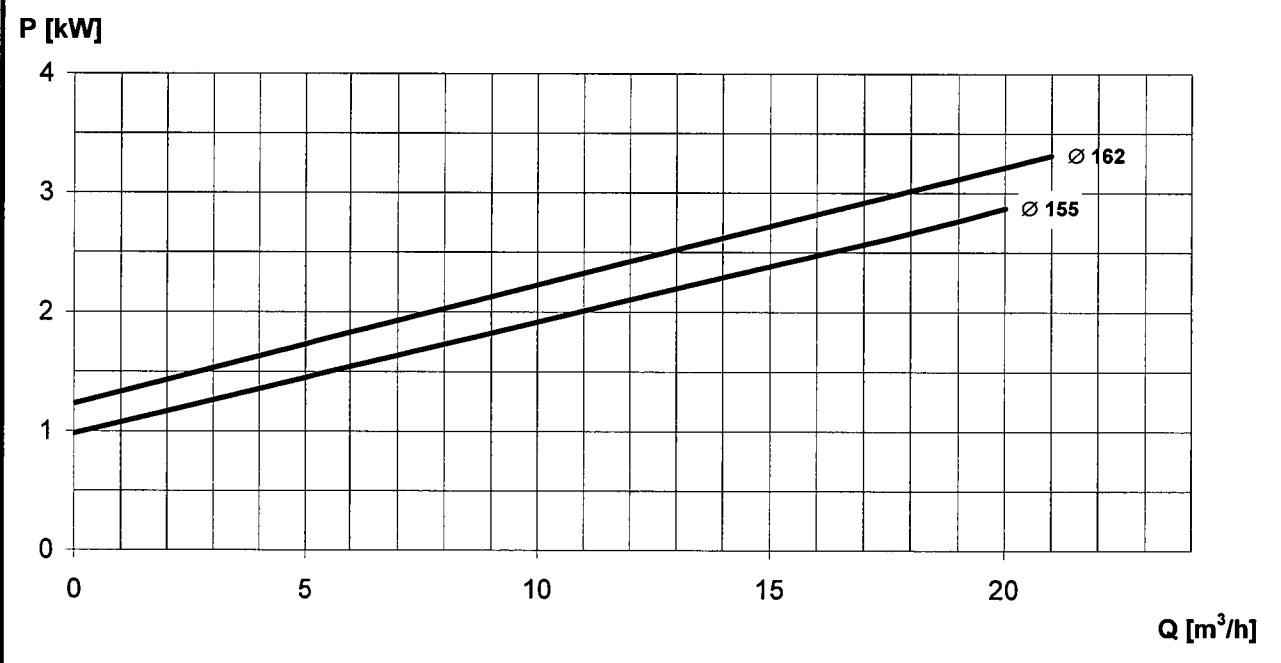
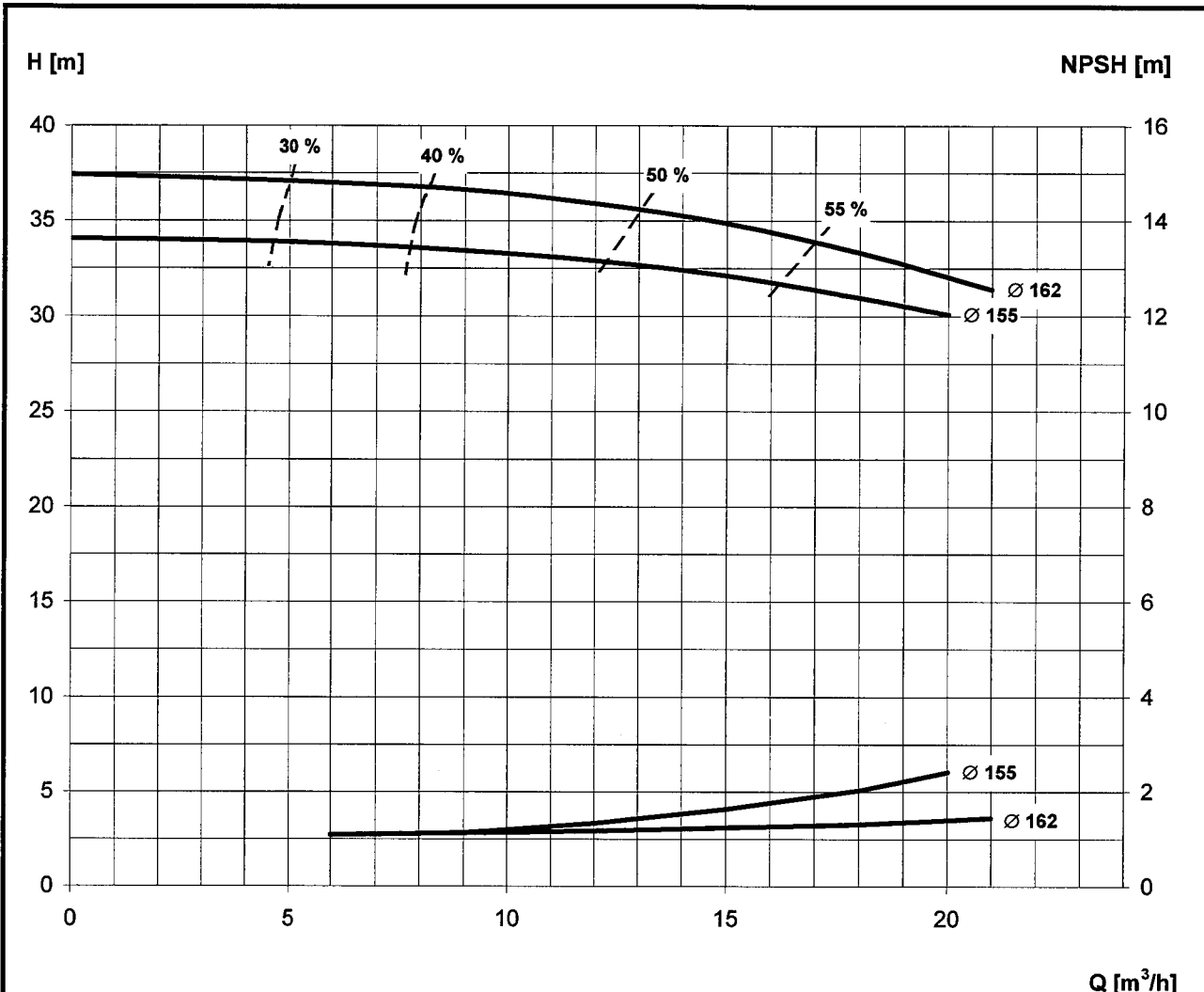
Name : Thomsen  
 Datum : 27.04.00

**FP 712**

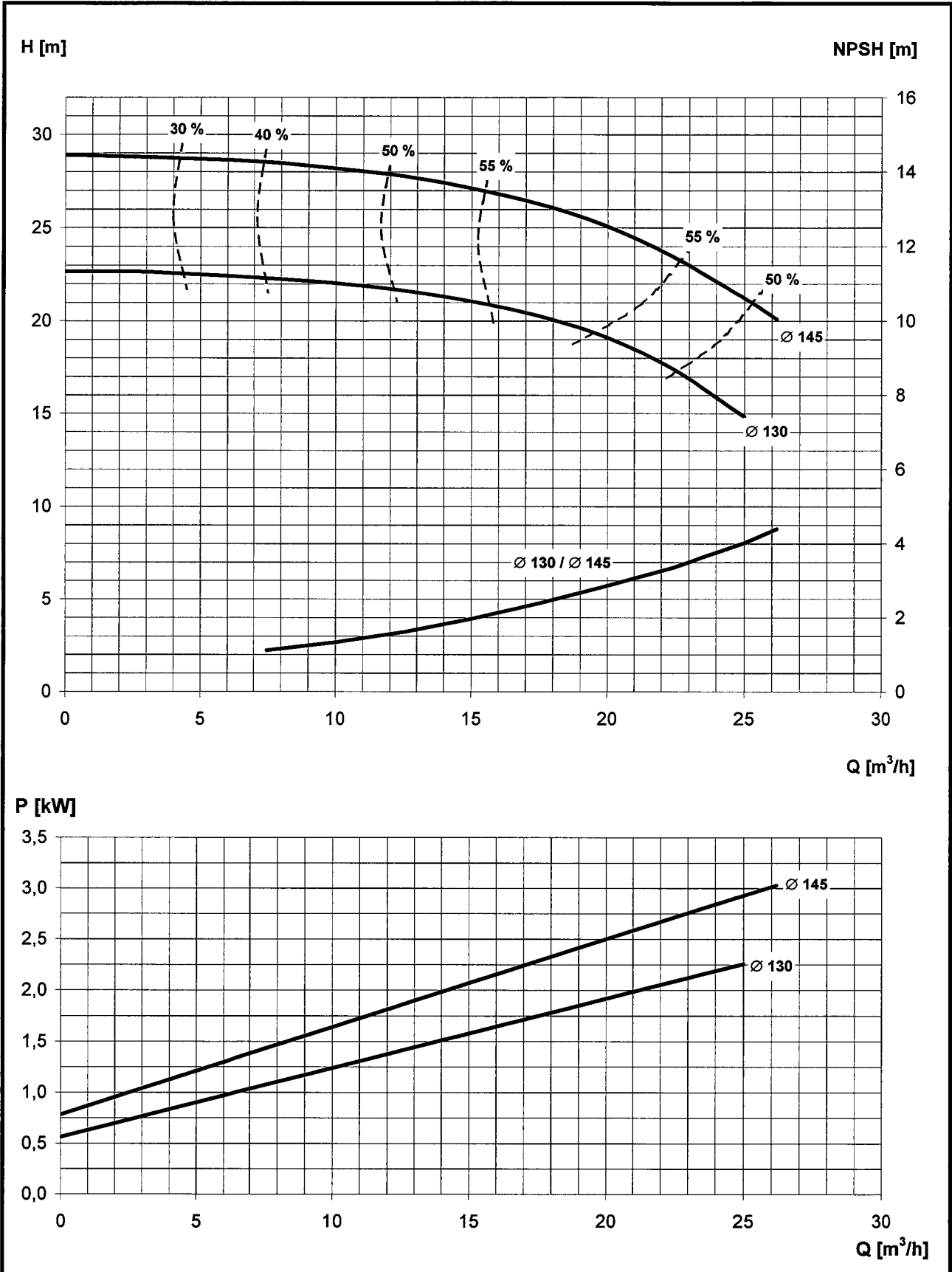
**Saugseite : DN 50**  
**Druckseite : DN 40**

$n = 2900 \text{ min}^{-1}$

**0413 85 1001**



zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 722 - BE</b>
	Datum : 25.07.00	
<b>Saugseite : DN 50</b> <b>Druckseite : DN 40</b>	<b>n = 2900 min<sup>-1</sup></b>	<b>0423 85 1001</b>



zulässige Leistungsschwankungen  $\pm 5\%$   
alle Angaben gelten für Wasser bei 20°C

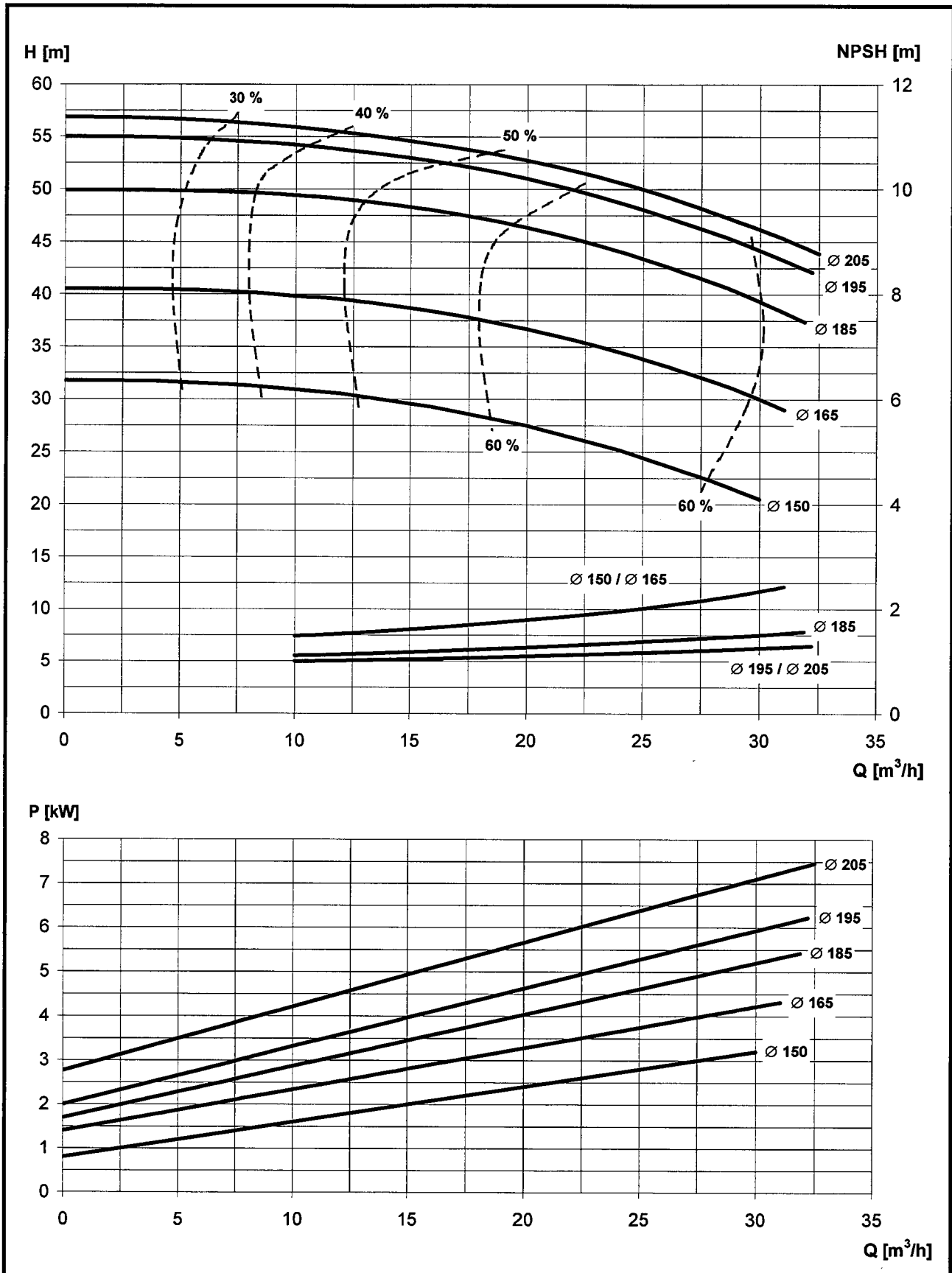
Name : Thomsen  
Datum : 25.07.00

**FP 722**

**Saugseite : DN 50**  
**Druckseite : DN 40**

$n = 2900 \text{ min}^{-1}$

**0423 85 1003**



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

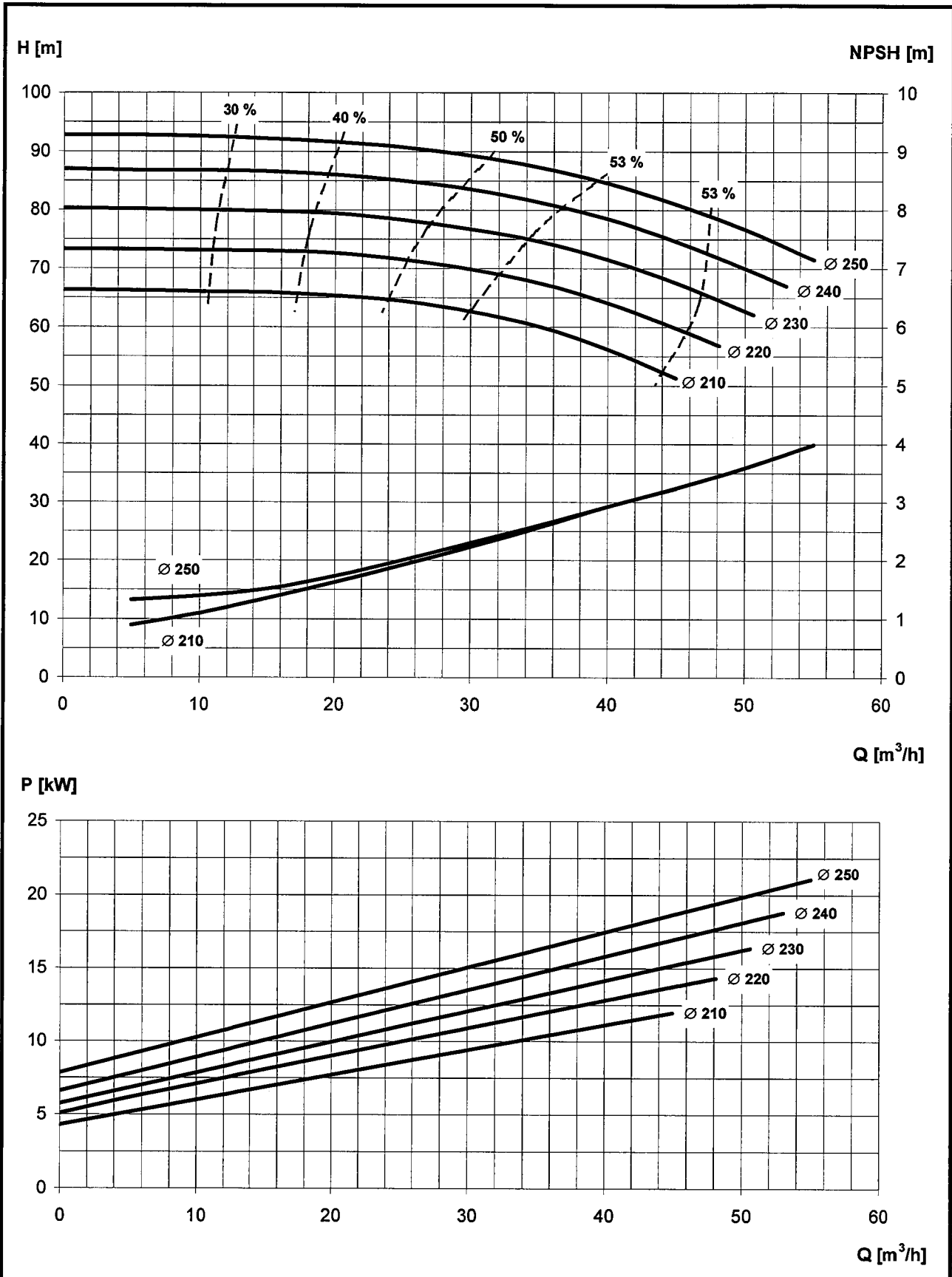
Name : Thomsen  
 Datum : 23.11.00

**FP 742**

**Saugseite : DN 65**  
**Druckseite : DN 50**

**n = 2900 min<sup>-1</sup>**

**0443 85 1001**



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

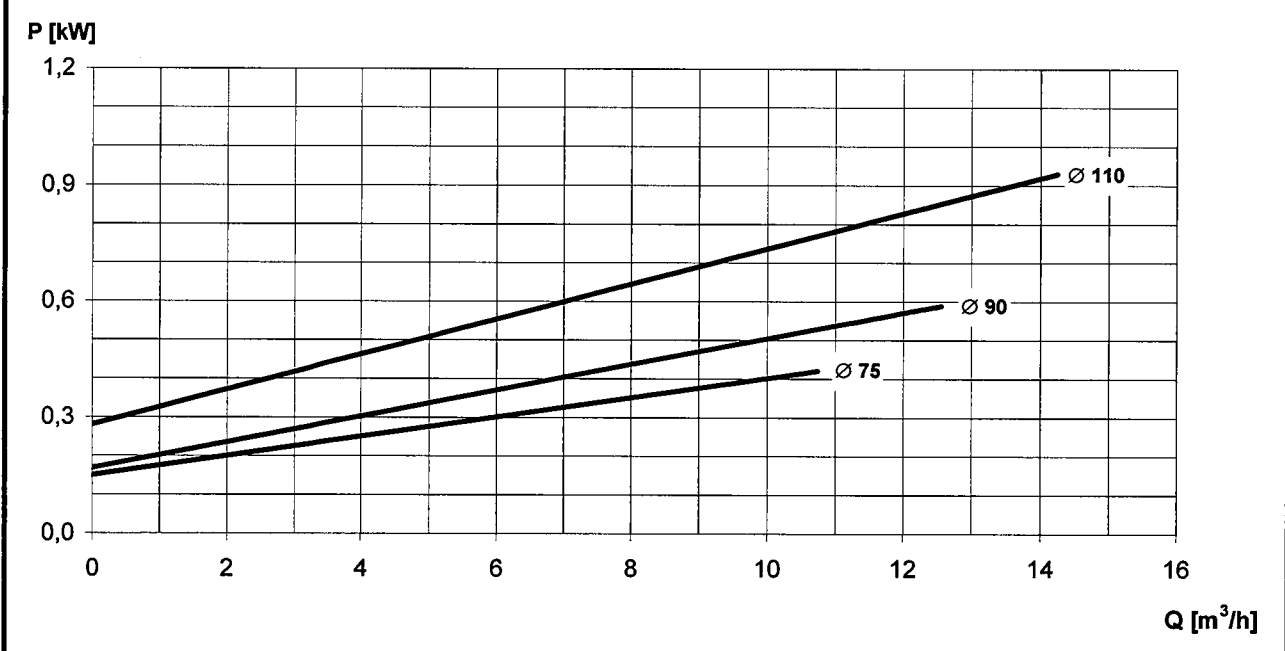
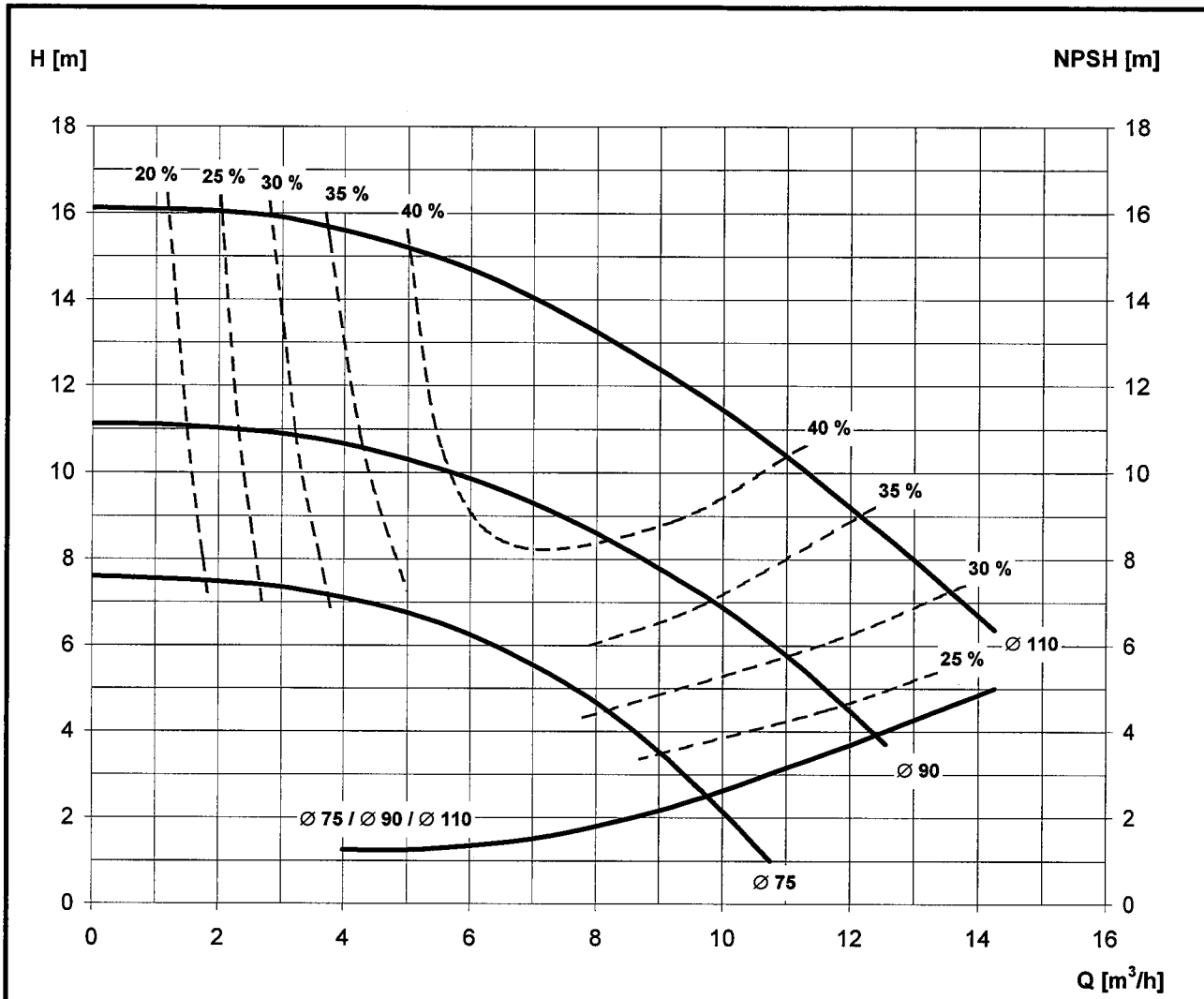
Name : Thomsen  
 Datum : 31.03.00

**FP 752**

**Saugseite : DN 80**  
**Druckseite : DN 50**

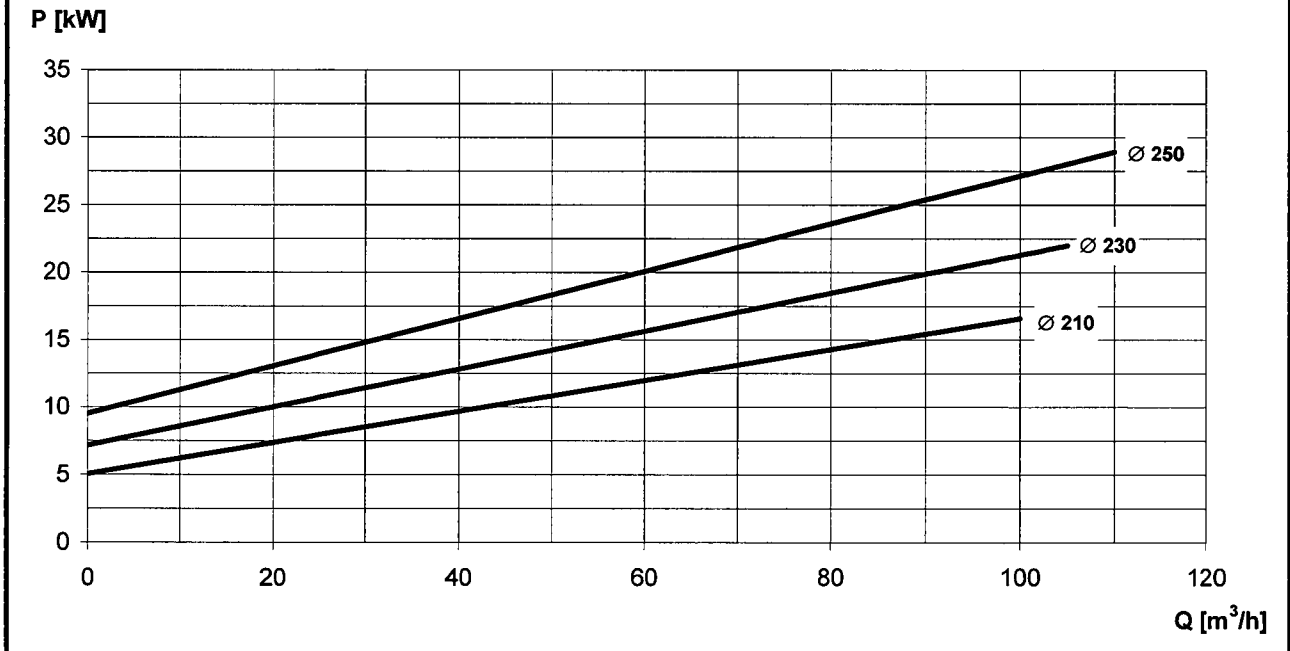
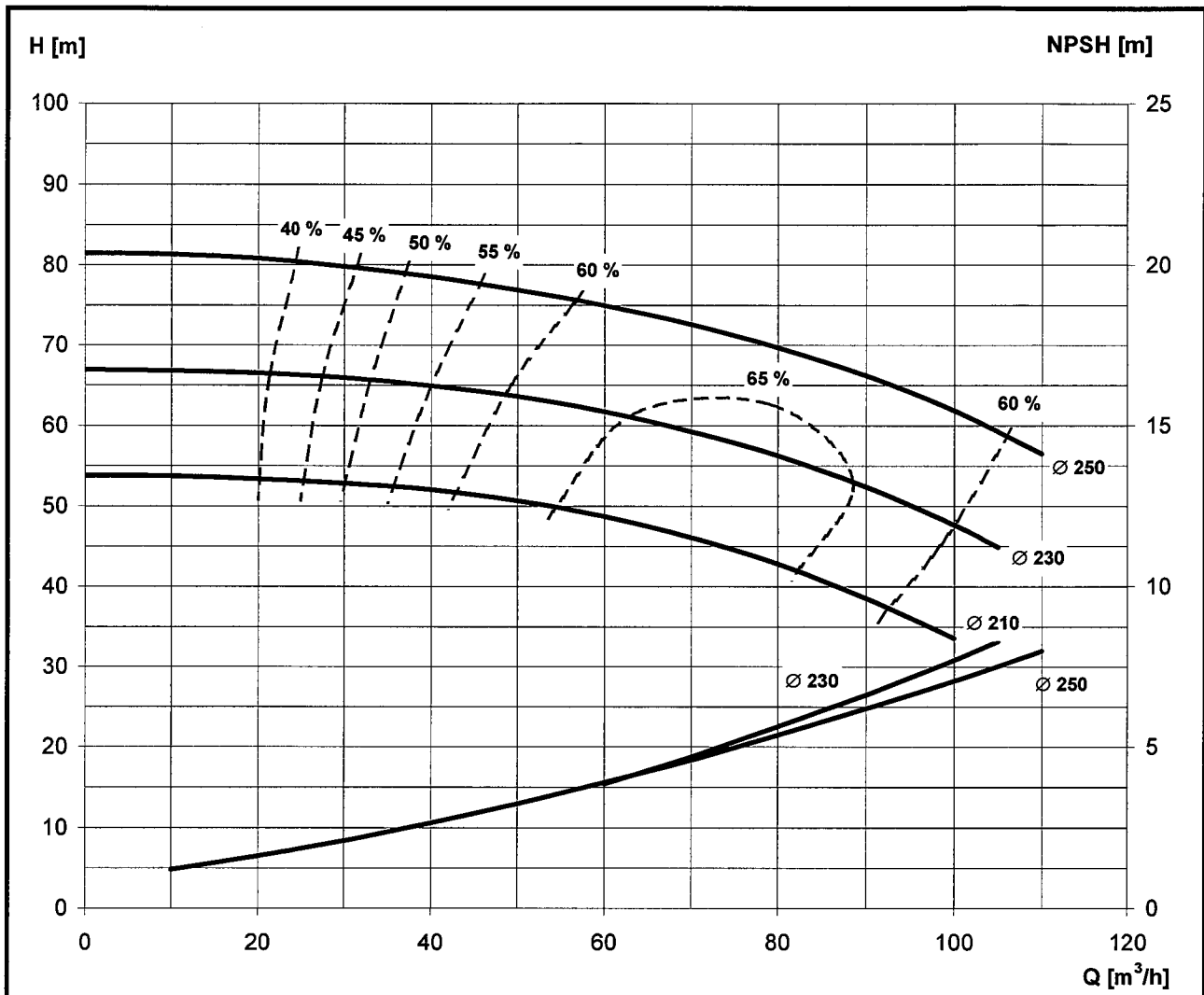
**n = 2900 min<sup>-1</sup>**

**0482 85 1001**

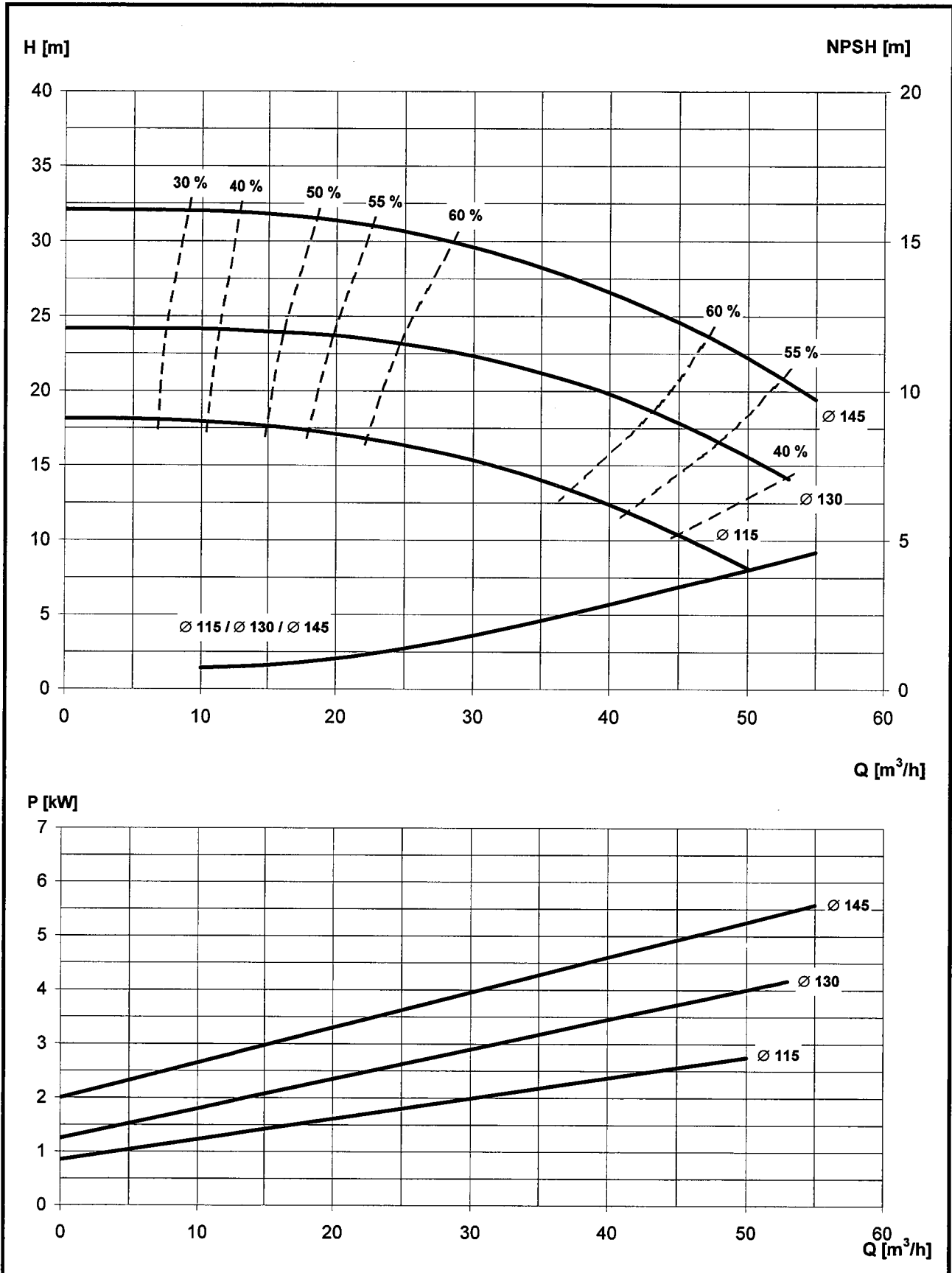


zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 3402</b>
	Datum : 25.05.00	
Saugseite : DN 40 Druckseite : DN 40	n = 2900 min <sup>-1</sup>	<b>0406 85 1001</b>





zulässige Leistungsschwankungen $\pm 5\%$ alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 3452</b>
	Datum : 21.08.00	
<b>Saugseite : DN 80</b> <b>Druckseite : DN 50</b>	<b><math>n = 2900 \text{ min}^{-1}</math></b>	<b>0456 85 1001</b>



zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei 20°C

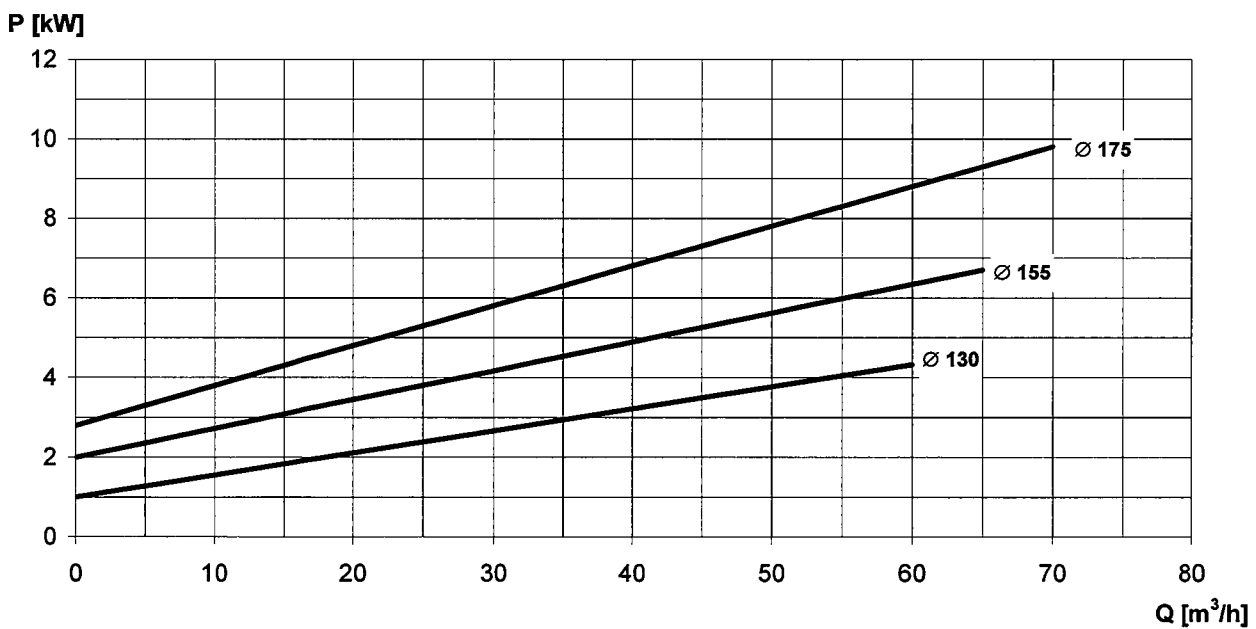
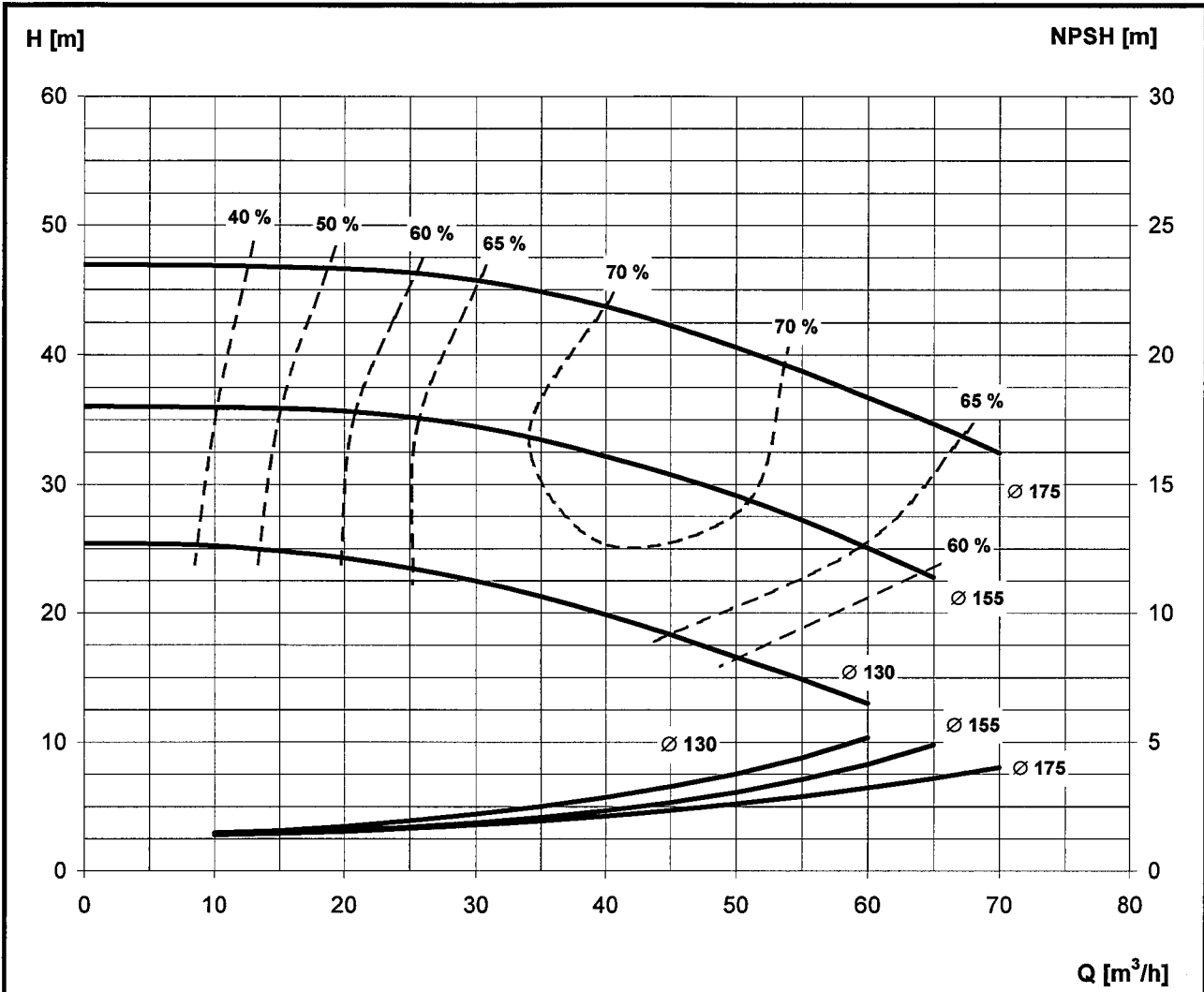
Name : Thomsen  
 Datum : 30.05.00

FP 3522

**Saugseite : DN 65**  
**Druckseite : DN 50**

n = 2900 min<sup>-1</sup>

0428 85 1001



zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei 20°C

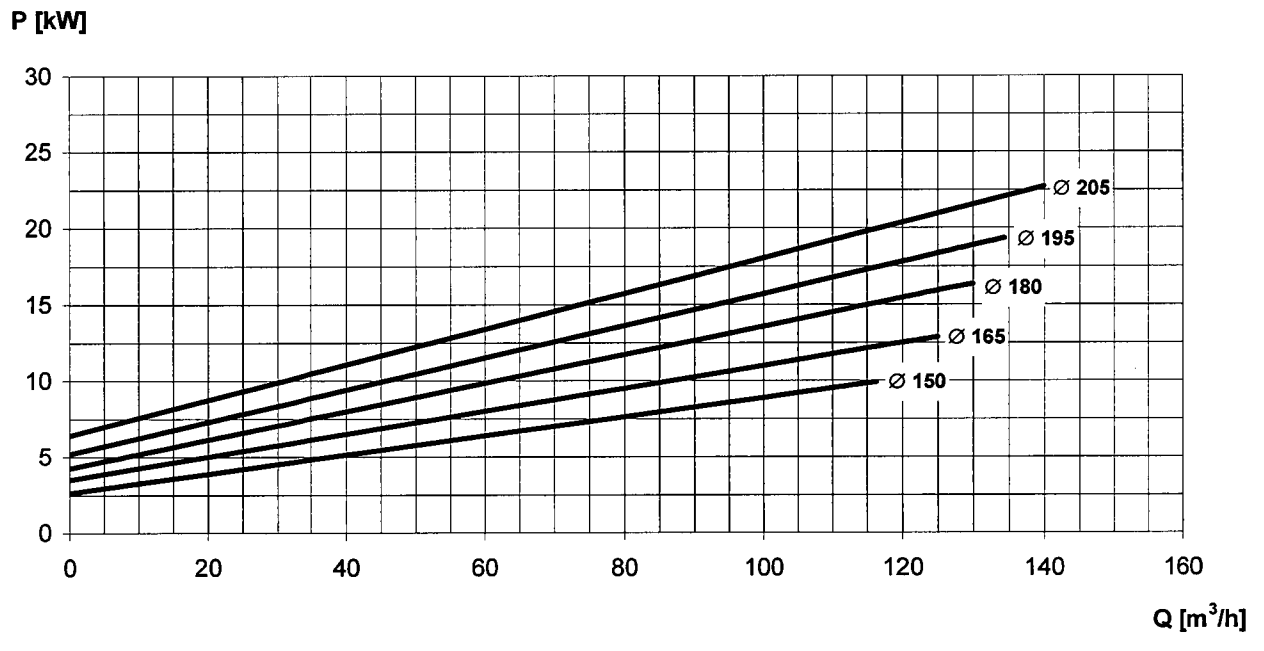
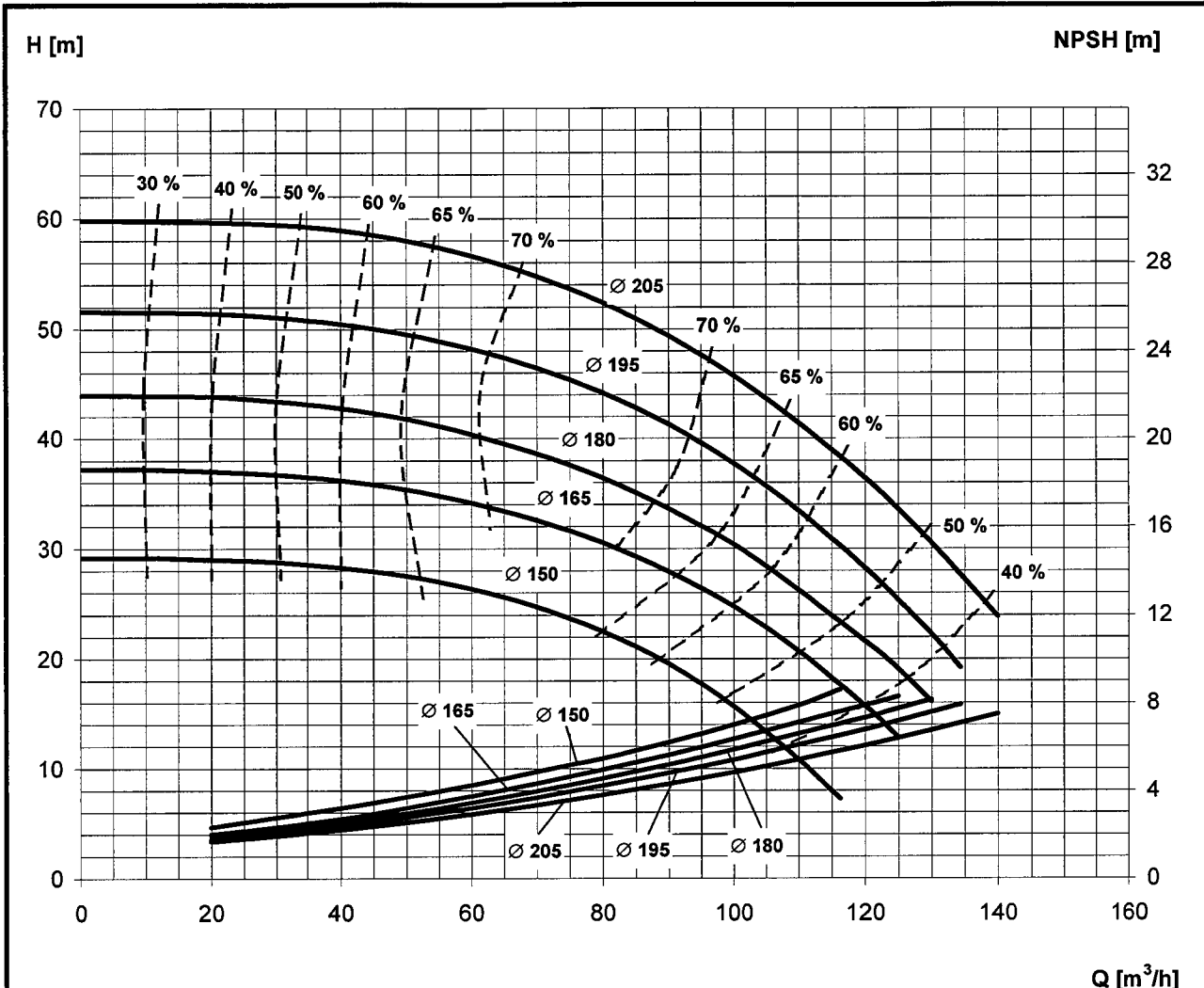
Name : Thomsen  
 Datum : 31.05.00

**FP 3532**

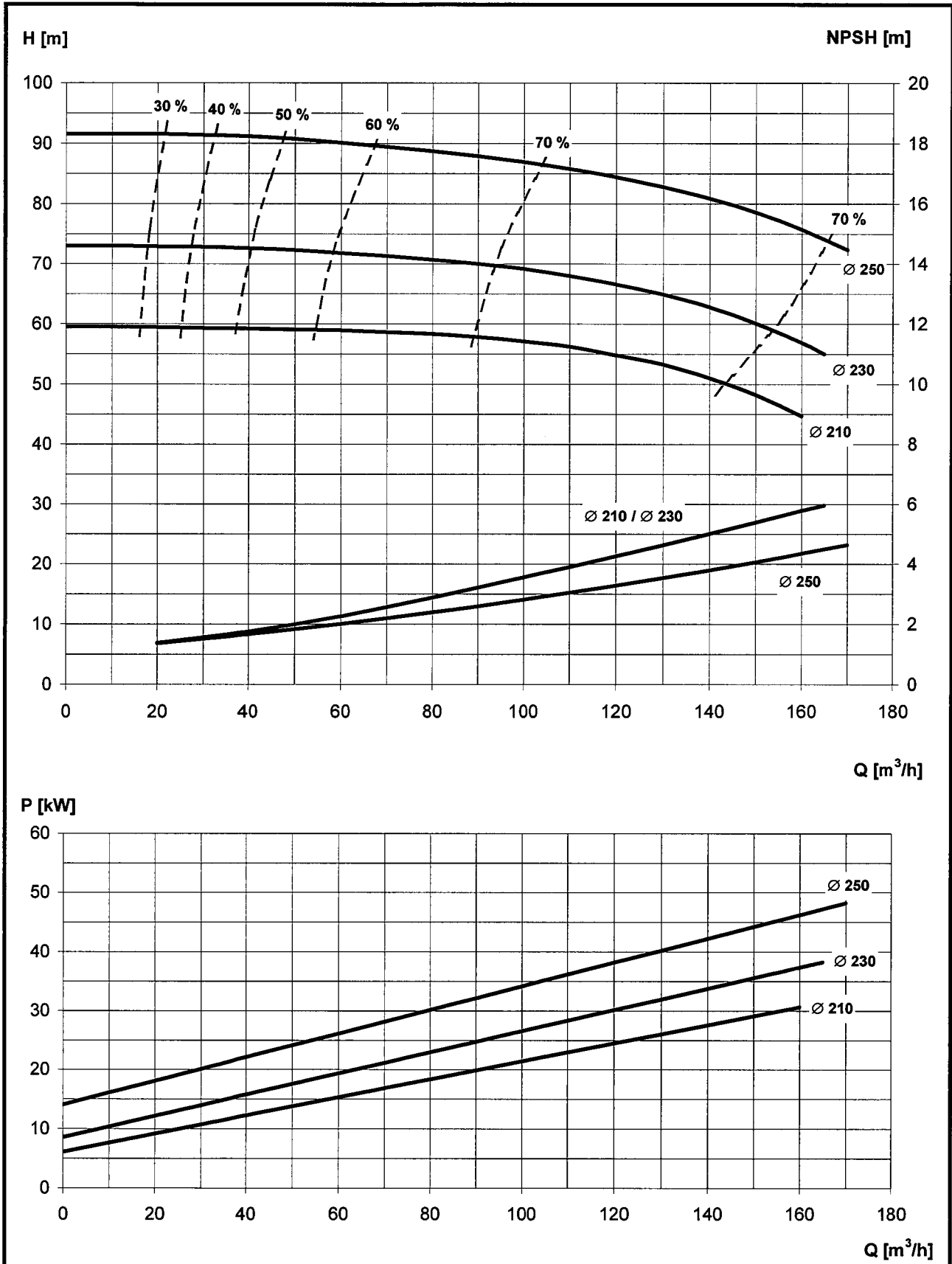
**Saugseite : DN 65**  
**Druckseite : DN 50**

**n = 2900 min<sup>-1</sup>**

**0438 85 1001**



zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 3542</b>
	Datum : 29.08.00	
Saugseite : DN 80 Druckseite : DN 65	n = 2900 min <sup>-1</sup>	<b>0448 85 1001</b>



zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei  $20^\circ C$

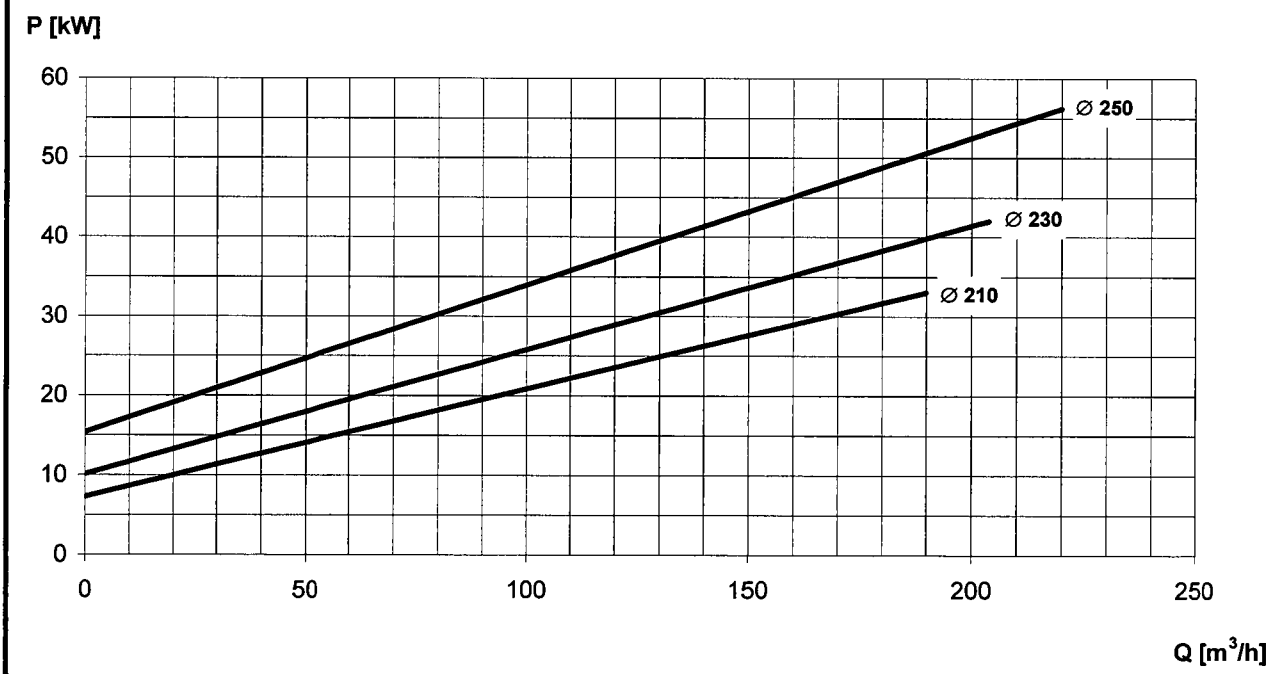
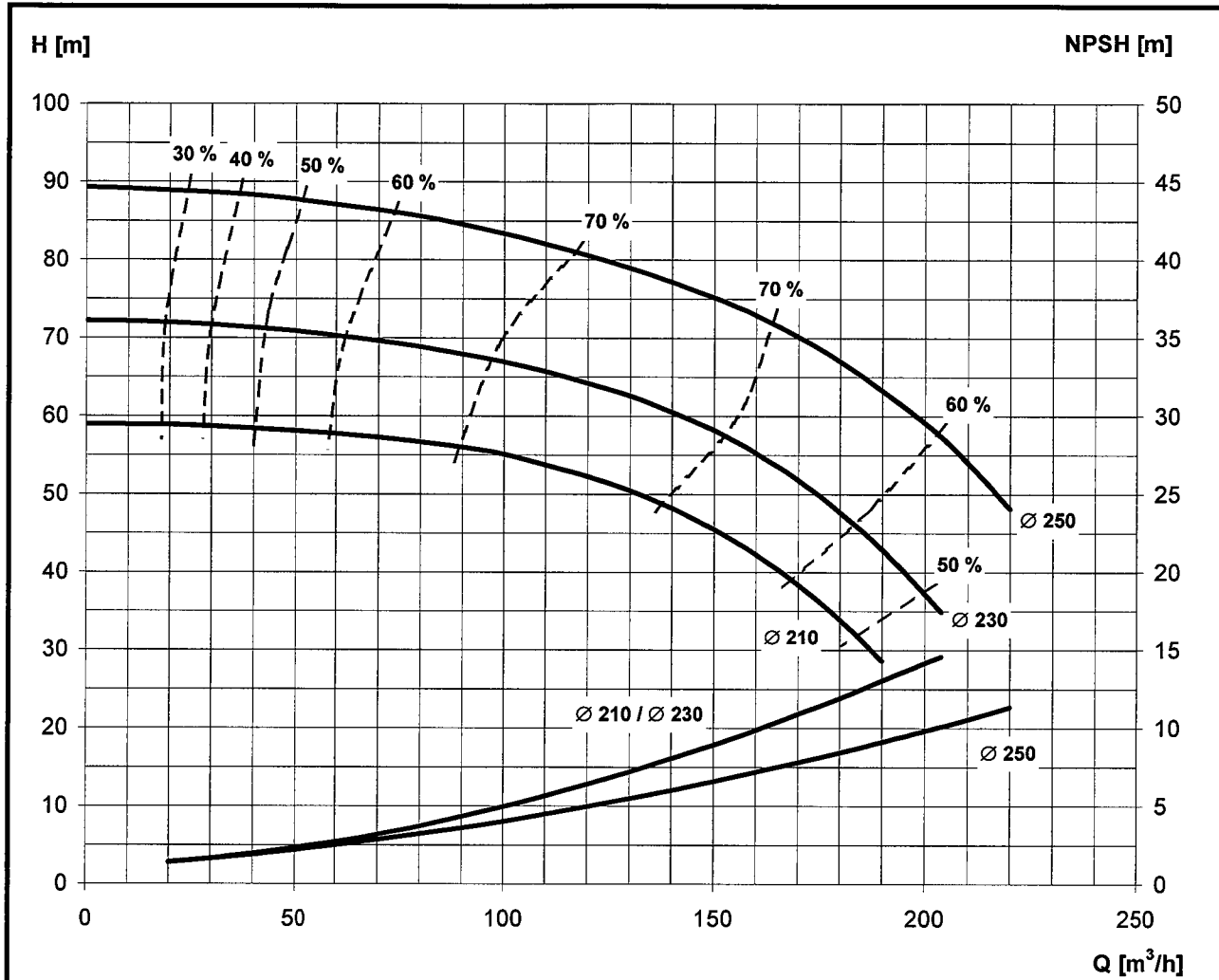
Name : Thomsen  
 Datum : 26.09.00

**FP 3552**

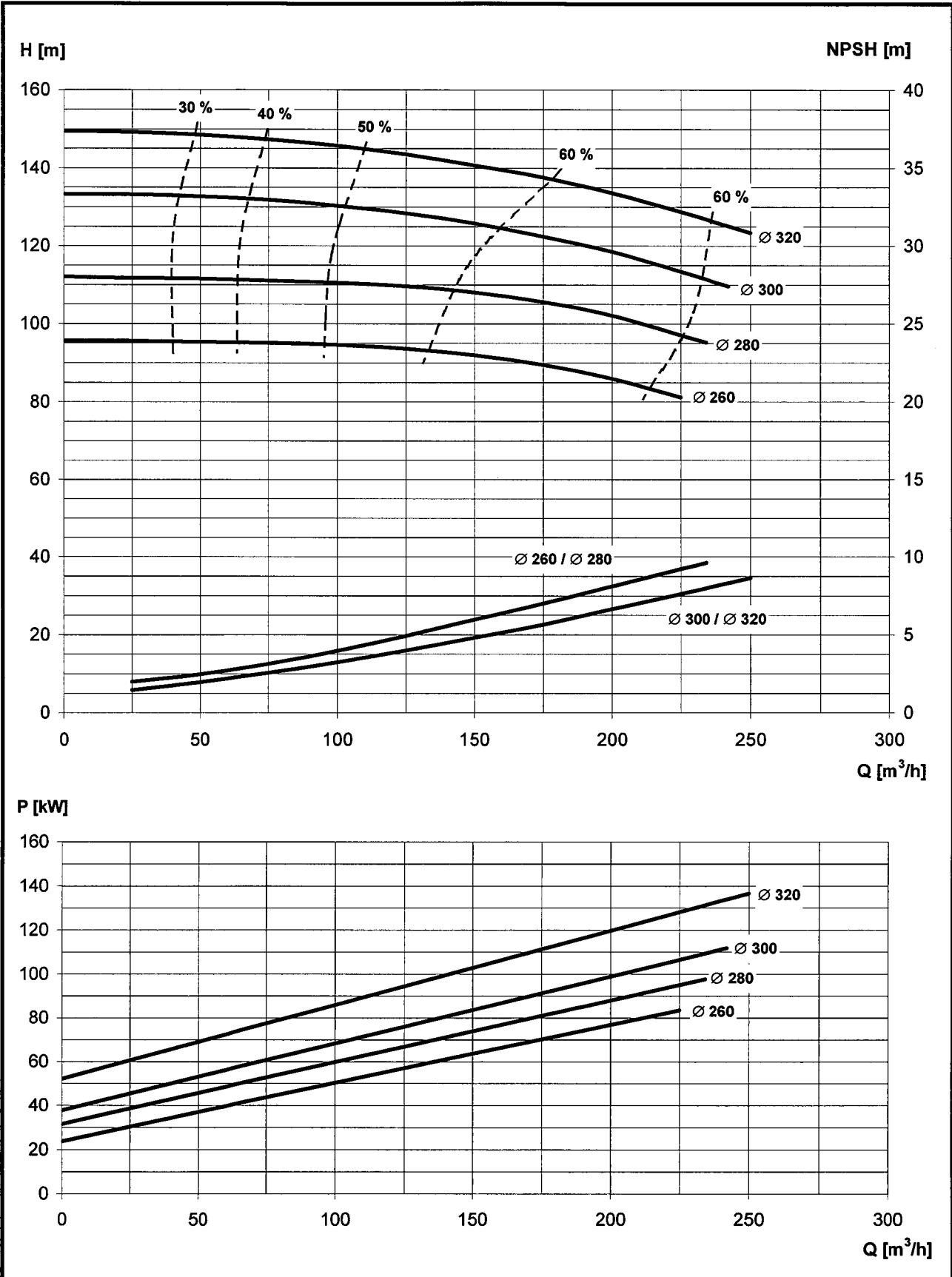
**Saugseite : DN 80**  
**Druckseite : DN 65**

$n = 2900 \text{ min}^{-1}$

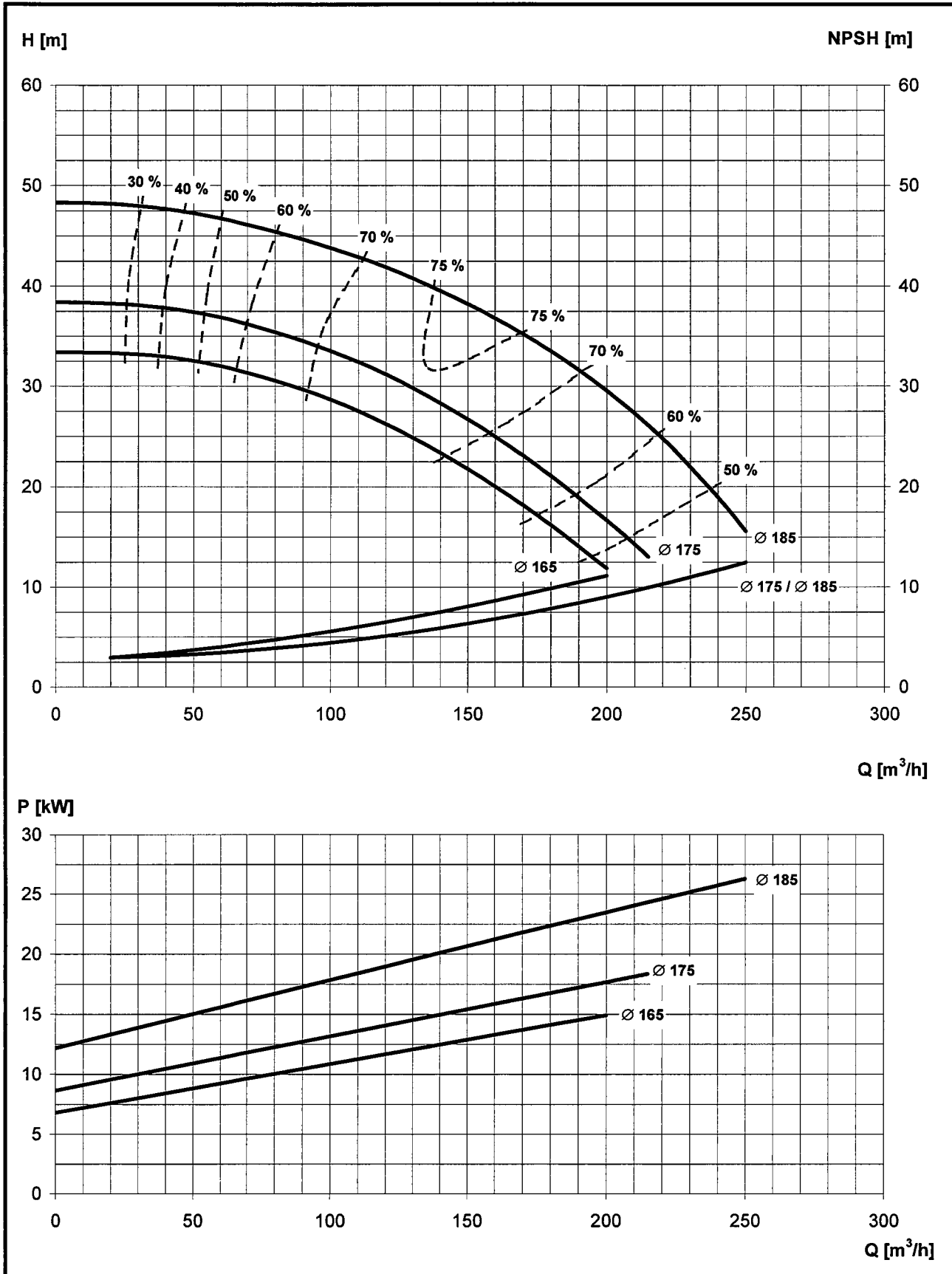
**0458 85 1001**



zulässige Leistungsschwankungen $\pm 5\%$ alle Angaben gelten für Wasser bei 20°C	Name : Thomsen	<b>FP 3552</b>
	Datum : 10.04.00	
<b>Saugseite : DN 100</b> <b>Druckseite : DN 65</b>	<b><math>n = 2900 \text{ min}^{-1}</math></b>	<b>0458 85 1002</b>



zulässige Leistungsschwankungen ± 5% alle Angaben gelten für Wasser bei 20°C	Name : Thomsen Datum : 01.11.00	<h2 style="margin: 0;">FP 1152</h2>
<b>Saugseite : DN 125</b> <b>Druckseite : DN 100</b>	<b>n = 2900 min<sup>-1</sup></b>	<h2 style="margin: 0;">0473 85 1002</h2>



zulässige Leistungsschwankungen ± 5%  
 alle Angaben gelten für Wasser bei 20°C

Name : Thomsen  
 Datum : 17.10.00

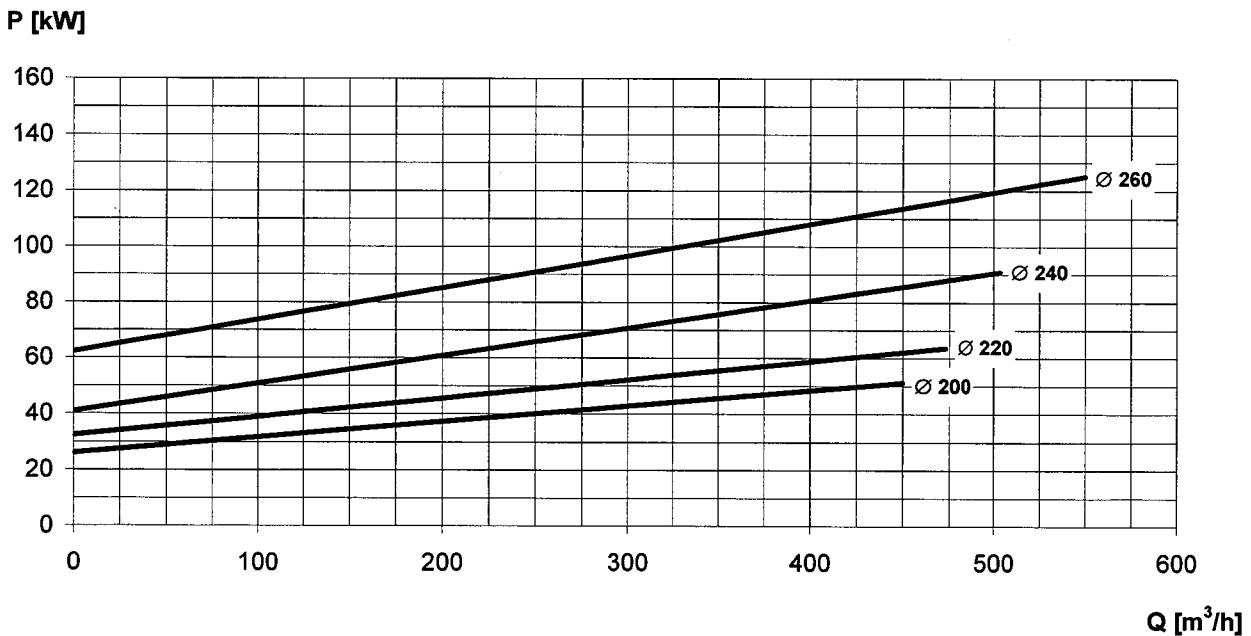
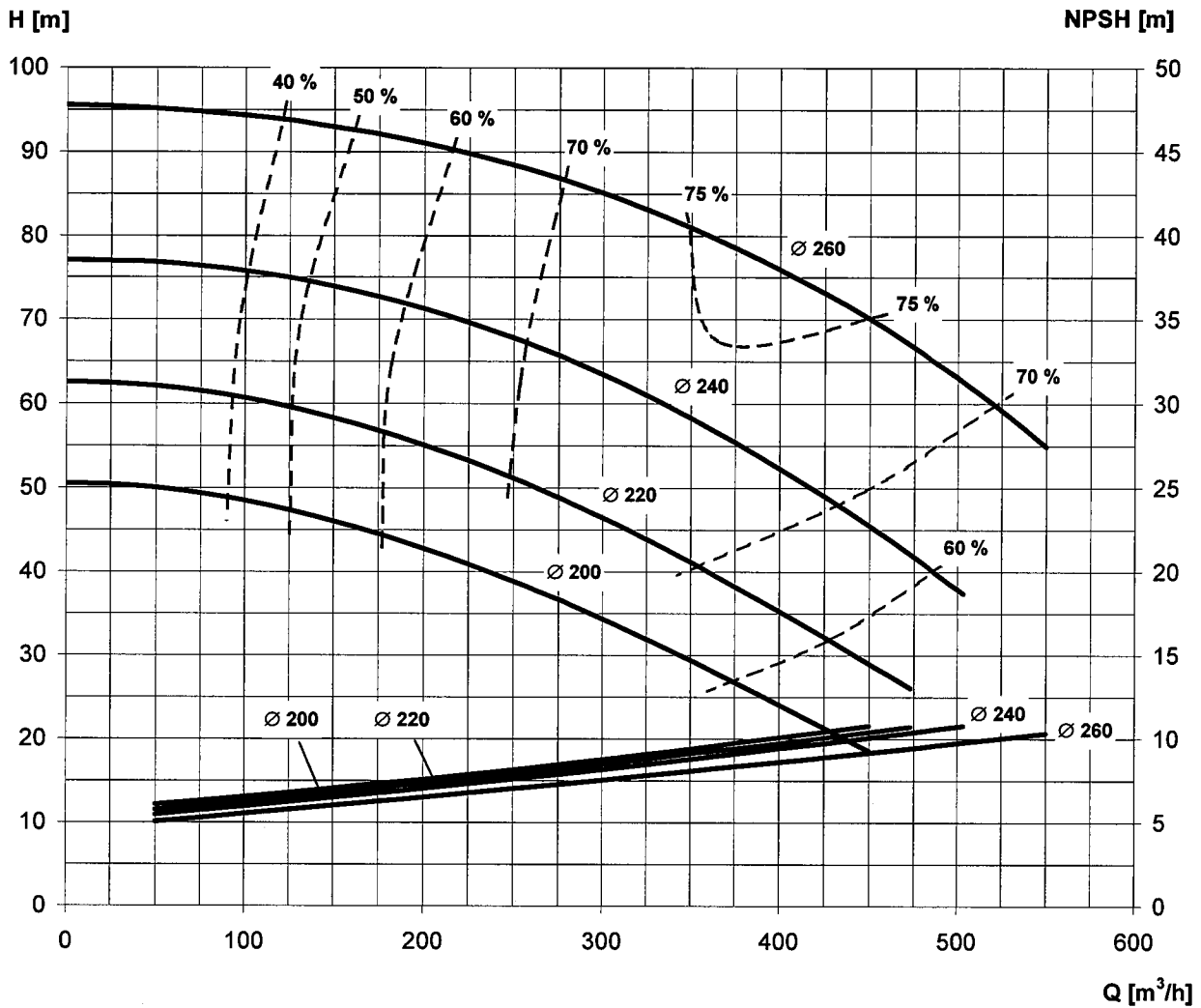
**FP 1232**

**Saugseite : DN 100**  
**Druckseite : DN 80**

**n = 2900 min<sup>-1</sup>**

**0474 85 1001**





zulässige Leistungsschwankungen  $\pm 5\%$   
 alle Angaben gelten für Wasser bei 20°C

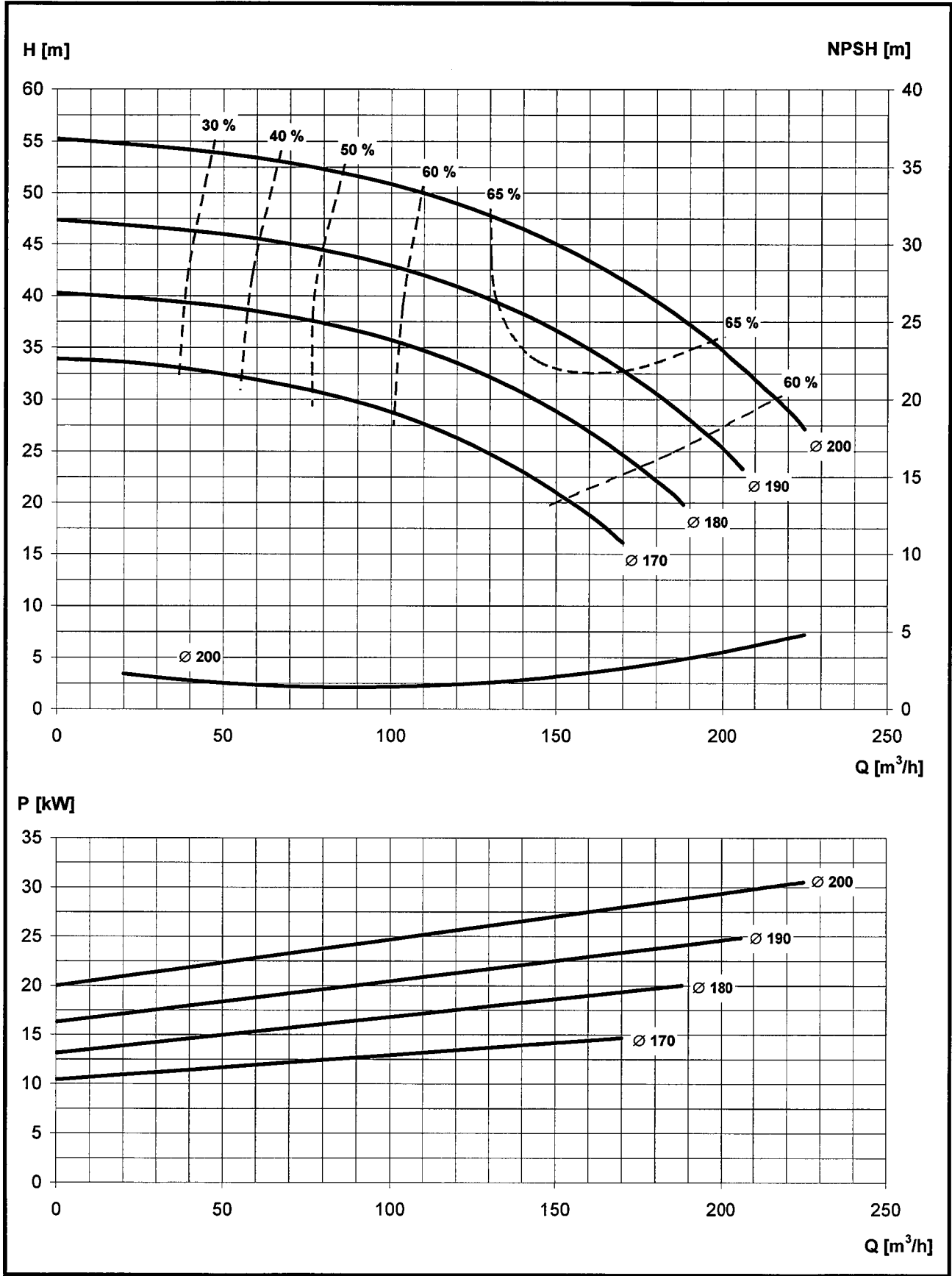
Name : Thomsen  
 Datum : 15.12.00

**FP 1252**

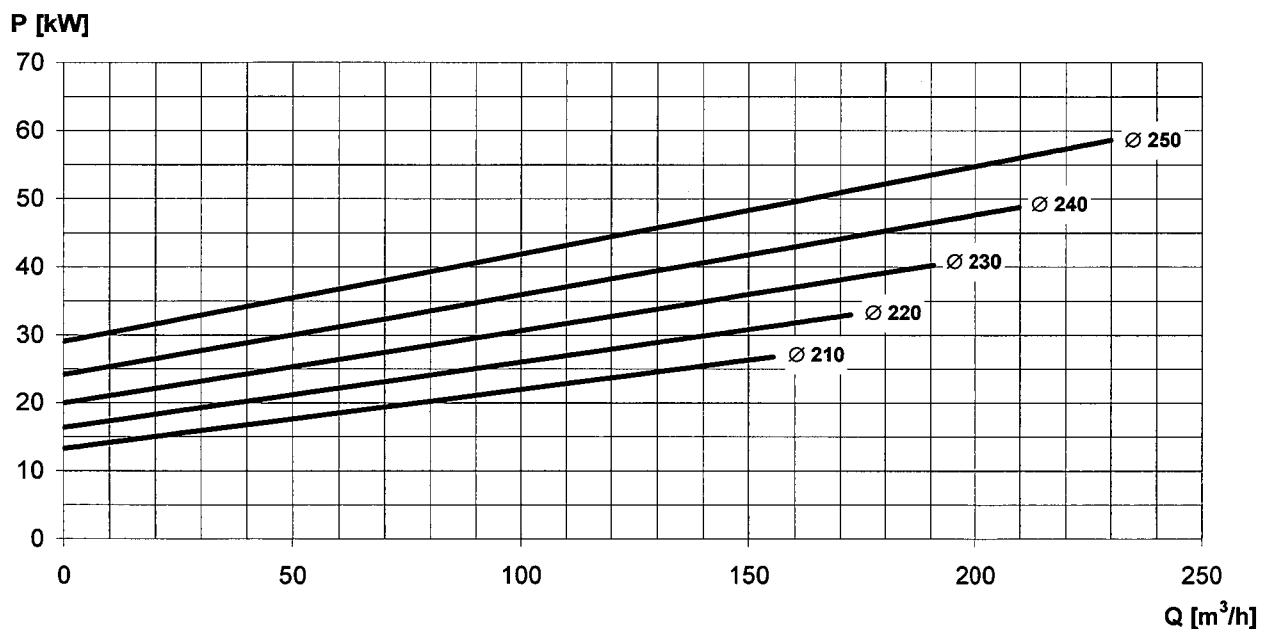
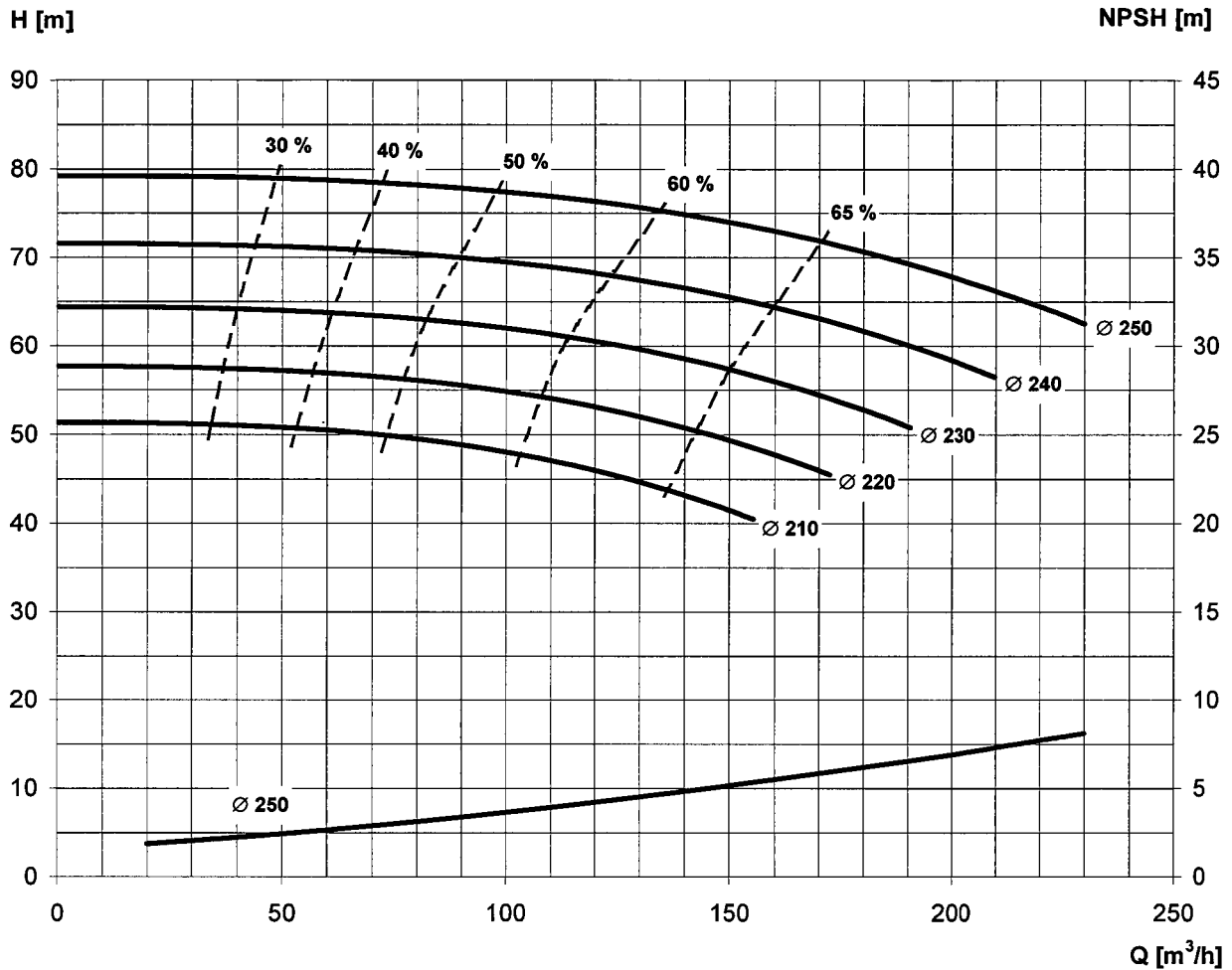
**Saugseite : DN 150**  
**Druckseite : DN 125**

$n = 2900 \text{ min}^{-1}$

**0475 85 1001**



zulässige Leistungsschwankungen $\pm 5\%$ alle Angaben gelten für Wasser bei $20^\circ C$	Name : Thomsen	<b>FP 102-200</b>
	Datum : 15.11.00	
<b>Saugseite : DN 125</b> <b>Druckseite : DN 100</b>	<b><math>n = 2900 \text{ min}^{-1}</math></b>	<b>0466 85 1001</b>



zulässige Leistungsschwankungen ± 5%  
alle Angaben gelten für Wasser bei 20°C

Name : Thomsen  
Datum : 15.11.00

**FP 102-250**

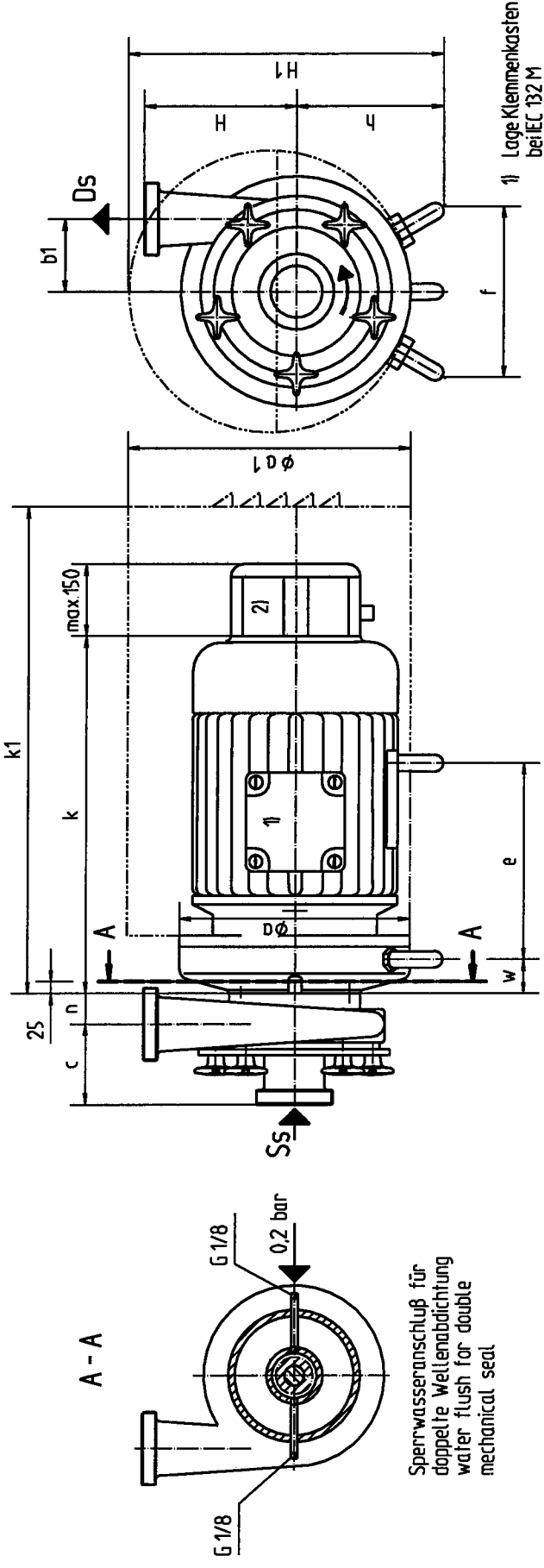
**Saugseite : DN 125**  
**Druckseite : DN 100**

**n = 2900 min<sup>-1</sup>**

**0468 85 1001**



Datum	Name	Auftrag
Bearb.		
Gepr.		



**A - A**  
 Sperrwasseranschluß für  
 doppelte Wellenabdichtung  
 water flush for double  
 mechanical seal

**Ausführung A :** mit Klotzen und Verkleidung  
 ss adj. feet and shroud

**Ausführung C :** mit Klotzen ohne Verkleidung  
 ss adj. feet without shroud

**Motor**  
 motor

**Maße  $\phi$ a, k und Motorgewichte sind abhängig vom Motorfabrikat**

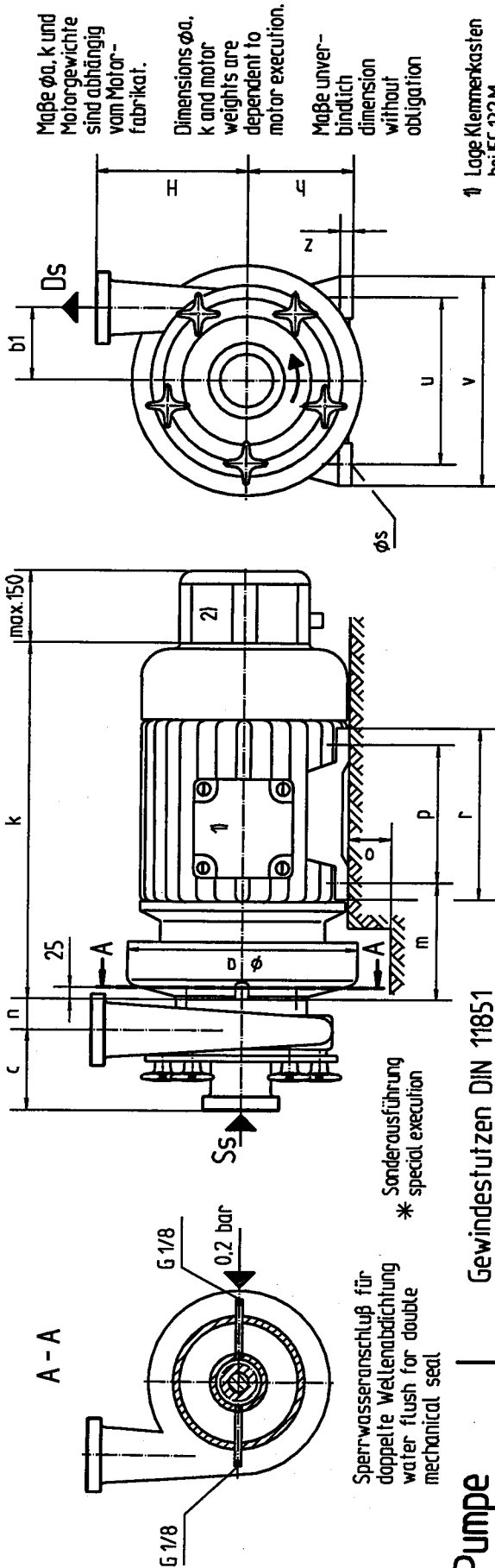
**Dimensions  $\phi$ a, k and motor weights are dependent to motor execution**

**Maße unverbindlich dimensions without obligation**

Pumpe pump Type	Gewindestutzen DIN 11851 thread DIN 11851										kg
	C - DN					H - DN					
	65	80	100	125	150	50	65	80	100	125	
FP 742	96	145	110	--	--	195	212	--	--	--	22
FP 752	110	145	94	--	--	205	--	--	--	--	50
FP 3441/3442	110	145	94	--	--	182	200	240	--	--	17
FP 3451/3452	140	145	112	112	112	182	200	240	--	--	24
FP 3522	80	46	100	--	--	162	180	190	243	14	14
FP 3531/3532	95	49	105	124	--	162	180	190	243	15	15
FP 3541/3542	115	47	99	99	--	218	182	200	220	19	19
FP 3551/3552	140	50	100	117	--	238	202	220	240	26	26
FP 1051/1052	170	46	--	--	--	148	--	--	231	51	51
FP 1151/1152	170	46	--	--	--	148	152	--	231	54	54
FP 3542 *	115	47	99	99	--	218	182	200	220	21	21

\* Sonderausführung  
 special execution

	Datum	Name	Auftrag
Bearb.			
Gepr.			



**Ausführung B :** mit Motorfuß ohne Verkleidung  
with foot mounted without shroud

### Motor motor

P [kW]  
n [1/min]

Motor	P [kW]	n [1/min]	Baugr. frame		φd	h	k	m	o	p	r	φs	u	v	z	kg
			2900	3500												
1450	11.0	1750	132 M	160 M	350	132	439	160	90	178	222	11	216	260	16,5	60
11.0	--	--	160 M	160 M	350	160	555	179	65	210	252	13,5	254	312	16,5	85
--	15.0	--	160 M	160 L	350	160	555	179	65	210	252	13,5	254	312	16,5	85
15.0	--	--	160 L	160 L	350	160	555	179	65	254	296	13,5	254	312	16,5	100
--	18.5	--	160 L	160 L	350	160	555	179	65	254	296	13,5	254	312	16,5	100
--	11.0	--	160 M	160 M	300	160	623	247	65	210	252	13,5	254	312	16,5	95
--	15.0	--	160 M	160 M	300	160	623	247	65	210	252	13,5	254	312	16,5	95

### Pumpe pump

Gewindestutzen DIN 11851  
thread DIN 11851

Typ type	b1	n	H - DN										kg		
			50	65	80	100	125	150	175	200	225	250			
FP 742	96	43	72	103	124	148	175	205	238	270	305	345	390	440	22
FP 752	145	44	72	103	124	148	175	205	238	270	305	345	390	50	
FP 344/3442	140	47	84	103	124	148	175	205	238	270	305	345	390	17	
FP 345/3452	140	47	85	103	124	148	175	205	238	270	305	345	390	24	
FP 3522	80	46	89	103	124	148	175	205	238	270	305	345	390	14	
FP 353/3532	95	49	87	103	124	148	175	205	238	270	305	345	390	15	
FP 354/3542	115	47	89	103	124	148	175	205	238	270	305	345	390	19	
FP 355/3552	140	50	90	103	124	148	175	205	238	270	305	345	390	26	
FP 1051/1052	170	46	--	--	--	--	--	--	--	--	--	--	--	51	
FP 1151/1152	170	46	--	--	--	--	--	--	--	--	--	--	--	54	
FP 3542 *	115	47	89	103	124	148	175	205	238	270	305	345	390	19	

Kreiselpumpe  
centrifugal pump

FP 34/35/740/750/1050/1150 B

7,5 kW

bis  
füll 18,5 kW

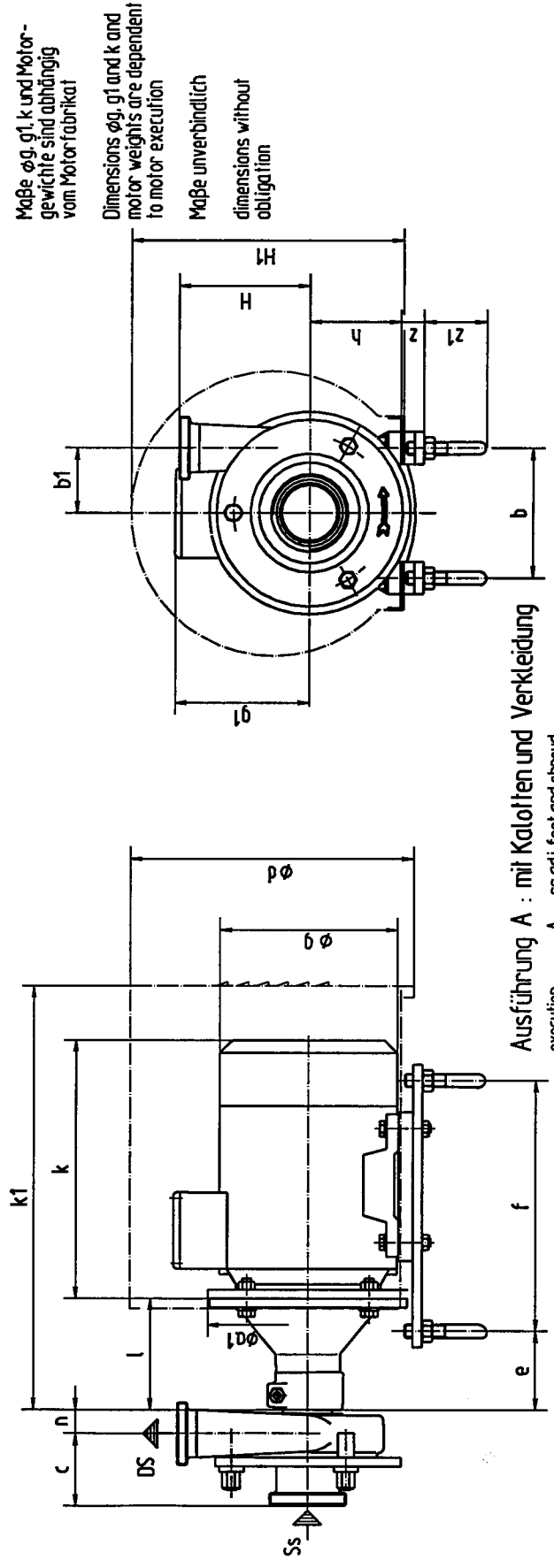
400 90 005 / 01.07







Datum	Name	Auftrag
Bearb.		
Gepr.		



Maße  $\phi$ , g, k und Motor-  
gewichte sind abhängig  
vom Motorfabrikat

Dimensions  $\phi$ , g, k and k and  
motor weights are dependent  
to motor execution

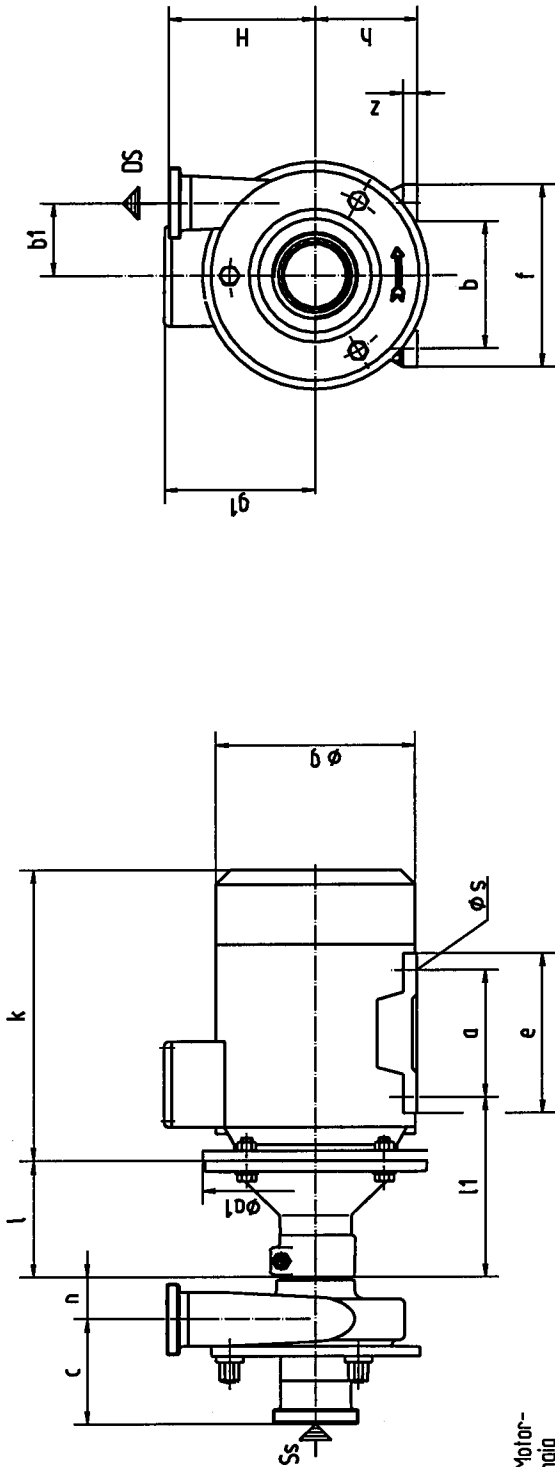
Maße unverbindlich  
dimensions without  
obligation

Ausführung A : mit Kalotten und Verkleidung  
execution A : ss adj feet and shroud

Ausführung C : mit Kalotten ohne Verkleidung  
execution C : ss adj feet without shroud

Pumpe pump Typ type	b1	n	Gewindestutzen thread DIN 11851 c - DN						H - DN	Klemm- scheibe clamping disc Ausf. l	Motor motor P [kW] n [1/min]	IEC Baugr. frame	$\phi$ 01	b	e	f	$\phi$ g	g1	h	k	z	z1	Verkleidg. shroud			
			40	50	65	80	100	100															kg	$\phi$ 1	H1	kg
FPE 711/712	58	22,5	83	83	83	83	83	83	147	147	0,75	80	125	68	320	159	129	80	255	35	65-85	9	300	456	275	
FPE 721/722	79	22,5	83	83	74	92	83	83	150	160	1,1	80	125	68	320	159	129	80	255	35	65-85	10	300	456	275	
FPE 741/742	96	28,5	72	72	108	110	72	72	195	212	1,5	90 S	200	140	320	176	148	90	244	25	65-85	13	300	456	285	
FPE 3401/3402	55	23	64	100	100	100	100	100	120	156	2,2	90 L	200	140	320	176	148	90	269	25	65-85	16	300	456	285	
FPE 3451/3452	141	33	85	95	112	112	85	85	182	200	3,0	100 L	250	160	320	196	155	100	303	35	65-85	23	350	530	320	
FPE 3521/3522	80	29	89	100	127	127	89	89	162	180	4,0	100 L	250	160	320	196	155	100	303	35	65-85	24	350	530	320	
FPE 3531/3532	95	31,5	87	105	124	124	87	87	162	180	5,5	112 M	250	190	320	220	168	112	320	35	65-85	30	350	530	332	
FPE 3541/3542	115	33	89	99	99	99	89	89	218	182	7,5	132 S	300	216	320	246	193	132	405	35	65-85	50	400	619	379	
FPE 3551	138	38	90	100	117	117	90	90	238	202	7,5	132 M	300	216	320	246	193	132	405	35	65-85	56	400	619	379	
											7,5															

Datum	Name	Auftrag
Bearb.	DS	
Gepr.		



Maße ø, g, l, k und Motor-  
gewichte sind abhängig  
vom Motorfabrikat

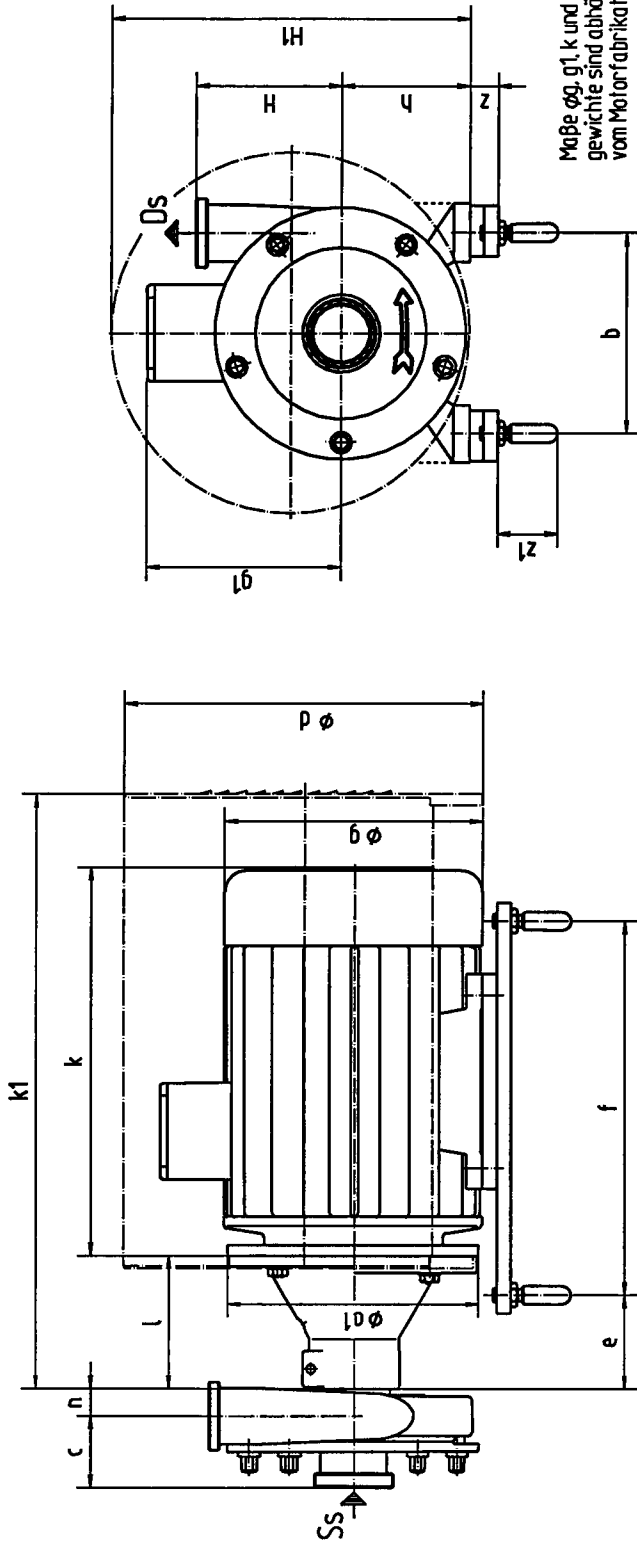
Dimensions ø, g, l and k and  
motor weights are dependent  
to motor execution

**Ausführung B : mit Motorfuß ohne Verkleidung**  
execution B : with motor feet without shroud

Technische Änderungen vorbehalten.  
Technical changes without notice.

Pumpe pump Typ type	Gewindestutzen DIN 11851 thread DIN 11851										Motor motor																
	C-DN					H-DN						Klemm- scheibe clamping disc	ø d1	a	b	e	f	ø g1	h	k	l1	ø s	z	kg			
b1	n	40	50	65	80	100	40	50	65	80	100														kg	ø 200	ø 250
FPE 711/712	58	39	83	83	83	92	110	120	147	150	156	160	162	180	190	212	240	240	243	14	9	10	9	10	9		
FPE 721/722	79	39	83	83	74	92	110	120	147	150	156	160	162	180	190	212	240	240	243	14	9	10	9	10	10	10	
FPE 741/742	96	41	83	83	72	92	110	120	147	150	156	160	162	180	190	212	240	240	243	15	9	10	11	11	13	13	
FPE 3401/3402	55	35	64	100	100	100	112	120	147	150	156	160	162	180	190	212	240	240	243	7	200	250	250	250	250	250	250
FPE 3451/3452	141	46	83	83	85	95	112	120	147	150	156	160	162	180	190	212	240	240	243	24	250	300	300	300	300	300	300
FPE 3521/3522	80	46	83	83	89	100	127	120	147	150	156	160	162	180	190	212	240	240	243	14	250	300	300	300	300	300	300
FPE 3531/3532	95	48	83	83	87	105	124	120	147	150	156	160	162	180	190	212	240	240	243	15	250	300	300	300	300	300	300
FPE 3541/3542	115	46	83	83	89	99	99	120	147	150	156	160	162	180	190	212	240	240	243	19	250	300	300	300	300	300	300
FPE 3551	138	51	90	100	117	117	117	120	147	150	156	160	162	180	190	212	240	240	243	26	300	300	300	300	300	300	300

	Datum	Name	Auftrag
Bearb.			
Gepr.			



Maße  $\phi$ , g, l, k und Motor-  
gewichte sind abhängig  
vom Motorfabrikat.

dimensions  $\phi$ , g, l and k and  
motor weights are dependent  
to motor execution.

Maße unverbindlich  
dimensions without  
obligation

**Ausführung: A - mit Kalotten und Verkleidung**

Execution : A - ss adj, feet with shroud

**Ausführung: C - mit Kalotten ohne Verkleidung**

Execution : C - ss adj, feet without shroud

**Pumpe**  
pump

Gewindestutzen  
thread

DIN 11851

C - DN

H - DN

Typ type	b1	n	Gewindestutzen thread DIN 11851 C - DN						H - DN						kg																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
			50	65	80	100	125	150	175	200	225	250	275	300																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
FPE 3451/3452	141	33	--	85	95	100	112	127	142	157	172	187	202	217	232	247	262	277	292	307	322	337	352	367	382	397	412	427	442	457	472	487	502	517	532	547	562	577	592	607	622	637	652	667	682	697	712	727	742	757	772	787	802	817	832	847	862	877	892	907	922	937	952	967	982	997	1012	1027	1042	1057	1072	1087	1102	1117	1132	1147	1162	1177	1192	1207	1222	1237	1252	1267	1282	1297	1312	1327	1342	1357	1372	1387	1402	1417	1432	1447	1462	1477	1492	1507	1522	1537	1552	1567	1582	1597	1612	1627	1642	1657	1672	1687	1702	1717	1732	1747	1762	1777	1792	1807	1822	1837	1852	1867	1882	1897	1912	1927	1942	1957	1972	1987	2002	2017	2032	2047	2062	2077	2092	2107	2122	2137	2152	2167	2182	2197	2212	2227	2242	2257	2272	2287	2302	2317	2332	2347	2362	2377	2392	2407	2422	2437	2452	2467	2482	2497	2512	2527	2542	2557	2572	2587	2602	2617	2632	2647	2662	2677	2692	2707	2722	2737	2752	2767	2782	2797	2812	2827	2842	2857	2872	2887	2902	2917	2932	2947	2962	2977	2992	3007	3022	3037	3052	3067	3082	3097	3112	3127	3142	3157	3172	3187	3202	3217	3232	3247	3262	3277	3292	3307	3322	3337	3352	3367	3382	3397	3412	3427	3442	3457	3472	3487	3502	3517	3532	3547	3562	3577	3592	3607	3622	3637	3652	3667	3682	3697	3712	3727	3742	3757	3772	3787	3802	3817	3832	3847	3862	3877	3892	3907	3922	3937	3952	3967	3982	3997	4012	4027	4042	4057	4072	4087	4102	4117	4132	4147	4162	4177	4192	4207	4222	4237	4252	4267	4282	4297	4312	4327	4342	4357	4372	4387	4402	4417	4432	4447	4462	4477	4492	4507	4522	4537	4552	4567	4582	4597	4612	4627	4642	4657	4672	4687	4702	4717	4732	4747	4762	4777	4792	4807	4822	4837	4852	4867	4882	4897	4912	4927	4942	4957	4972	4987	5002	5017	5032	5047	5062	5077	5092	5107	5122	5137	5152	5167	5182	5197	5212	5227	5242	5257	5272	5287	5302	5317	5332	5347	5362	5377	5392	5407	5422	5437	5452	5467	5482	5497	5512	5527	5542	5557	5572	5587	5602	5617	5632	5647	5662	5677	5692	5707	5722	5737	5752	5767	5782	5797	5812	5827	5842	5857	5872	5887	5902	5917	5932	5947	5962	5977	5992	6007	6022	6037	6052	6067	6082	6097	6112	6127	6142	6157	6172	6187	6202	6217	6232	6247	6262	6277	6292	6307	6322	6337	6352	6367	6382	6397	6412	6427	6442	6457	6472	6487	6502	6517	6532	6547	6562	6577	6592	6607	6622	6637	6652	6667	6682	6697	6712	6727	6742	6757	6772	6787	6802	6817	6832	6847	6862	6877	6892	6907	6922	6937	6952	6967	6982	6997	7012	7027	7042	7057	7072	7087	7102	7117	7132	7147	7162	7177	7192	7207	7222	7237	7252	7267	7282	7297	7312	7327	7342	7357	7372	7387	7402	7417	7432	7447	7462	7477	7492	7507	7522	7537	7552	7567	7582	7597	7612	7627	7642	7657	7672	7687	7702	7717	7732	7747	7762	7777	7792	7807	7822	7837	7852	7867	7882	7897	7912	7927	7942	7957	7972	7987	8002	8017	8032	8047	8062	8077	8092	8107	8122	8137	8152	8167	8182	8197	8212	8227	8242	8257	8272	8287	8302	8317	8332	8347	8362	8377	8392	8407	8422	8437	8452	8467	8482	8497	8512	8527	8542	8557	8572	8587	8602	8617	8632	8647	8662	8677	8692	8707	8722	8737	8752	8767	8782	8797	8812	8827	8842	8857	8872	8887	8902	8917	8932	8947	8962	8977	8992	9007	9022	9037	9052	9067	9082	9097	9112	9127	9142	9157	9172	9187	9202	9217	9232	9247	9262	9277	9292	9307	9322	9337	9352	9367	9382	9397	9412	9427	9442	9457	9472	9487	9502	9517	9532	9547	9562	9577	9592	9607	9622	9637	9652	9667	9682	9697	9712	9727	9742	9757	9772	9787	9802	9817	9832	9847	9862	9877	9892	9907	9922	9937	9952	9967	9982	9997

**Klemm-  
scheibe**  
clamping  
disc

**Motor**  
motor

Ausf.	l	kg	P [kW]		n [1/min]	IEC
			2900	3500		
$\phi$ 350	185	12	11,0	11,0	1450	160 M
$\phi$ 350	185	12	--	15,0	1750	160 M
$\phi$ 350	185	12	15,0	18,5		160 L
$\phi$ 350	185	12	18,5	22,0		180 M

Verkleidg. shroud	$\phi$ d	k1	z1	kg	h	k	z	z1	kg	Verkleidg. shroud	
										$\phi$ d	kg
	500	829	82	75-85	160	517	43	75-85	82	480	480
	500	829	91	75-85	160	517	43	75-85	91	480	480
	500	829	107	75-85	160	517	43	75-85	107	480	480
	500	829	129	75-85	180	578	23	75-85	129	500	500

Kreiselpumpe  
centrifugal pump

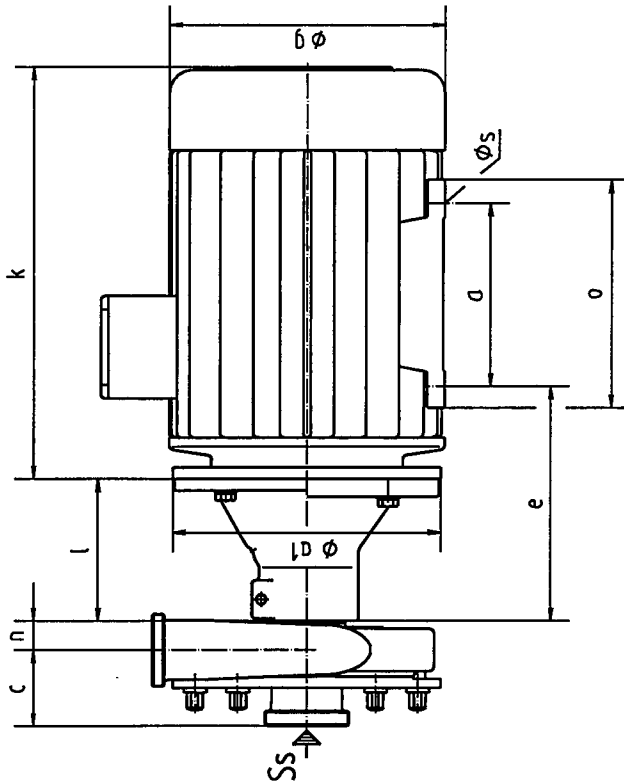
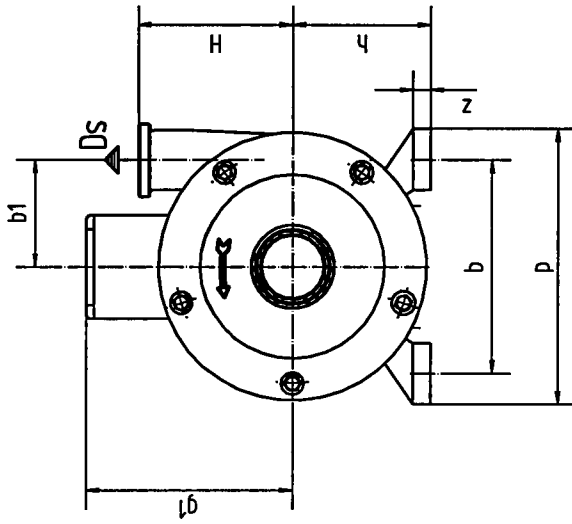
FPE 34/35/700 A C

11 kW

bs  
iii 22 kW

400 90 174 / 02.08

Datum	Name	Auftrag
Bearb.		
Gepr.		



Maße  $\phi$ , g1, k und Motor-gewichte sind abhängig vom Motorfabrikat.

dimensions  $\phi$ , g1 and k and motor weights are dependent to motor execution.

Maße unverbindlich dimensions without obligation

Ausführung: B - mit Motorfuß ohne Verkleidung

Execution : B - with motor feet without shroud

## Motor motor

Pumpe pump	Typ type	b1	n	Gewindestutzen DIN 11851 thread DIN 11851						H - DN	P [kW]	n [1/min]	IEC Baugr. frame	a	$\phi$ d1	b	e	$\phi$ g	g1	h	k	l	o	p	$\phi$ s	z	kg
				C - DN	50	65	80	100	120																		
FPE 3451 / 3452		141	33	--	85	95	100	112	182	200	240	--	24	210	350	254	293	312	250	160	517	185	260	320	14	22	82
FPE 3522		80	29	--	89	100	127	162	180	190	243	14	210	350	254	293	312	250	160	517	185	260	320	14	22	91	
FPE 3531 / 3532		95	33	--	87	105	124	162	180	190	243	17	254	350	254	293	312	250	160	517	185	304	320	14	22	107	
FPE 3541 / 3542		115	33	--	89	99	99	218	182	200	220	19	241	350	279	306	356	291	180	578	185	300	352	14	20	129	
FPE 3551 / 3552		138	38	--	90	100	117	238	202	220	240	26	18.5	180 M	241	350	356	291	180	578	185	300	352	14	20	129	
FPE 741 / 742		96	41	72	72	108	110	195	195	195	22	18.5	180 M	241	350	356	291	180	578	185	300	352	14	20	129		

Kreiselpumpe centrifugal pump

FPE 34 / 35 / 740 B

11 kW

bis fill 22 kW

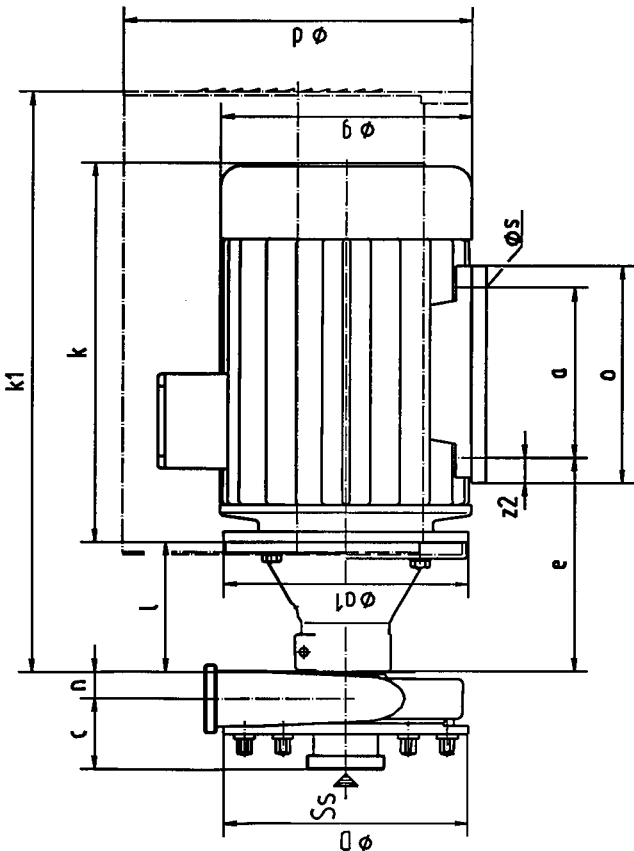
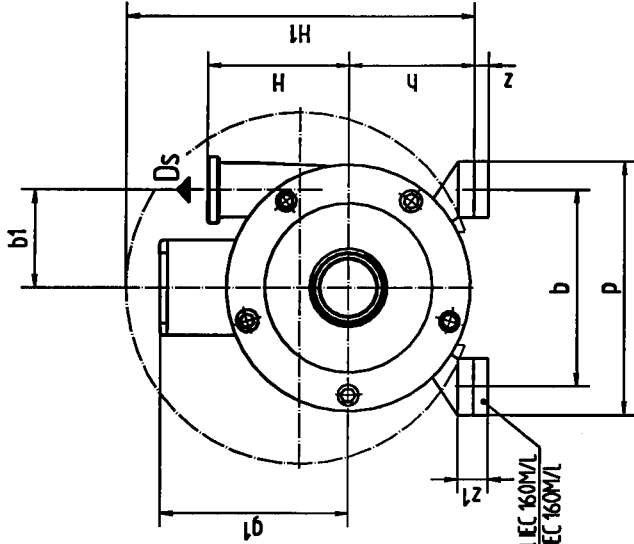
400 90 184 / 02.08

	Datum	Name	Auftrag
Bearb.			
Gepr.			

Maße  $\phi$ , g1, k, o, p und Motor-  
gewichte sind abhängig  
vom Motorfabrikat.

dimensions  $\phi$ , g1 and k, o, p and  
motor weights are dependent  
to motor execution.

Maße unverbindlich  
dimensions without  
obligation



### Ausführung D : mit Motorfuß und Verkleidung

Execution D : with motor feet and shroud

### Pumpe

### Gewindestutzen DIN 11851

Typ type	b1	n	$\phi$ D	C - DN				H - DN				kg
				50	65	80	100	50	65	80	100	
FPE 3451/3452	141	33	350	--	85	95	112	182	200	240	--	24
FPE 3522	80	29	230	--	89	100	127	162	180	190	243	14
FPE 3531/3532	95	33	260	--	87	105	124	162	180	190	243	17
FPE 3541/3542	115	33	290	--	89	99	99	218	182	200	220	19
FPE 3551/3552	138	38	350	--	90	100	117	238	202	220	240	26
FPE 741/742	96	41	270	72	108	110	195	212	--	--	--	22

### Klemmscheibe

Ausf.	l	kg
$\phi$ 350	185	12
$\phi$ 350	185	12
$\phi$ 350	185	12
$\phi$ 350	185	12
$\phi$ 350	185	12

### Motor

Motor	a	$\phi$ a1	b	e	$\phi$ g	g1	h	k	o	p	$\phi$ s	z	Z1	Z2	kg
160 M	210	350	254	293	312	220	160	517	320	318	14	23	45	32	77
160 M	210	350	254	293	312	220	160	517	320	318	14	23	45	32	91
160 L	254	350	254	293	312	220	160	517	320	318	14	23	45	32	107
180 M	241	350	279	306	356	178	180	578	300	356	14	3	23	29,5	129
180 L	279	350	279	306	356	178	180	578	340	356	14	3	23	30,5	140

### Verkleidg. shroud

$\phi$ d	k1	H1	kg
500	830	480	480
500	830	480	480
500	830	480	480
500	830	500	500
500	830	500	500

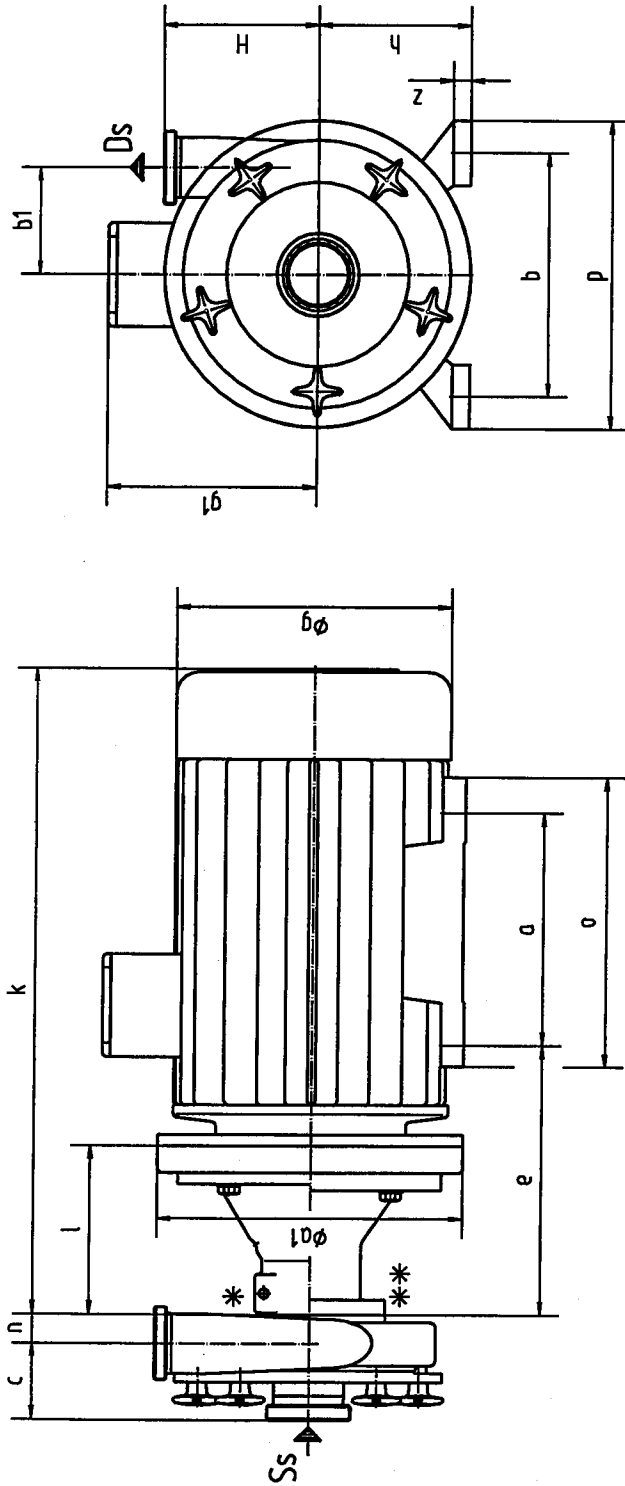
Kreiselpumpe  
centrifugal pump

FPE 34/35 740 D

11,0 kW bis 22,0 kW

400 90 194 / 02.04

Datum	Name	Auftrag
Bearb.		
Gepr.		



Maße  $\phi$ , g, g1, k und Motor-  
gewichte sind abhängig  
vom Motorfabrikat.

Dimensions g, g1, k and  
motor weights are dependent  
to motor execution.

Ausführung : B - ohne Verkleidung  
Execution : B - with out shroud

Pumpe pump	Gewindestutzen DIN 11851 thread DIN 11851										Motor motor																
	C - DN					H - DN																					
Type	b1	n	40	50	65	80	100	120	150	180	200	240	300	3000	Baugr. frame	$\phi a1$	e	a	o	$\phi g$	g1	h	k	z	b	p	kg
FPE 3452	141	33	--	--	85	95	112	--	182	245	240	--	24	30,0	200L	400	353	305	380	360	292	200	848	30	318	403	208
FPE 3542	115	33	--	--	89	99	99	--	218	182	200	220	19	37,0	200L	400	353	305	380	360	292	200	848	30	318	403	227
FPE 3552	138	38	--	--	90	90	117	--	238	202	220	240	26	45,0	225M	450	369	311	395	431	364	225	923	32	356	450	335
FPE 752	145	44	--	--	103	80	--	205	--	--	--	50	--	30,0	200L	400	319	305	380	360	292	200	814	30	318	403	208

Kreiselpumpe  
centrifugal pump

FPE 750/3400/3500

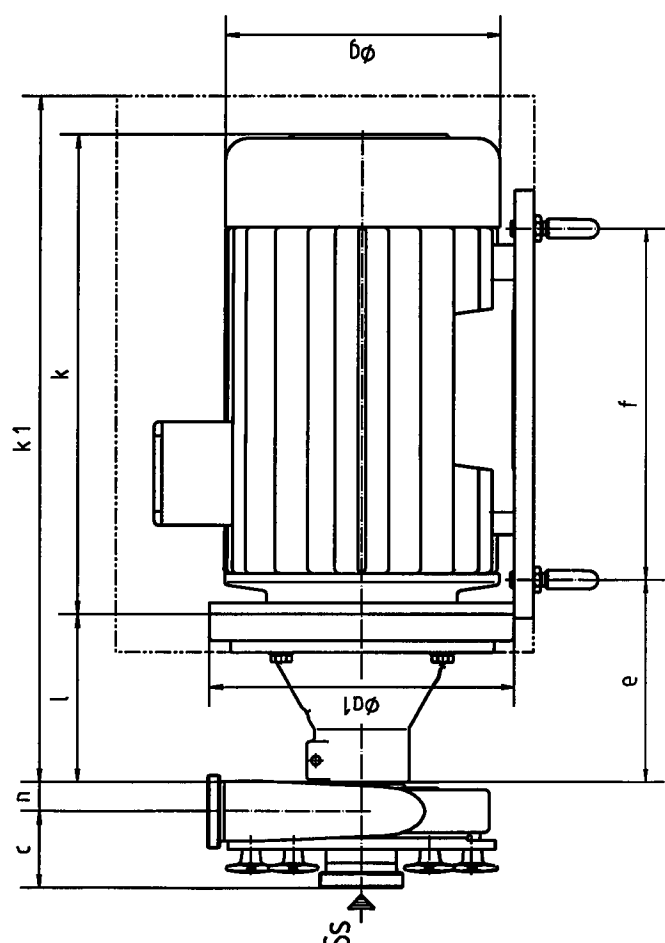
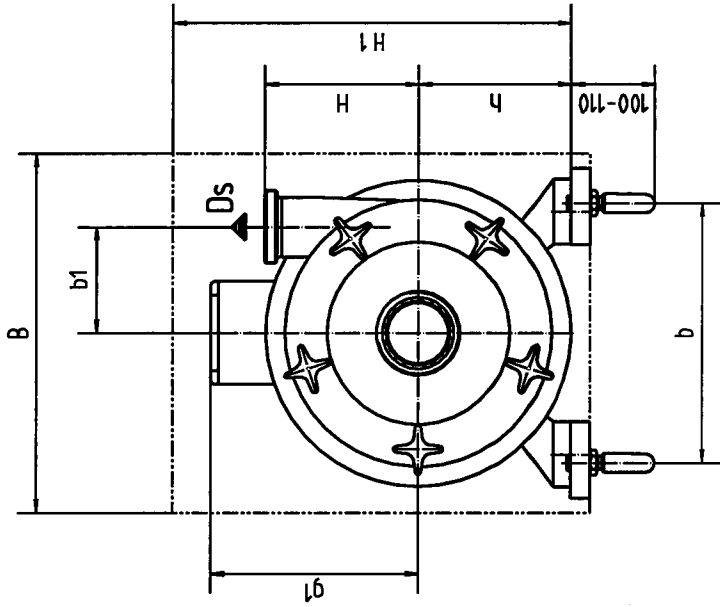
B

bis  
till

45,0kW

400 90 045 / 0104

Datum		Name		Auftrag	
Bearb.					
Gepr.					



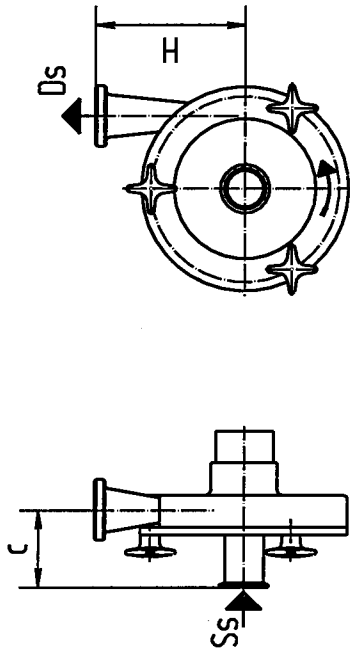
Maße  $\phi$  g, g1, k und Motor-  
gewichte sind abhängig  
vom Motorfabrikat.  
Dimensions g, g1, k and  
motor weights are dependent  
to motor execution.

Ausführung : C - ohne Verkleidung  
Execution : C - with out shroud

Ausführung : A - mit Kalotten und Verkleidung  
Execution : A - ss adj. feet and shroud

Pumpe pump	Type	b1	n	Gewindestutzen DIN 11851 thread DIN 11851								Klemm- scheibe clamping disc	Verkleidung shroud	Motor motor																
				C - DN				H - DN							Ausf. l	kg	B	H1	k1	kg	P (kW) 1/min	Baugr. frame	$\phi a1$	e	f	$\phi g$	g1	h	k	b
FPE 3452	140	33	--	40	50	65	80	100	40	50	65	80	100	kg																
FPE 3542	115	33	--	--	85	95	112	--	182	200	240	--	24	19	480	577	1089	30	37,0	200L	400	218	580	360	290	200	628	318	227	
FPE 3552	140	38	--	--	90	100	117	--	238	202	220	240	26	26	480	577	1089	30	45,0	225M	450	269	550	470	344	225	735	386	330	

Datum	Name	Auftrag
Bearb.		
Gepr.		



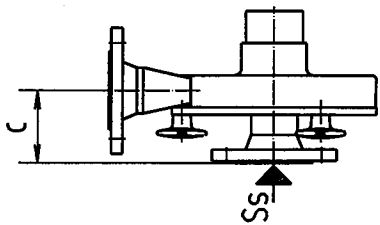
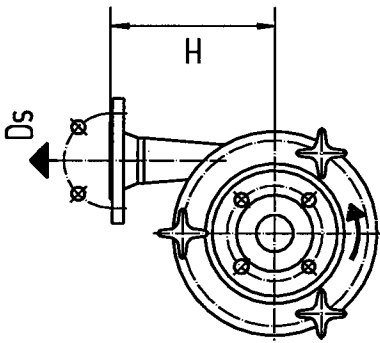
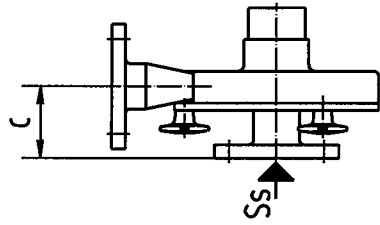
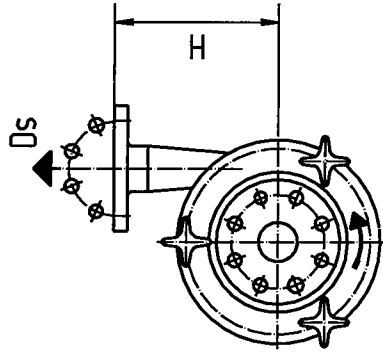
Pumpe pump	RJT(BS4825) - Gewindestutzen RJT(BS4825) - thread						SMS - Gewindestutzen sms - thread						RJT(AS1528) - Gewindestutzen RJT(AS1528) - thread														
	C - DN			H - DN			C - DN			H - DN			C - DN			H - DN											
Type	1 1/2"	2"	2 1/2"	3"	4"	6"	1 1/2"	2"	2 1/2"	3"	4"	5"	1 1/2"	2"	2 1/2"	3"	4"	1 1/2"	2"	2 1/2"	3"	4"	1 1/2"	2"	2 1/2"	3"	4"
FP 711/712	91	92	92	92	92	92	147	170	91	91	91	91	91	147	160	163	163	147	160	160	163	163	147	160	160	163	163
FP 721/722	92	92	92	92	92	92	160	168	92	92	92	92	92	160	160	163	163	160	160	160	163	163	160	160	160	163	163
FP 741/742	92	92	92	92	92	92	195	195	92	92	92	92	92	195	195	195	195	195	195	195	195	195	195	195	195	195	195
FP 3401/3402	74	74	74	74	74	74	128	128	74	74	74	74	74	128	128	128	128	128	128	128	128	128	128	128	128	128	128
FP 3411/3412	92	92	92	92	92	92	190	190	92	92	92	92	92	190	190	190	190	190	190	190	190	190	190	190	190	190	190
FP 3421/3422	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 3431/3432	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 3441/3442	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 3451/3452	92	92	92	92	92	92	128	128	92	92	92	92	92	128	128	128	128	128	128	128	128	128	128	128	128	128	128
FP 3521/3522	74	74	74	74	74	74	170	170	74	74	74	74	74	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 3531/3532	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 3541/3542	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 3551/3552	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 1051/1052	92	92	92	92	92	92	147	147	92	92	92	92	92	147	147	147	147	147	147	147	147	147	147	147	147	147	147
FP 1151/1152	92	92	92	92	92	92	170	170	92	92	92	92	92	170	170	170	170	170	170	170	170	170	170	170	170	170	170
FP 1251/1252	92	92	92	92	92	92	164	164	92	92	92	92	92	164	164	164	164	164	164	164	164	164	164	164	164	164	164
FP 751/752	92	92	92	92	92	92	235	235	92	92	92	92	92	235	235	235	235	235	235	235	235	235	235	235	235	235	235

Maße verbindlich  
dimension without obligation



Datum	Name	Auftrag
Bearb.		
Gepr.		

Maße unverbindlich  
dimension without obligation



Pumpe pump	Flansch DIN 2633 flange DIN 2633										FN / FG - Flansch FN/FG - flange																			
	c - DN					H - DN					c - DN					H - DN														
Type	40	50	65	80	100	125	150	200	40	50	65	80	100	125	150	40	50	65	80	100	125	150	200	40	50	65	80	100	125	
FP 711/712	103	106	106	106	106	106	106	106	167	190	190	190	190	190	190	150	150	150	150	150	150	150	150	150	150	150	169	133	100	125
FP 721/722	103	106	97	106	106	106	106	106	170	190	190	190	190	190	190	150	150	150	150	150	150	150	150	150	150	150	169	133	100	125
FP 741/742	132	95	95	160	160	160	160	160	218	218	218	218	218	218	218	123	123	123	123	123	123	123	123	123	123	123	197	133	100	125
FP 751/752	84	134	134	145	145	145	145	145	260	260	260	260	260	260	260	123	123	123	123	123	123	123	123	123	123	123	197	133	100	125
FP 3401/3402	113	116	154	171	171	171	171	171	182	234	234	234	234	234	234	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3421/3422	107	107	107	107	107	107	107	107	157	176	176	176	176	176	176	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3431/3432	107	107	107	112	112	112	112	112	185	185	185	185	185	185	185	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3441/3442	108	108	108	112	112	112	112	112	205	243	243	243	243	243	243	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3451/3452	108	108	108	113	113	113	113	113	205	243	243	243	243	243	243	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3521/3522	112	112	112	116	116	116	116	116	185	224	224	224	224	224	224	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3531/3532	110	110	110	117	117	117	117	117	185	224	224	224	224	224	224	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3541/3542	112	112	112	117	117	117	117	117	205	205	205	205	205	205	205	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 3551/3552	113	113	113	118	118	118	118	118	225	289	289	289	289	289	289	138	138	138	138	138	138	138	138	138	138	138	163	133	100	125
FP 1051/1052	112	112	112	120	120	120	120	120	251	350	350	350	350	350	350	139	139	139	139	139	139	139	139	139	139	139	163	133	100	125
FP 1151/1152	112	112	112	112	112	112	112	112	167	168	168	168	168	168	168	139	139	139	139	139	139	139	139	139	139	139	163	133	100	125
FP 1231/1232	112	112	112	112	112	112	112	112	133	133	133	133	133	133	133	139	139	139	139	139	139	139	139	139	139	139	163	133	100	125

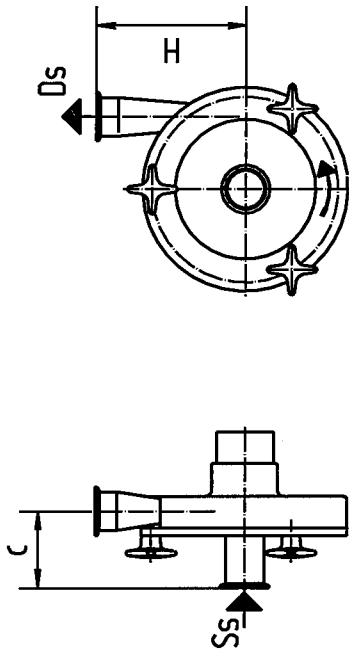
Kreiselpumpe  
centrifugal pump

FP/FPE 700/3400/3500

Flanschanschlüsse  
flange connection

400 9 0 011 / 00.05

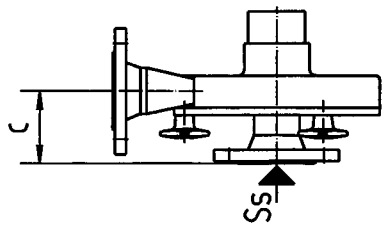
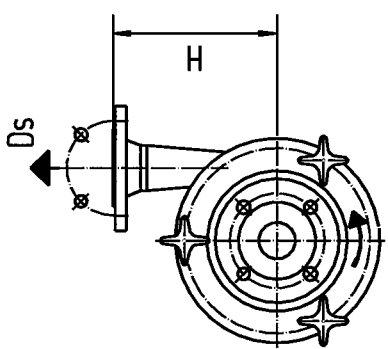
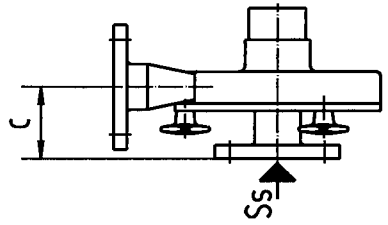
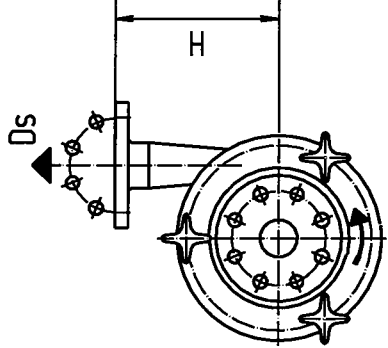
Datum	Name	Auftrag
Bearb.		
Gepr.		



Pumpe pump	Tri - clamp						ISO - clamp 2852						DIN - Clamp DIN 32676								
	c - DN			H - DN			c - DN			H - DN			c - DN			H - DN					
Type	1"	1 1/2"	2"	2 1/2"	3"	4"	1 1/2"	2"	2 1/2"	3"	4"	1 1/2"	2"	2 1/2"	3"	4"	40	50	65	80	100
FP 711/712	--	112	112	112	112	147	112	112	--	--	--	144	--	--	--	--	--	--	--	--	--
FP 721/722	--	112	112	103	--	170	--	91	103	--	--	170	160	--	--	--	--	--	--	--	--
FP 741/742	--	--	102	101	--	195	--	102	101	--	--	149	195	--	--	--	--	195	--	--	--
FP 3401/3402	103	94	93	--	--	--	93	106	--	--	--	149	191	--	--	--	--	--	--	--	--
FP 3411/3412	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FP 3421/3422	--	--	--	--	--	155	166	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FP 3431/3432	--	--	--	--	111	190	--	--	--	--	--	--	--	--	190	--	--	--	--	--	--
FP 3441/3442	--	--	--	--	113	211	--	--	--	--	--	--	--	--	231	--	--	--	--	--	--
FP 3451/3452	--	--	--	114	114	210	--	114	--	115	115	--	159	231	231	--	--	--	--	--	--
FP 3521/3522	--	--	--	118	118	210	--	118	--	115	115	--	175	190	190	--	--	211	161	191	211
FP 3531/3532	--	--	--	117	110	191	--	118	116	116	118	191	211	211	211	--	--	191	211	231	231
FP 3541/3542	--	--	--	118	118	211	--	118	118	118	118	211	211	231	231	--	--	211	231	231	231
FP 3551/3552	--	--	--	119	119	231	--	118	119	123	123	231	231	231	231	--	--	231	231	231	231
FP 1051/1052	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FP 1151/1152	--	--	--	--	--	205	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FP 751/752	--	148	99	--	--	--	--	--	87	--	--	--	--	--	--	--	--	--	--	--	--

Maße unverbindlich  
dimension without obligation

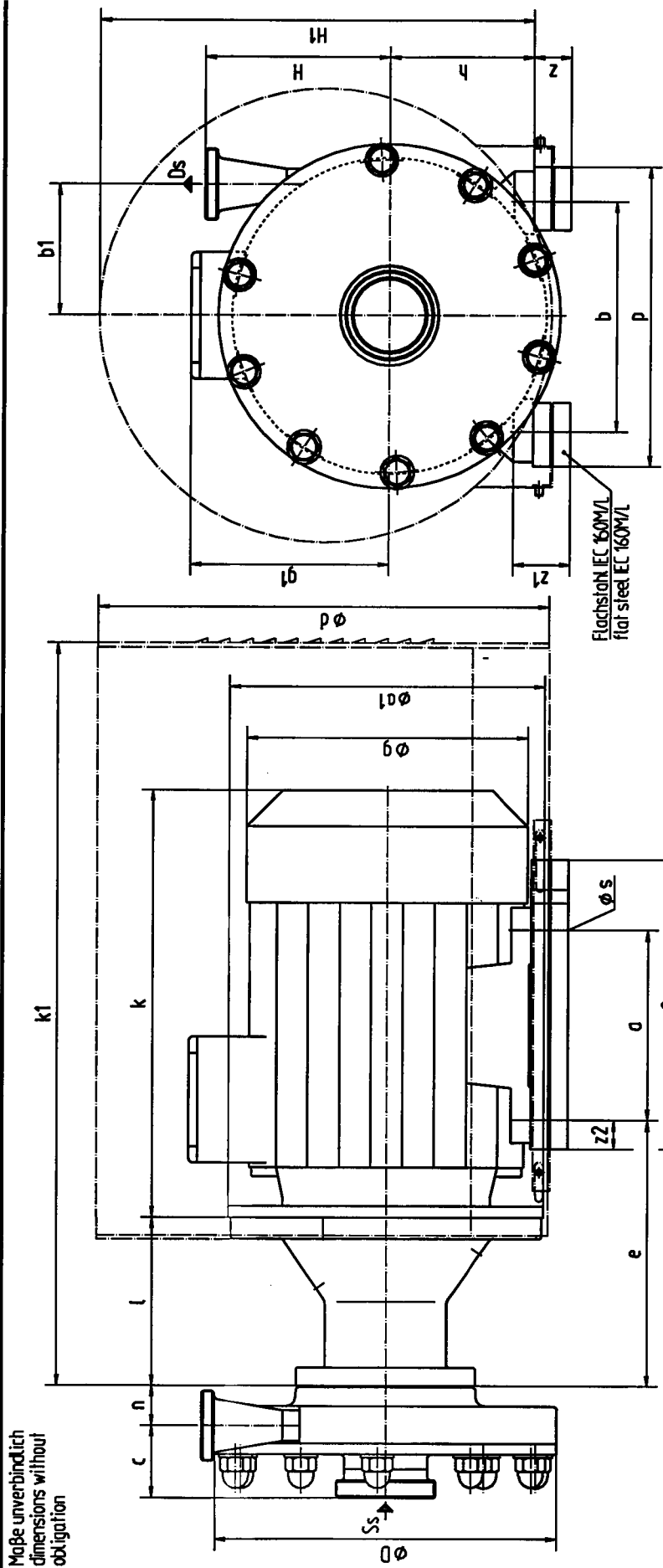
Datum	Name	Auftrag
Bearb.		
Gepr.		



Pumpe pump	Varivent - Flansch Varivent - flange					Nocado - Flansch Nocado - flange					Sterilflansch Neumo sterile flange connection Neumo					mit Nut with groove														
	c - DN					H - DN					c - DN					H - DN														
Type	40	50	65	80	100	125	150	175	200	225	40	50	65	80	100	125	150	175	200	225	40	50	65	80	100	125	150	175	200	225
FP 711/712	86	86	77	75	75	75	75	75	75	75	152	152	198	198	198	114	114	114	114	114	180	180	259	259	259	174	174	174	174	174
FP 721/722	86	86	77	75	75	75	75	75	75	75	152	152	198	198	198	114	114	114	114	114	180	180	259	259	259	174	174	174	174	174
FP 741/742	86	86	77	75	75	75	75	75	75	75	152	152	198	198	198	114	114	114	114	114	180	180	259	259	259	174	174	174	174	174
FP 752	86	86	77	75	75	75	75	75	75	75	152	152	198	198	198	114	114	114	114	114	180	180	259	259	259	174	174	174	174	174
FP 34.01/34.02	67	67	67	67	67	67	67	67	67	67	123	123	123	123	123	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 34.11/34.12	96	96	96	96	96	96	96	96	96	96	165	165	165	165	165	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 34.21/34.22	88	88	88	88	88	88	88	88	88	88	140	140	140	140	140	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 34.31/34.32	85	85	85	85	85	85	85	85	85	85	165	165	165	165	165	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 34.41/34.42	87	87	87	87	87	87	87	87	87	87	185	185	185	185	185	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 34.51/34.52	88	88	88	88	88	88	88	88	88	88	164	164	164	164	164	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 35.21/35.22	93	93	93	93	93	93	93	93	93	93	165	165	165	165	165	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 35.31/35.32	90	90	90	90	90	90	90	90	90	90	185	185	185	185	185	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 35.41/35.42	92	92	92	92	92	92	92	92	92	92	205	205	205	205	205	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 35.51/35.52	93	93	93	93	93	93	93	93	93	93	285	285	285	285	285	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 1051/1052	93	93	93	93	93	93	93	93	93	93	253	253	253	253	253	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 1151/1152	93	93	93	93	93	93	93	93	93	93	253	253	253	253	253	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174
FP 1251/1252	93	93	93	93	93	93	93	93	93	93	253	253	253	253	253	114	114	114	114	114	259	259	259	259	259	174	174	174	174	174

Maße unverbindlich  
dimension without obligation

Datum	Name	Auftrag
Bearb.		
Gepr.		



**Ausführung D: mit Motorfuß und Verkleidung**  
Execution D: with motor feet and shroud

Maße unverbindlich  
dimensions without  
obligation

Maße  $\phi$ , g1, k, o, p und Motor-  
gewichte sind abhängig  
vom Motorfabrikat.

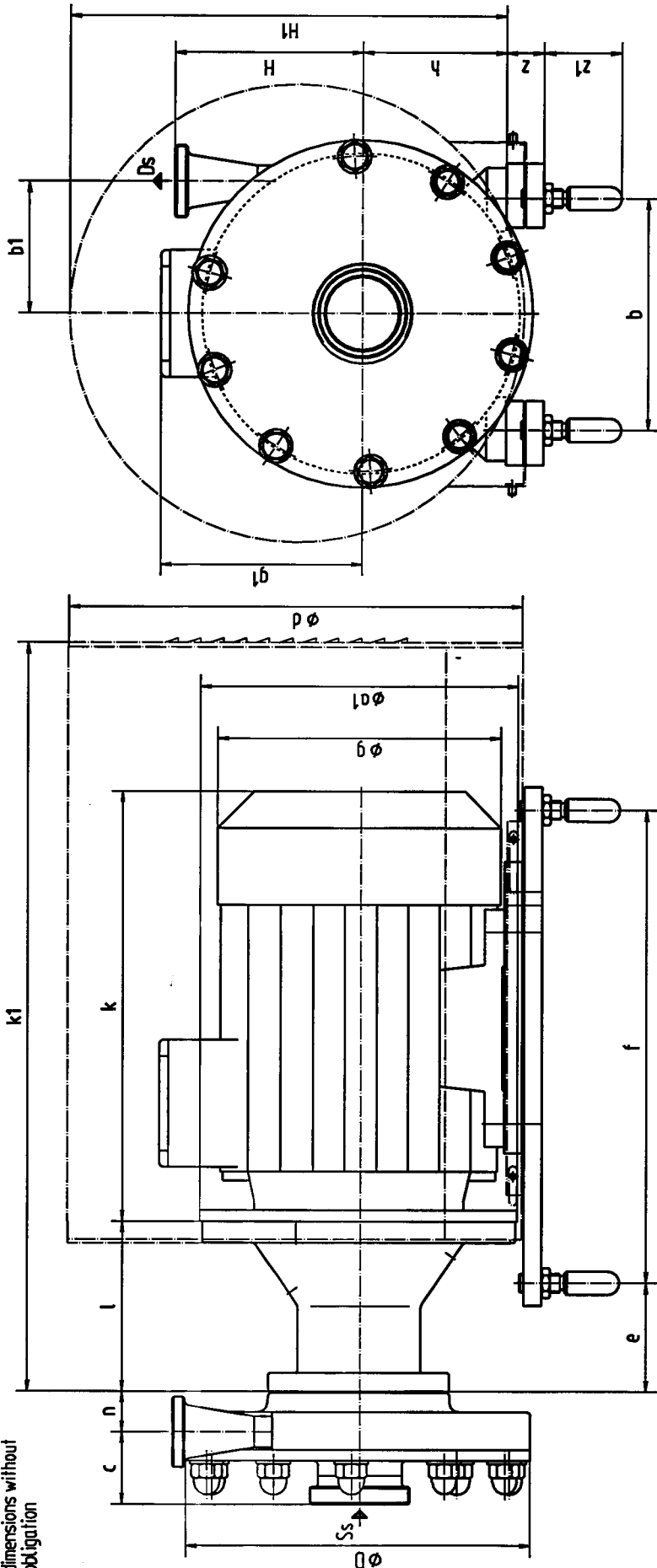
dimensions  $\phi$ , g1 and k, o, p and  
motor weights are dependent  
to motor execution.

<b>Pumpe</b> pump	Typ type	b1	n	$\phi$ D	Gewindestützen DIN 11851 thread DIN 11851			H - DN	kg					
					c - DN	50	65			80	100	125	150	175
FPE 751/752		145	44	380	--	103	80	--	205	245	--	50		

Laterne lantern		Motor motor		Verkleidg. shroud																	
Ausf.	l	P [kW]	n [1/min]	a	$\phi$ a1	b	e	$\phi$ g	g1	h	k	o	p	$\phi$ s	z	z1	z2	kg	k1	H1	kg
$\phi$ 350/300	201	7.5	2900	140	300	216	290	246	190	132	405	218	256	12	3	21	20	48	400	636	379
$\phi$ 350/300	201	9.2	3500	178	300	216	290	246	190	132	405	218	256	12	3	21	20	50	400	636	379
$\phi$ 350/300	201	11.0	160 M	210	350	254	294	312	220	160	517	320	320	14	23	45	32	77	500	872	480
$\phi$ 350	186	15.0	160 M	210	350	254	294	312	220	160	517	320	320	14	23	45	32	91	500	872	480
$\phi$ 350	186	18.5	160 L	241	350	254	294	312	220	180	578	300	356	14	3	23	29.5	129	500	872	500
$\phi$ 350	186	22.0	180 M	279	350	279	307	356	178	180	578	340	356	14	3	23	30.5	140	500	872	500

Datum	Name	Auftrag
Bearb.		
Gepr.		

Maße unverbindlich  
dimensions without  
obligation



Maße  $\phi$ , g, k und Motor-  
gewichte sind abhängig  
vom Motorfabrikat.

dimensions  $\phi$ , g, k and  
motor weights are dependent  
to motor execution.

### Ausführung A: mit Kalotten und Verkleidung

Execution A : ss adj feet and straud

### Ausführung C: mit Kalotten ohne Verkleidung

Execution C : ss adj feet without straud

### Pumpe

pump

Typ type	b1	n	$\phi$ D
FPE 751/752	145	44	380

### Gewindestützen DIN 11851

thread DIN 11851

C - DN		H - DN	
50	65	80	100
103	80	--	--
205	245	--	50

### Laterne

lantern

Ausf.	l	kg
$\phi$ 350/300	201	201
$\phi$ 350/300	201	201
$\phi$ 350	186	186
$\phi$ 350	186	186
$\phi$ 350	186	186
$\phi$ 350	186	186

### Motor

motor

P [kW]	n (1/min)	IEC Baufr.	$\phi$ D1	b	e	f	$\phi$ g	g1	h	k	z	z1	kg
14,50	2900	132 S	300	216	180	320	246	190	132	405	40	65-85	48
17,50	3500	132 M	300	216	180	320	246	190	132	405	43	65-85	50
7,5	9,2	132 M	300	216	180	320	246	190	132	405	43	65-85	50
11,0	11,0	160 M	350	254	119	520	312	220	160	517	43	75-85	77
15,0	15,0	160 M	350	254	119	520	312	220	160	517	43	75-85	91
18,5	18,5	160 L	350	254	119	520	312	220	160	517	43	75-85	107
22,0	22,0	180 M	350	279	132	520	356	178	180	578	23	75-85	129
		180 L	350	279	132	520	356	178	180	578	23	75-85	140

### Verkleidg.

straud

$\phi$ d	k1	H1	kg
400	636	379	48
400	636	379	50
400	636	379	50
500	822	480	77
500	822	480	91
500	822	480	107
500	822	500	129
500	822	500	140

Kreiselpumpe  
centrifugal pump

FPE 750 AC

7,5 kW

bis  
bill

22,0 kW

400 90 238 / 02.04

*English translation of the original operating instructions  
Assembly Instructions*

# **Centrifugal Pump FP Series**

Pump Type:

Pump No.:



## Copyright



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The German version is the original version of the operating instructions manual. Other languages are translations of the original operating manual.

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# 1 Introduction

## 1.1 Foreword

This operator's manual describes all FP centrifugal pump sizes, models, and versions.

Information on the model, size, and version of your pump can be found on the rating plate on your pump and in the "Order-Related Documents" in the attached documents.

## 1.2 Manufacturer

FRISTAM Pumpen KG (GmbH & Co.)

Kurt-A.-Körber-Chaussee 55

21033 Hamburg

GERMANY

Tel.: +49-40-72556-0

Fax: +49-40-72556-166

E-mail: info@fristam.de

## 1.3 Scope of Supply

The package includes the following items:

- Pump with motor = pump unit
  - optional: without motor
- Covers for pipe fittings
- Optional: assembly kit
- *Fristam* accessories (if applicable)
- Documentation
- ▶ Check the shipment for completeness and damage. Immediately notify *Fristam* of any missing items or damage.

## 1.4 Pump Without Motor (Optional)

The pump can optionally be supplied without a motor. In this case, continue reading up to and including *Chapter 3, "Design and Function," page 7*, and then skip to *Chapter 11, "Appendix 2 – Assembly Instructions (Optional)," page 33*.

## 1.5 Scope of Documentation

The documentation includes the following items:

- **This operator's manual**
  - Appendix 1 with maintenance, lubrication, and tightening torque tables
  - Appendix 2 with assembly instructions
- **Attached documents:**
  - Order-Related Documents
  - Supplier Documentation (motor, coupling, etc.)

- Documentation on *Fristam* accessories (if applicable)
- Certificates (materials certificates, etc.), if applicable
- Declaration of Conformity or Declaration of Incorporation

## 1.6 Display Conventions

List items are preceded by dashes:

- Part 1
- Part 2

Handling instructions that must be performed in a specified order are numbered:

1. Turn device on.
2. Turn device off.

Handling instructions that do not need to be performed in a specified order are preceded by triangular bullets:

- ▶ Action
- ▶ Action

### 1.6.1 Safety Instructions

#### **⚠ DANGER**

A safety instruction with the signal word "Danger" indicates personal hazards causing death or serious injury.

#### **⚠ WARNING**

A safety instruction with the signal word "Warning" indicates personal hazards that may lead to death or serious injury.

#### **⚠ CAUTION**

A safety instruction with the signal word "Caution" indicates personal hazards that may lead to mild to moderate injuries.

#### **NOTICE**

A safety instruction with the signal word "Note" warns of the possibility of material damage.

## 2 Safety

### 2.1 Basic Safety Instructions

- ▶ Please read this operator's manual completely before using the pump and keep it available at the pump installation location.
- ▶ Heed the applicable national regulations of the owner's country and the company's work and safety regulations.
- ▶ All work described here may only be performed by qualified experts with caution.
- ▶ Danger of contamination: Heed legal and operational safety regulations when pumping dangerous media.

### 2.2 Intended Use

The standard FP centrifugal pump versions are designed for use in the food industry, the pharmaceutical and biotechnology industry, and CIP process technology.

They can be used to pump liquids with dynamic viscosities of up to 1200 mPa s and media temperatures of up to 150°C. The medium can contain a slight amount of air or gas, be homogeneous, or contain a small amount of additives.

Each pump is designed according to customer requirements. The seal materials have been selected for the respective medium. The pump may only be used to pump the medium it was designed for (see *Order-Related Documents* in the attached documents).

### 2.3 Improper Use

The standard FP centrifugal pump versions may not be used in explosive atmospheres. Special explosion-proof versions are available for this.

Pumping of media other than those specified can destroy the pump.

Standard pump units from *Fristam* are described in this operator's manual. If nonstandard items or extras are installed, the operator assumes the responsibility for operation.

### 2.4 Warning and Instruction Labels

- ▶ Do not alter or remove the labels on the pump.
- ▶ Immediately replace damaged or lost labels with ones that are true to the originals.

#### 2.4.1 Direction of Rotation



Fig. 1 "Impeller Direction of Rotation" label

This label shows the direction of rotation of the impeller. It is located at the front on the pump cover.

#### 2.4.2 Hot Surface



Fig. 2 Safety label: "Hot Surface"

This label indicates that parts can become hot during operation or, if applicable, that hot media is being pumped. Only touch the pump if you are wearing suitable gloves.

#### 2.4.3 No Dry Running

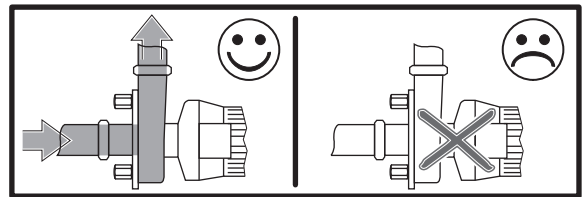


Fig. 3 Safety label: "No Dry Running"

This label indicates that the pump cannot be run dry. There must always be medium in the suction line and the pump when the pump is started. Otherwise, the pump will be damaged.

#### 2.4.4 Rating Plate

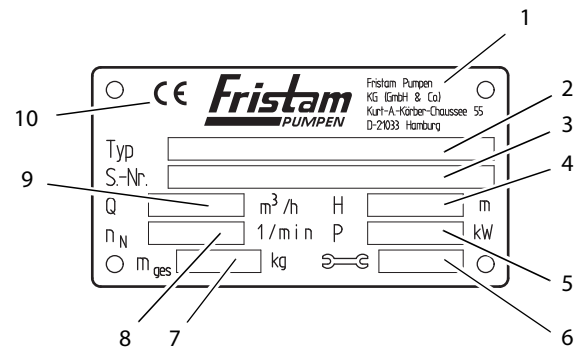


Fig. 4 Pump unit rating plate

- 1 Manufacturer
- 2 Type: pump series, pump size, model, version
- 3 SN: serial number of the pump
- 4 H: discharge head [m]
- 5 P: motor output [kW]
- 6 Year of manufacture
- 7 mttl: mass (total) [kg]
- 8  $n_N$ : rated speed [1/min]
- 9 Q: flow rate [ $m^3/h$ ]
- 10 CE mark

### 2.5 Noise Emissions

- ▶ The local noise exposure regulations must be complied with. For noise emission values for the pumps, please see *Chapter 10.1, "Specifications," page 27.*

**⚠ CAUTION**

**Noise Generated by Running Pump**

Hearing damage.

- ▶ Wear ear protectors when using pumps with specified sound pressure levels of greater than 80 dBA.

**2.6 Disposal**

**2.6.1 Disposal of Transportation Package**

- ▶ Recycle the transportation package.

**2.6.2 Models KF and L 1: Disposal of Grease**

- ▶ Dispose of grease and objects saturated with grease in an environmentally friendly manner in accordance with applicable regulations.

**2.6.3 Models L 2, L 3, and L 4: Disposal of Lubricating Oil**

- ▶ Dispose of oil and objects saturated with oil in an environmentally friendly manner in accordance with applicable regulations.

**2.6.4 Disposal of Pump**

1. Carefully clean the pump. Dispose of residues in an environmentally friendly manner in accordance with applicable regulations.
2. Dismantle the pump into its constituent parts.
3. Dispose of the pump parts in an environmentally friendly manner in accordance with applicable regulations.

**2.6.5 Disposal of Electrical and Electronic Scrap**

- ▶ Dispose of electrical and electronic scrap in accordance with applicable directives.

## 3 Design and Function

### 3.1 Principles of Design

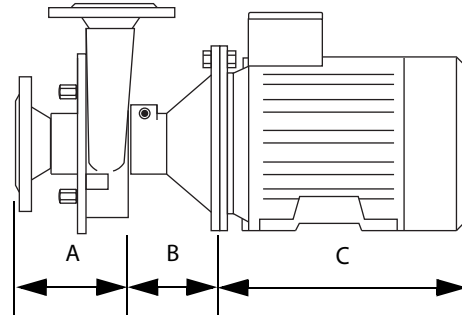


Fig. 5 Principles of design of pumps illustrated using the FPE model

A	Pump head
B	Lantern
C	Electric motor

#### 3.1.1 Pump Head (A)

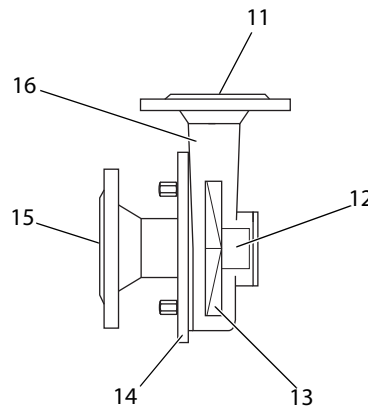


Fig. 6 Pump head

11	Discharge line connection
12	Shaft seal
13	Impeller
14	Pump cover
15	Suction line connection
16	Pump casing

#### Shaft Seal (12)

Two seal types are available for use:

- Single shaft seal
- Double shaft seal

With the double shaft seal, there are two additional connections for the sealing liquid on the pump casing. These connections are not shown in the following figures.

### Impeller (13)

Open impellers are standardly used in the FP pump series.

### Pump Cover (14)

The connection for the suction line is located on the pump cover.

### Pump Casing (16)

The connection for the discharge line is located on the pump casing. The impeller and the shaft seal are built into the pump casing.

### 3.1.2 Lantern (B) and Electric Motor (C)

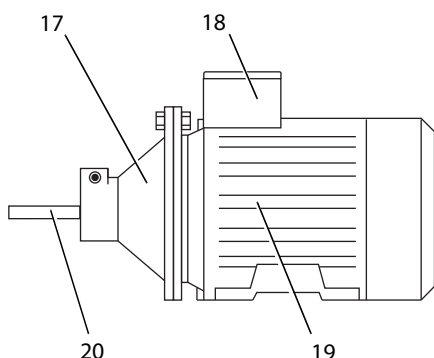


Fig. 7 Lantern and electric motor

17	Lantern
18	Electrical connection
19	Electric motor
20	Pump shaft

### Lantern (17)

The lantern is present in all models except the special motor.

The lantern connects the pump casing to the motor. Two different versions are possible, depending on pump size:

- The pump casing is screwed to the lantern via a flange connection.
- The pump casing is inserted into the lantern and mounted with a clamp.

Models with lanterns:

- FPE and FP...V
- KF  
An additional bearing for the pump shaft is located inside the lantern with base.
- L  
An additional bearing for the pump shaft is located inside the lantern with base. The pump shaft is connected to the motor via a coupling.

### Electric Motor (19)

The following motor types can be mounted:

- IEC standard motor with key and shaft pin in the following models:

- IM B3: model with base
- IM B5: model with flange
- IM B3/5: model with flange and base

With the IEC standard motor, a *Fristam* pump shaft is clamped to the motor shaft pin.

- Special motor with *Fristam* pump shaft

With the special motor, the *Fristam* pump shaft is already integrated and connected permanently to the motor.

## 3.2 Models

The model is indicated on the rating plate. See *Chapter 2.4.4, "Rating Plate," page 6.*

The following are shown as examples:

- Lantern clamp-mounted
- Without enclosure  
See *Chapter 3.4, "Versions," page 9.*

### 3.2.1 Model FP

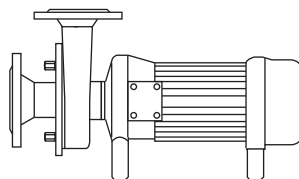


Fig. 8 Model FP

Motor: Special motor

Design: Without lantern

### 3.2.2 Model FPE or FP...V

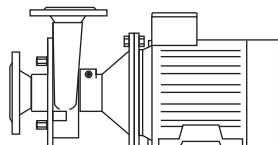


Fig. 9 Model FPE or FP...V

Motor: IEC standard motor, model B3/B5

Design: With lantern

### 3.2.3 Model KF

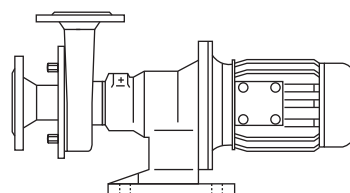


Fig. 10 Model KF

Motor: IEC standard motor, model B5  
 Design: Compact bearing support with base

H Pump casing with heating jacket  
 h Pump cover with heating jacket

### 3.2.4 Model L

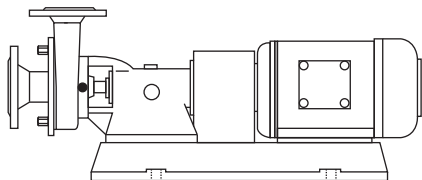


Fig. 11 Model L

Motor: IEC standard motor, model B3  
 Design: Bearing block with coupling, coupling protection, base frame

### 3.3 Pump Key

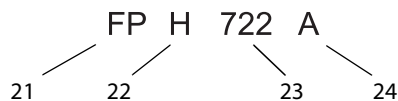


Fig. 12 Type designation example

21	Pump type
22	Supplementary character 1
23	Pump size
24	Supplementary character 2

#### (21) Pump Type

- FP Special motor with extended motor shaft
- FPE Attached pump shaft
- FP...V Extended insert shaft as pump shaft

#### (22) Supplementary Character 1

- S Open impeller with large clearance to casing
- R Semiopen impeller with large clearance to cover
- H High-pressure pump
- X Impeller for high pressures
- Z Casing with circulation line

#### (24) Supplementary Character 2

- A, B, C, D Versions; see Chapter 3.4, "Versions," page 9:
- KF Compact bearing support with base
- L1, L2, L3 Bearing block with coupling
- V Stainless steel lantern, double shaft seal, ø75mm at lantern neck

### 3.4 Versions

Version	Enclosure	Spherical Cap Legs	Motor Foot
A	With	With	Without
B	Without	Without	With
C	Without	With	Without
D	With	Without	With

Table 1 Versions

Note: If the (optional) pump without motor is supplied, please first read Chapter 11, "Appendix 2 – Assembly Instructions (Optional)" on page 33.

## 4 Transportation

### 4.1 Transportation

Transportation may only be performed by trained personnel. The pump can be moved using an industrial truck or a crane. Always move the pump in the installation condition.

#### 4.1.1 Safety Instructions

- ▶ Danger of injury from falling or unsecured parts.
  - Only use suitable means of conveyance and hoists. Information on pump weight can be found on the pump's rating plate as well as in the *Order-Related Documents* in the attached documents.
  - Before moving the pump secure it to prevent it from tipping over. Secure the pump to the pallet with tie-down straps, or screw the pump to the pallet.
  - Do not leave the pump in a raised position for longer than necessary.
- ▶ Damage to pump by contamination, impact, or moisture.
  - Remove the protective film just prior to installation.
  - Remove the pipe fitting covers just prior to connection to the pipes.

#### 4.1.2 Moving With Industrial Trucks

##### Preparation

- ▶ Ensure that the pump is adequately secured to the pallet.

##### Procedure

1. Pick up the pallet with the forks on the industrial truck.

- Carefully move the pallet to the designated location and set down.

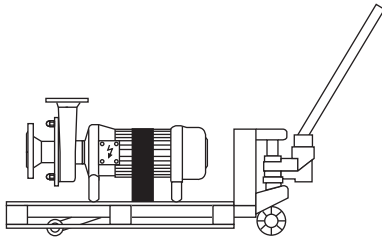


Fig. 13 Moving with industrial truck

#### 4.1.3 Moving With Crane

##### ⚠ WARNING

##### Falling Parts

Death from crushing, pinching of extremities, material damage.

- ▶ Do not lift the pump at the eyebolts on the motor and pump casing to move because these eyebolts are not designed for the total weight.
- ▶ Only use hoists that are designed for the total weight of the pump.
- ▶ Ensure that the area below the pump is clear of people.

##### ⚠ WARNING

##### Swinging Parts

Crushing and serious injuries.

- ▶ Start and stop the crane with pump smoothly.
- ▶ Ensure that the danger zone of the pump is clear of people.

##### Auxiliary Equipment

Hoists: round slings tested in accordance with DIN EN 1492-1 and 1492-2

##### Preparation

- ▶ Remove load-securing devices.

##### Procedure

- Wrap the round sling twice around the back end of the motor. Do not lay over the fan shroud (see Fig. 14 Moving with crane).
- Lay the other end of the round sling between the lantern and the pump casing. Do not lay the round sling over any sharp edges or corners.
- Guide both loops to the crane hook and rotate by 180° to ensure that the belt will not slip on the hook.
- For double shaft seal:

**Note:** Round sling compresses sealing water tubes. Material damage to double shaft seal.

- ▶ Do not lay the round sling on the sealing water tubes.

- Position the center of gravity to ensure that the pump is lifted horizontally.
- Lift the pump.

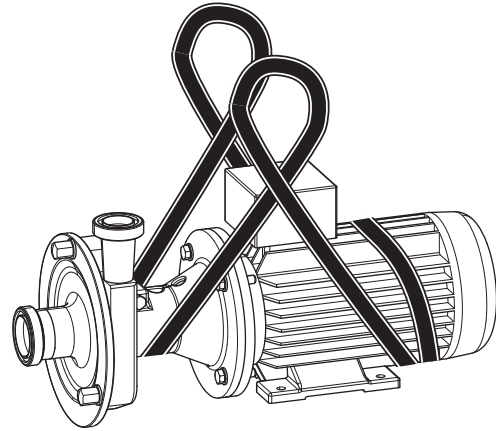


Fig. 14 Moving with crane

## 5 Storage

### 5.1 Safety Instructions

- ▶ Corrosion: Condensation can build up under a tarp and destroy the pump.
  - Ensure adequate ventilation.

### 5.2 Storage Conditions

- ▶ Store the pump as follows:
  - Dry, in low humidity
  - Protected against frost and heat, optimally at a temperature of 20°C to 25°C
  - Ventilated
  - Dust-free

### 5.3 Long-Term Storage

For a storage time of longer than six months, heed the following:

- ▶ The shaft seals must be specially treated before long-term storage:
  - **For single shaft seal**

The impeller nut must be loosened so that the seal can relax and the elastomers do not stick together.
  - **For double shaft seal**

Remove the complete shaft seal and store separately to prevent the elastomers from sticking together.

Information on the shaft seal can be found in the *Order-Related Documents*.

- ▶ All movable pump parts must be rotated every three months.

### 5.3.1 Storage of Elastomers

#### Storage Conditions

- Storage temperature between +5°C and +20°C
- Relative air humidity below 70%
- No direct sunlight
- Deformation-free storage

## 5.4 Recommissioning

- ▶ After long-term storage and before commissioning, check seals, bearings, and lubrication.

# 6 Installation

## 6.1 Safety Instructions

- ▶ Danger of injury from falling parts.
  - Wear safety shoes.
  - Check load capacity and attachment of hoists.
- ▶ Danger of injury from unstable assembly.
  - Tighten screws to the specified tightening torque (see *Chapter 10.1.1, "Tightening Torques for Screws and Nuts," page 27*).
  - Use a torque wrench or an impact driver with adjustable torque.
- ▶ Material damage from swinging during adjustment of spherical cap feet.
  - Use spherical cap base plates.

## 6.2 Installation Location

For standard pumps, the installation location must meet the following requirements:

- Nonexplosive atmosphere
- Dust-free environment
- Ambient temperature: –20°C to +40°C
- Moisture and salt contents in ambient air:  
The values are given in the motor supplier documentation. It can be found in the attached documents.
- Foundation sized adequately for the pump weight
- Horizontal and level installation surface, adequate installation surface strength for pump mass
- Adequate clearance for maintenance work
- Adequate air supply for motor cooling

## 6.3 Reduction of Noise and Vibration

### 6.3.1 Primary Measures

- ▶ Operate the pump in the optimum working range.
  - Do not starve the pump. Avoid throttling too much. Only operate with a low flow rate if necessary for regulation purposes.
  - Do not operate with very high flow rates. Optionally install a flow controller in the discharge line.
  - Operate the pump without cavitation (see *Chapter 6.4.1, "Installation of Pipes," page 12*).
- ▶ Decouple the suction and discharge lines from vibrations.
  - Support lines.
  - Align lines.
  - Install vibration isolators.

### 6.3.2 Secondary Measures

- ▶ Take structural measures such as the following:
  - Acoustic paneling
  - Enclosure in housing

## 6.4 Pump Fixation

### Models FP/FPE/FP..V

- ▶ Versions A and C:  
Set up the pump on the spherical cap bearings and align.
- ▶ Versions B and D:  
Screw the pump on the motor foot to the foundation.

### Model KF

- ▶ Versions A and C:  
Set up the pump on the spherical cap bearings and align.
- ▶ Versions B and D:  
Screw the pump on the compact bearing support with base to the foundation.

### Model L

- ▶ Versions A and C:  
Set up the pump on the spherical cap bearings and align.
- ▶ Versions B and D:  
Screw the pump on the base frame to the foundation.

### Carriage (Optional)

1. Set up the pump at the installation location. Lock the locks on the rollers (if present) or secure the carriage with chocks.
2. Ground the carriage to dissipate electrostatic charge.
3. Position hose line to ensure that it cannot be damaged.



### 6.4.1 Installation of Pipes

- ▶ Lay and connect pipes as follows:
  - Keep the pipe resistance as low as possible: Avoid unnecessary installation of valves, elbows, and abrupt pipe transitions.

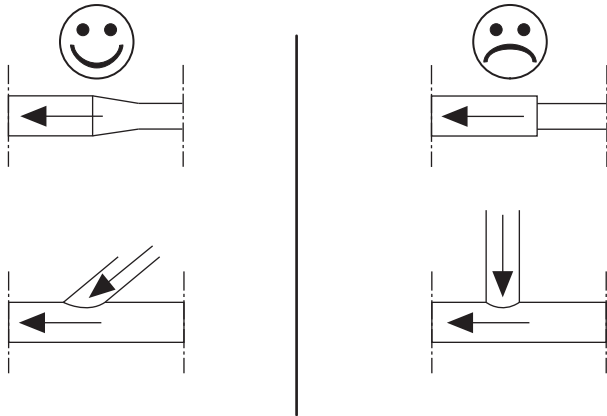


Fig. 15 Pipe transitions

- Design pipe cross section so that no unnecessary pressure losses or cavitation occurs in the suction area and so that the condition  $NPSH_a > NPSH_r$  is fulfilled.
- Verify this in the project planning stage.
- Always lay the suction lines so that they are continuously rising: Rule out the possibility of air pockets and dips in pipes.

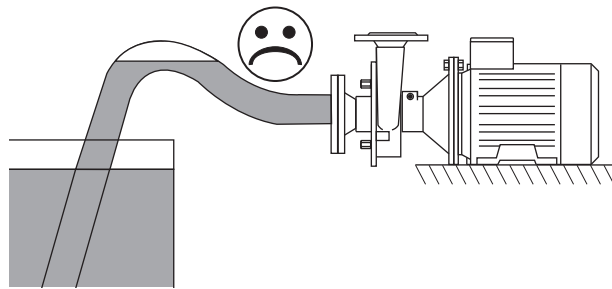


Fig. 16 Air pocket

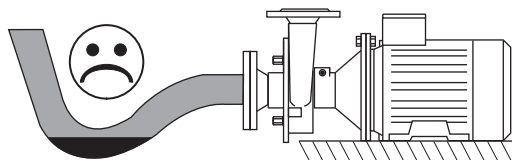


Fig. 17 Dip in pipe

- Pipe bends upstream of suction connection: Heed minimum clearance and minimum bend radius:

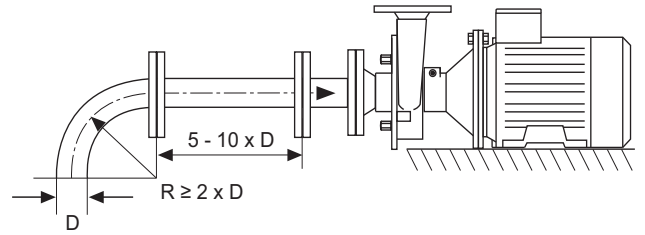


Fig. 18 Laying of the suction line

- Connect the pipes to the pump so that they are free of tension and compression to ensure that no stresses are applied to the pump.
- Secure pipes to ceilings, walls, or floor using pipe clamps.
- Align pipes flush with pump connections using a bracket.

### 6.5 Electrical Connection

Electrical connection may only be performed by a qualified electrician.

1. Heed the connection values on the motor's rating plate. The specified voltage must not be exceeded.
2. Connect the motor according to the circuit diagram in the terminal box of the motor.
3. Protect cable feedthroughs against penetration by moisture.
4. Turn on the motor for 2 to 3 seconds. Compare the direction of rotation of the motor fan wheel against the direction indicated by the arrow on the pump head.
5. Reverse the polarity if necessary.

### 6.6 Connection of Sealing or Quenching Liquid (Optional)

For versions with double shaft seals, the gap must be flushed with sealing or quenching liquid.

- ▶ Use a suitable medium, e.g., water, as a sealing or quenching liquid.
- ▶ Install and seal the supplied flushing tubes.
- ▶ Install the sight glass in the drain line.

### 6.7 Cleaning

Only use cleaning agents that comply with the hygiene guidelines for the respective pumping medium.

1. Before sealing the pump ensure that there are no foreign objects inside the pump or pipes.
2. Seal the pump.
3. Connect the pipes.
4. Thoroughly clean the pump and the pipe system before initial use.

## 7 Operation

### 7.1 Safety Instructions

- ▶ **Danger of burning:** Pumping of hot media can cause the pump to become very hot. Check the temperature before touching the pump.
- ▶ **Noise emissions:** The A-weighted sound pressure level of the pumps can be greater than 80 dBA. Always wear ear protectors in the vicinity of the running pump.
- ▶ **Danger of bursting:** If the allowable pressure and temperature ranges are exceeded, the pump may burst or become leaky. The pressure and temperature ranges for the pump must be complied with; see *Order-Related Documents* in the attached documents.
- ▶ **Danger of bursting:** Cold extinguishing agents used to extinguish a pump fire can cause the hot pump to burst. Do not cool the pump down excessively when extinguishing the fire.
- ▶ **Pump running in reverse direction despite emergency shut-off:** If the pump is shut off using the emergency shut-off function, it will run in reverse direction due to the pumping medium in the discharge line. Install a check valve in the discharge line.
- ▶ **Destruction of shaft seal when pump runs in reverse direction.** Reverse running destroys the springs in the shaft seal. Always operate the pump in the direction of rotation. See *Chapter 2.4.1, "Direction of Rotation," page 6.*

### 7.2 Commencement of Operation

**NOTICE**

#### Damage to Shaft Seals

If the pump runs without a pumping medium, the mechanical seal will be damaged.

- ▶ Ensure that the pumping medium always reaches the upper edge of the outlet side before and during operation.

**NOTICE**

#### Damage to Double Shaft Seals

If the pump runs without a sealing medium, the shaft seal will be damaged.

Ensure that during operation:

- The sealing liquid flows with the necessary pressure through the double shaft seal.
- The temperature of the sealing liquid T is maintained at < 70°C.

1. Open the valve in the suction line.
2. Close the valve in the discharge line.

3. Fill the pump and the suction line up to the upper edge of the pump with pumping medium. Allow any air pockets that are present to escape.
4. Turn on the motor. The pump now pumps against the closed valve in the discharge line. This will limit the starting current.
5. Slowly open the valve in the discharge line and adjust to the working point.

### 7.3 Monitoring of Operation

During operation heed the following points:

- ▶ **Damage to shaft seal:** Regulation of the pump output via the suction-side valve can lead to damage of the pump and the shaft seals. Regulate the pump output only by means of the discharge-side valve.
- ▶ **Damage to pumping medium:** If during operation the valve in the discharge line is closed abruptly or for a long period of time, water hammers can occur in the pump and lead to damage to the pump and/or the pumping medium. During operation do not close the valve in the discharge line abruptly or for a long period of time.
- ▶ **Damage to pump:** Exceeding of the output can lead to damage of the pump and the shaft seals. Do not exceed the maximum speed of 3,600 rpm.
- ▶ **Damage to motor during operation with frequency converter:** If the speed is too low, the motor will overheat. Please refer to the motor supplier documentation in the attached documents.

### 7.4 Stopping of Operation

1. Turn off the motor.
2. Close the valve in the suction line to prevent dry running of the pump.
3. Close the valve in the discharge line.

### 7.5 Pump Decommissioning

1. Turn off the motor.
2. Close the valve in the suction line.
3. Close the valve in the discharge line.
4. De-energize the pump.
5. Empty the pump.
6. Clean the pump.
7. Dry the pump.
8. Protect the interior of the pump from moisture, e.g., with silica gel.
9. Seal the pipe connections with caps to prevent penetration of dirt and foreign objects.
10. Please see *Chapter 5, "Storage," page 10* for additional steps.

## 7.6 Cleaning in Place

### 7.6.1 CIP Process

The FP series pumps are suitable for the CIP (Cleaning In Place) process. The following guidelines apply to the CIP process:

#### Example of a Cleaning Cycle

1. Perform preliminary flush with water.
2. Perform caustic flush with lye (NaOH; see *Table 2 CIP cleaning*).
3. Perform intermediate flush with water.
4. Perform acid flush with nitric acid (HNO<sub>3</sub>; see *Table 2 CIP cleaning*).
5. Flush with water.

Medium	Process Temperature [°C]
NaOH (approx. 1%–2%)	80–85
HNO <sub>3</sub> (approx. 1%)	60–65

Table 2 CIP cleaning

The pump's differential pressure should be 2–3 bar so that adequate flow rates are reached.

If values deviate from these specifications, please contact *Fristam*.

### 7.6.2 SIP Process

The FP series pumps can only be used with the SIP (Sterilization In Place) process with the prior approval of *Fristam*.

Suitability depends on the selected elastomers.

The maximum process temperature is 145°C.

## 8 Faults

For information on faults, possible causes, and remedies, please see *Chapter 10.4, "Troubleshooting Table," page 28*.

### 8.1 Safety Instructions

- ▶ Danger of burning: Pumping of hot media can cause the pump to become very hot. Check the temperature before touching the pump.
- ▶ Pump running in reverse direction despite emergency shut-off: If the pump is shut off using the emergency shut-off function, it can continue to run in reverse direction due to the pumping medium in the discharge line. Install a check valve.

## 9 Maintenance

For information on maintenance intervals, please see *Chapter 10.2, "Maintenance Intervals," page 27*.

### 9.1 Safety Instructions

- ▶ Rotating parts: Danger of injury. Before removing the coupling guard and guard plate, turn off the pump motor and prevent it from being able to be turned on accidentally.
- ▶ Danger of burning: Pumping of hot media can cause the pump to become very hot. Check the temperature before touching the pump.
- ▶ Electric shock: Liquids flowing through the system result in buildup of electrostatic charge. Ground the pipes and the pump.
- ▶ Uncontrolled outflow of liquids: Before maintenance or adjustment of the pump:
  - Close the suction and discharge valves in front of and behind the pump.
  - Block off the sealing or quenching liquid line.
- ▶ Leaking liquids: Acid burns and contamination. Before opening the pump completely empty the pump casing.
- ▶ Tension cracks: Do not rapidly cool the pump. Material damage from scratching of polished surfaces. For a polished surface, use a copper socket wrench socket.

### 9.2 Replacement Parts

- ▶ Use of replacement parts that are not approved by *Fristam Pumpen KG (GMBH & Co.)* can lead to serious personal injury and material damage. If you have any questions regarding approved replacement parts, please contact *Fristam*.
- ▶ *Fristam* registers all shipped pumps. For ordering replacement parts from *Fristam*, you require the following information:
  - Serial number: see
    - rating plate or
    - number stamped into pump casing.

### 9.3 Inspection of Sealing and Quenching Liquid (Optional)

For pumps equipped for "sealing liquid" or "quenching liquid," the sealing liquid head must be checked daily.

- ▶ Check the sealing liquid head and compare with the specified value.
  - The specified value can be found in the *Order-Related Documents* on the "Sectional Drawing" of the shaft seal. The *Order-Related Documents* are attached to this operator's manual.
- ▶ The sealing liquid is heated by hot pumping medium and by operation of the pump.

Ensure that the temperature T of the sealing liquid is < 70°C during operation.

## 9.4 Lubrication of Motor Bearings

- ▶ Lubricate the motor bearings in accordance with the motor manufacturer's specifications (see "Motor Supplier Documentation").

## 9.5 Lubrication of Shaft Bearing

### 9.5.1 Models FP, FPE, and FP...V

The models FP, FPE, and FP...V do not have additional shaft bearings, and hence no shaft bearing lubrication is necessary.

### 9.5.2 Models L 2, L 3, and L 4

For the models L 2, L 3, and L 4, the oil must be changed at regular intervals.

1. Turn on the motor and let it run until the normal operating temperature is reached.
2. Turn off the motor and prevent it from being able to be turned on accidentally.
3. Place a suitable oil collection container under the oil drain plug.
4. **Caution!** Danger of burning from hot oil.
  - ▶ Wear suitable protective gloves.
  - ▶ Loosen and remove the oil drain plug.
5. Drain the oil completely and dispose of oil in accordance with local regulations.
6. Clean and remount the oil drain plug and seal.
7. Fill with new oil (see Chapter 10.3, "Lubricant Table," page 28). For the required amount, please see Table 3 Oil volumes.

Type	Oil Volume
L 2	1 liter
L 3	3 liters
L 4	5 liters

Table 3 Oil volumes

### 9.5.3 Model L1

- ▶ Do not relubricate the deep groove ball bearing, but replace it completely.
  - At constant operating conditions, the raising of power consumption, noise level or vibration indicates that wear has occurred. Replace the deep groove ball bearing consequently.

Model	Bearing Grease Amount
L1	10 g

Table 4 Bearing grease amount: model L1

### Prerequisites

- Pump head has been removed.
- Motor with coupling has been removed.

### Procedure

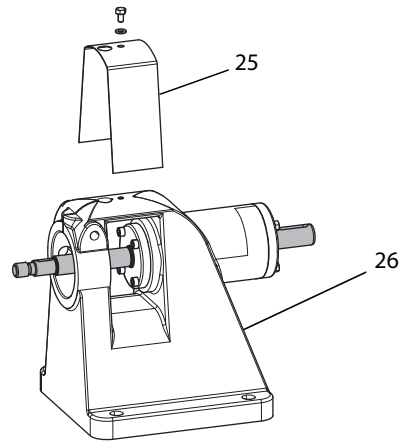


Fig. 19 Removing bearing block cover

1. Take the cover (25) off of the bearing block (26).

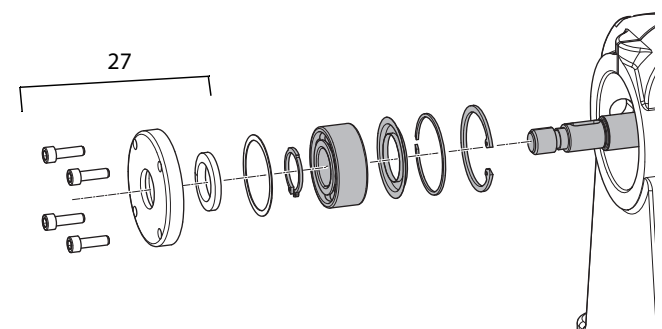


Fig. 20 Model L1, pump shaft, pump-side

2. Remove the bearing cap (27) on the pump side.

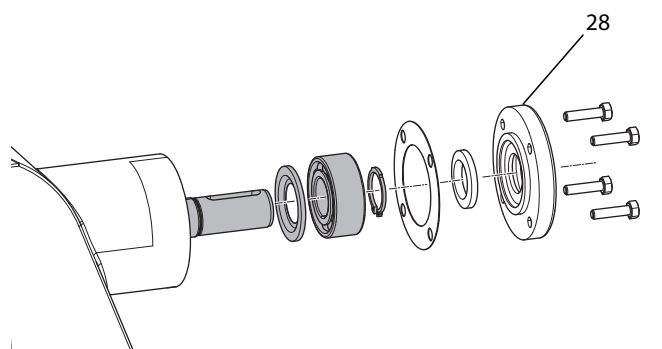


Fig. 21 Model L1, pump shaft, motor-side

3. Remove the bearing cap (28) on the motor side.
4. Force out the shaft in the direction of the pump head.

Note: All parts that are gray in the above two figures remain on the shaft.

5. Clean the surfaces of all parts and check for damage. Replace if necessary.

6. Relubricate the angular contact ball bearing. See *Table 4 Bearing grease amount: model L1*.
7. Press the pump shaft with the bearing into the bearing block.
8. Mount the bearing cap on the motor side.
9. Mount the bearing cap on the pump side.
10. Mount the cover (25).

#### 9.5.4 Model KF

- ▶ Do not relubricate the deep groove ball bearing, but replace it completely.
  - At constant operating conditions, the raising of power consumption, noise level or vibration indicates that wear has occurred. Replace the deep groove ball bearing consequently.
- ▶ Grease the cylindrical roller bearing with bearing grease.

Model	Bearing Grease Amount
KF 1	20 g
KF 2	40 g
KF 3	60 g

Table 5 Bearing grease amounts: model KF

#### Prerequisites

- Pump head has been removed.
- Motor has been removed.

#### Procedure

1. Remove the bearing cap (31).
2. Force out the pump shaft (29) with the bearing toward the motor side.

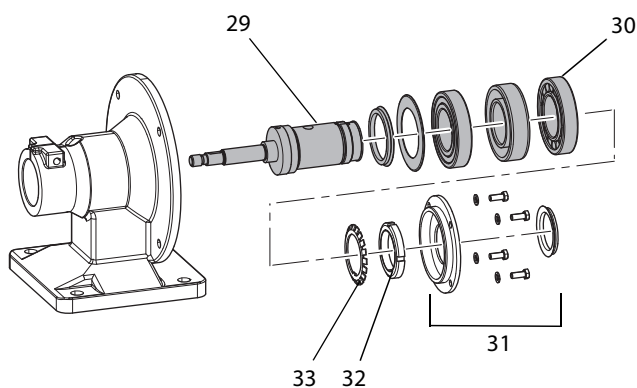


Fig. 22 Model KF, shaft bearing

3. Remove the bearing nut (32) and the guard plate (33).
4. Remove the outer race of the cylindrical roller bearing.
 

Note: All parts that are gray in the above figure remain on the shaft.
5. Clean the surfaces of all parts and check for damage. Replace if necessary.
6. Relubricate the cylindrical roller bearing (29). See *Table 5 Bearing grease amounts: model KF*.

7. Put the outer race back onto the shaft.
8. Place the guard plate and the bearing nut on the shaft, and tighten the bearing nut.
9. Press the pump shaft with the bearing back into the lantern.
10. Mount the bearing cap (31).

## 9.6 Motor Replacement

### Special Motor

1. Turn off the motor and prevent it from being able to be turned on accidentally.
2. Remove the pump head (see *Chapter 9.8, "Pump Head Removal," page 17*).
3. Replace the special motor.
4. Replace the mechanical seal if necessary, and mount the pump head (see *Chapter 9.10, "Pump Head Attachment," page 19*).

### IEC Standard Motor for FPE and FP...V

1. Turn off the motor and prevent it from being able to be turned on accidentally.
2. Remove the pump head (see *Chapter 9.8, "Pump Head Removal," page 17*).
3. Take the lantern off of the motor.
4. Remove the shaft.
5. Replace the motor.
6. Mount the shaft and align (see *Chapter 9.11, "Models FPE and FP...V: Mounting and Alignment of the Pump Shaft," page 25*).
7. Mount the lantern.
8. Only for flange connection: Check the clearance if necessary (see *Chapter 9.9, "Checking of the Clearances," page 18*).
9. Replace the mechanical seal, and mount the pump head (see *Chapter 9.10, "Pump Head Attachment," page 19*).

### IEC Standard Motor for Model KF

1. Turn off the motor and prevent it from being able to be turned on accidentally.
2. Take the motor off of the compact bearing support with base.
3. Dispose of the motor in an environmentally friendly manner. See *Chapter 2.6.5, "Disposal of Electrical and Electronic Scrap," page 7*.
4. Insert the key of the old motor into the new motor.
5. Screw the motor to the compact bearing support with base.

### IEC Standard Motor for Model L

1. Turn off the motor and prevent it from being able to be turned on accidentally.
2. Remove the coupling guard.

3. Detach the motor from the base frame or the foundation.
4. Take the coupling parts off of the motor.
5. Dispose of the motor in an environmentally friendly manner. See *Chapter 2.6.5, "Disposal of Electrical and Electronic Scrap," page 7.*
6. Mount the coupling parts onto the replacement motor (proceed as described in *Chapter 9.12, "Model L: Coupling Replacement," page 25* to replace the coupling).
7. Place the replacement motor on the base frame or the foundation.
8. Check the parallel and angular misalignment of the shafts.

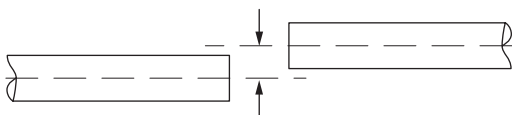


Fig. 23 Parallel misalignment

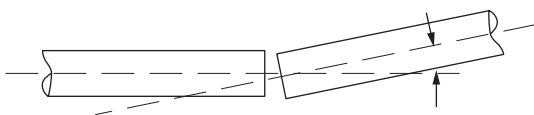


Fig. 24 Angular misalignment

9. Minimize deviations from the angular and parallel misalignment. Realign the shafts if necessary.
10. Screw the motor to the base frame or the foundation.
11. Mount the coupling guard.

## 9.7 Shaft Seal Replacement

The shaft seal must be replaced if:

- Pumping medium or sealing or quenching liquid flows out of the pump on the atmosphere side.
- Sealing liquid leaks into the pumping medium.

### Procedure

1. Remove the pump head (see *Chapter 9.8, "Pump Head Removal," page 17*).
2. Replace the mechanical seal, and mount the pump head (see *Chapter 9.10, "Pump Head Attachment," page 19*). Perform the following tasks according to the given shaft seal:
  - ▶ Preassemble the seals on the shaft.
  - ▶ Preassemble the pump casing.
  - ▶ Mount the pump casing on the lantern.
  - ▶ Mount the mechanical seal.
  - ▶ Mount the impeller.
  - ▶ Screw on the pump cover.

## 9.8 Pump Head Removal

### 9.8.1 Preparation

1. Turn off the motor and prevent it from being able to be turned on accidentally.
2. Close the valve in the discharge line.
3. Close the valve in the suction line.
4. Completely empty the pump.

### 9.8.2 Procedure

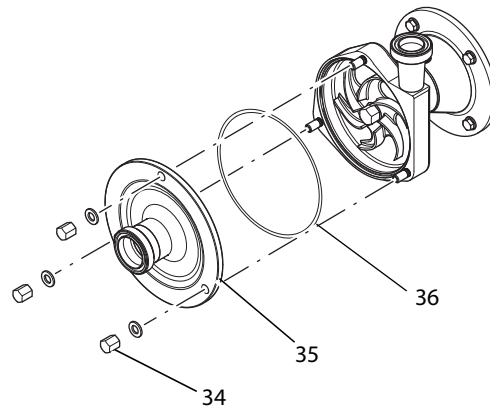


Fig. 25 Pump cover

1. Loosen the nuts (**34**) on the pump cover.
2. Remove the nuts, the washers, the pump cover (**35**), and the cover seal (**36**).

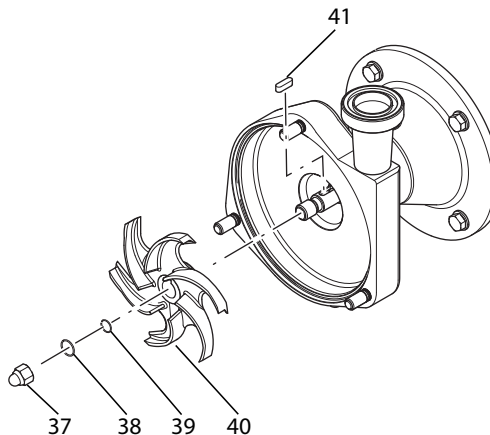


Fig. 26 Impeller

3. **WARNING:** Risk of injury when stopping the impeller by hand. Block the impeller (**40**) with a wooden wedge. Loosen the impeller nut (**37**), and remove with the O-ring (**38**).
4. Take the snap ring (**39**), the impeller (**40**), and the key (**41**) off of the shaft.
5. Only for pumps with double shaft seals: Remove the flushing tubes for sealing or quenching liquid.

TIP: For large pump casings, there is an M 12 thread on the top of the casing. An eyebolt can be screwed into the thread for suspension of the pump head from a crane.

6. Pull the pump head with the pump-side shaft seal off of the shaft as follows:

6a. Clamp connection variant

1. Loosen the clamp bolt.
2. Slightly spread the clamp connection with a wedge.
3. Pull the pump casing out of the clamp connection.

6b. Flange connection variant

1. Loosen the fastening screws on the flange and remove.
2. Remove the pump casing.

7. Take the shaft seal out of the pump casing.

## 9.9 Checking of the Clearances

The position of the impeller is determined by the position on the shaft.

The clearances are set through the position of the pump casing with respect to that of the impeller.

### Prerequisites

- Pump casing is connected firmly to the lantern.
- Pump cover has been removed.
- The impeller has been mounted and the impeller nut tightened.

### 9.9.1 Measurement of the Impeller-Pump Cover Clearance

1. Measure the height H of the pump cover (42) using vernier calipers.

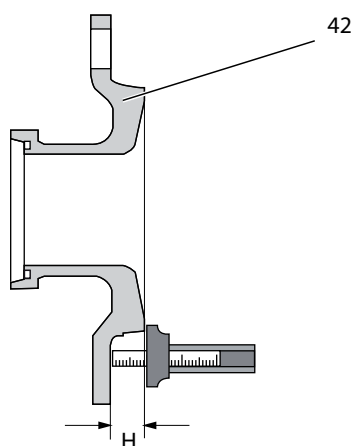


Fig. 27 Height

2. Measure the clearance A between the pump casing (43) and the impeller (44) using vernier calipers.

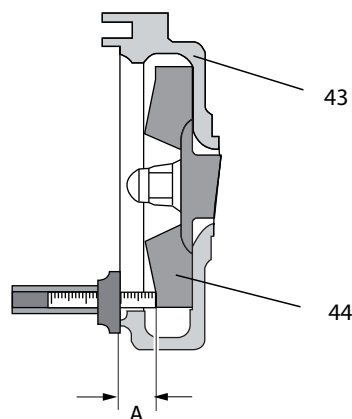


Fig. 28 Clearance

3. Calculate the clearance (clearance = A-H).

4. Compare the clearance with Table 6 Clearances.

### 9.9.2 Measurement of the Impeller-Casing Clearance

1. Measure the clearance between the impeller and the casing using a leaf feeler gauge (Fig. Impeller-casing clearance).
2. Compare the clearance with Table 6 Clearances.

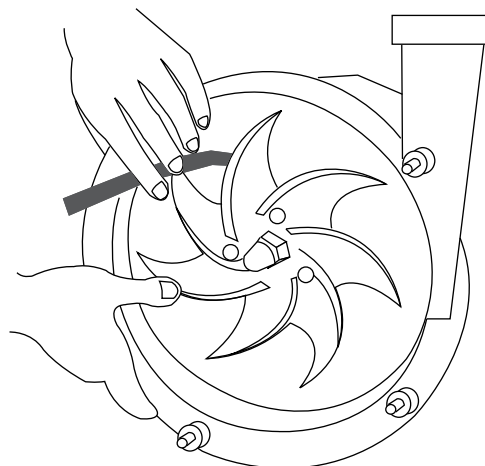


Fig. 29 Impeller-casing clearance

Pump Size	Clearances in mm	
	Impeller-Pump Cover	Impeller-Casing
711/712	0.5	0.5
721/722	0.5	0.7
741/742	0.5	0.5
751/752	1.0	1.0
3401/3402	0.5	0.5
3521/3522	0.5	0.5
3531/3532	0.5	1.5
3541/3542	1.0	1.0
3451/3452	1.0	1.0
3551/3552	1.0	1.0
1151/1152	2.0	2.0

Table 6 Clearances



Pump Size	Clearances in mm	
	Impeller–Pump Cover	Impeller–Casing
1231/1232	1.0	1.5
1251/1252	1.5	1.5
101/102-200	0.5	1.2
101/102-250	0.5	1.2

Table 6 Clearances

## 9.10 Pump Head Attachment

The pump assembly is dependent on the respective pump size and model as well as the respective shaft seal (see *Order-Related Documents* in the attached documents).

### NOTICE

#### Incorrect Elastomers

Pump leakiness.

- ▶ Ensure that the elastomers are appropriate for the condition of the pumping medium. Please refer to the *Order-Related Documents*.

#### Preparation

- ▶ Clean all pump parts and check for damage and accuracy of fit.
- ▶ If necessary, rework or replace pump parts.
- ▶ Assemble in clean conditions, carefully, and using little force. The seals could be permanently deformed or break in part.
- ▶ Replace all O-rings.
- ▶ To reduce friction, wet the O-rings and the sliding faces with water, alcohol, or silicone grease.
- ▶ Clean the sealing surfaces of the mechanical seals with a degreaser, e.g., OKS 2610 Universal Cleaner. Do not allow the sealing surfaces to come into contact with oil or grease and do not touch with your fingers afterwards.

Tip: The joint retaining compound "Euro Lock A64.80," e.g., is suitable for gluing in bearings and bushings.

Tip: The screw retaining compound "Euro Lock A24.10," e.g., is suitable for gluing in set screws.

#### 9.10.1 Clearance Setting for Flange Connection

Note: For pumps with flange connections, the clearance is set using shims. To determine the exact number and thicknesses of shims needed, first mount the impeller nut, the impeller, and the key as follows and then remove again.

1. Slide the pump casing (45) and the shims (46) over the shaft to the flange (47) and screw on.

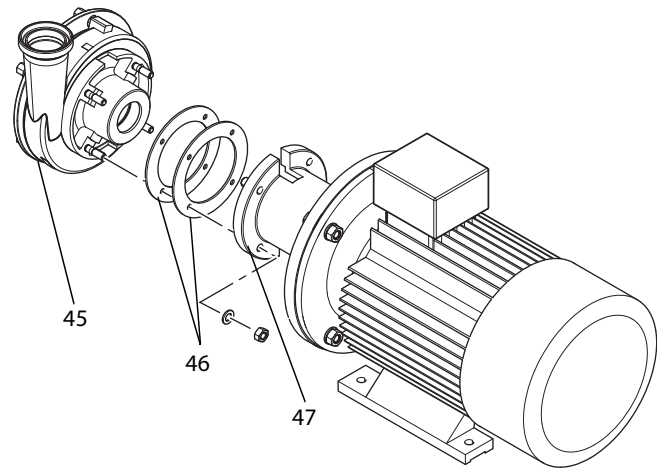


Fig. 30 Setting the clearance for the flange connection

2. Slide the seal driver onto the shaft.
3. Slide the key and the impeller onto the shaft.
4. Tighten the impeller nut.
5. Check the clearances (see *Chapter 9.9, "Checking of the Clearances,"* page 18).
6. Remove the impeller nut, the impeller, and the key.
7. Remove the pump casing.
8. If the clearance is incorrect:
  - ▶ Adjust the clearance using the appropriate shims.

#### 9.10.2 Mounting of Seals

The shaft seal built into the respective pump is given in the attached documents in the *Order-Related Documents* in the form of a *Sectional Drawing* and a *Replacement Parts List*.

The assembly of standard shaft seals is described in the following sections with the application cases A to F. The version for your order can deviate from this.

If anything is unclear or if you require further information, please contact *Fristam*.

Applica- tion Case	Pump	Shaft Seal	Pump Sizes
<b>A</b>	FP/FPE	Single	340/350/700/1150/1230
<b>B</b>	FP/FPE	Single	1250
<b>C</b>	FPE	With quench	340/350/700, with clamp connection: $\varnothing$ 60 mm
<b>D</b>	FPE	With quench	340/350/740, with clamp connection: $\varnothing$ 100 mm 1150/1230/750, with flange connection
<b>E</b>	FP/FP...V	Double	340/350/700/1150/1230
<b>F</b>	FP/FPE	Double	1250

Table 7 Standard shaft seals



**Application Case A**

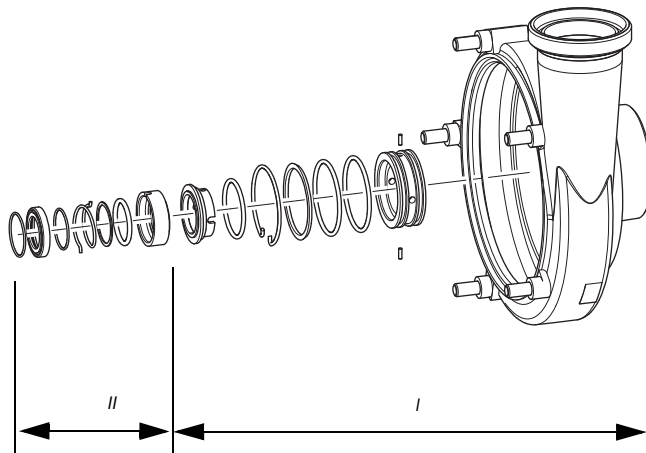


Fig. 31 Application case A

In the above figure, parts are grouped according to assembly steps:

I	Preassembly of the pump casing
II	Completion of assembly on the shaft

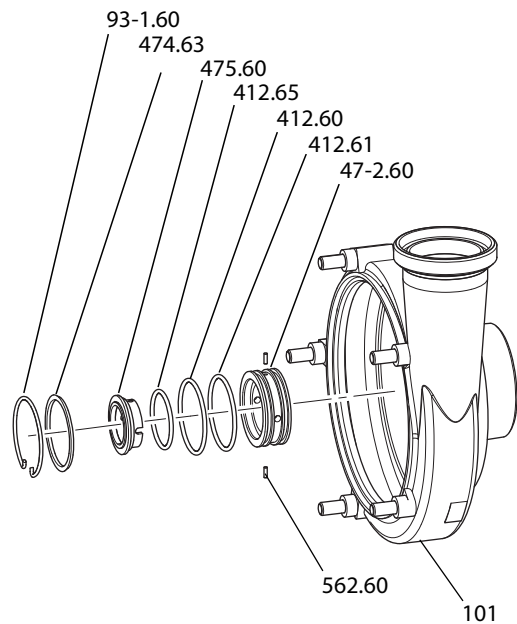


Fig. 32 Application case A, preassembly of the pump casing

To preassemble the pump casing (I):

1. Glue the cylindrical pin (**562.60**) into the mechanical seal chamber (**47-2.60**) with a retaining compound.  
Note: Glue in the cylindrical pin so that it will later not touch the shaft but still completely engage in the slot on the stationary seal ring (**475.60**).
2. Place O-rings (**412.60**) and (**412.61**) into the mechanical seal chamber.
3. Guide the preassembled mechanical seal chamber into the pump casing (**101**).

4. Place the thrust collar (**474.63**) on the pump casing and secure with snap ring (**93-1.60**).

Preassembly of the pump casing is now finished.

5. Equip the stationary seal ring (**475.60**) with an O-ring (**412.65**).
6. Guide the stationary seal ring into the mechanical seal chamber.

Note: Guide in so that the cylindrical pins on the mechanical seal chamber engage in the slots on the stationary seal ring.

Preassembly of the mechanical seal chamber is now finished.

7. Mount the preassembled pump casing (**101**) on the shaft as described in Chapter 9.10.3, "Mounting of the Pump Casing," page 24.

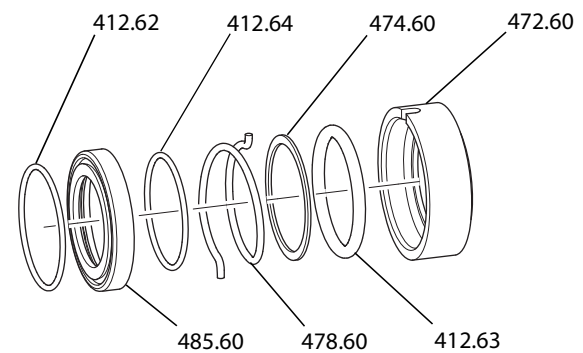


Fig. 33 Application case A, completion of assembly on the shaft

To complete assembly on the shaft (II):

8. Equip the rotating seal ring (**472.60**) with an O-ring (**412.63**).
9. Equip the seal driver (**485.60**) with O-rings (**412.62**) and (**412.64**).
10. Slide the rotating seal ring with the thrust collar (**474.60**), the spring (**478.60**), and the seal driver onto the shaft. Let the folded end of the spring snap into the rotating seal ring.
11. Finish the assembly of the shaft seal by attaching the impeller; see Chapter 9.10.4, "Mounting of the Impeller," page 24.

## Application Case B

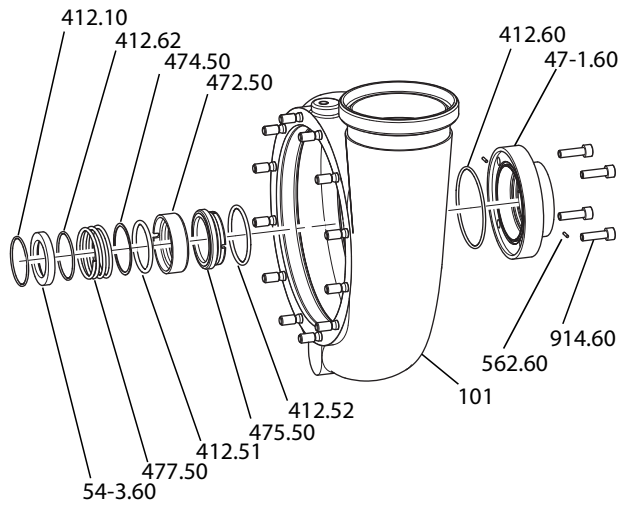


Fig. 34 Standard shaft seal: application case B

To preassemble the pump casing:

1. Glue the cylindrical pin (**562.60**) into the mechanical seal chamber (**47-1.60**) with a retaining compound.
2. Insert the O-ring (**412.60**) into the mechanical seal chamber.
3. Use socket screws (**914.60**) to fasten the mechanical seal chamber to the pump casing (**101**).
4. Equip the stationary seal ring (**475.50**) with an O-ring (**412.52**) and guide into the mounted mechanical seal chamber on the pump side.

Note: The cylindrical pins on the mechanical seal chamber must engage in the slots on the stationary seal ring.

To complete assembly on the shaft:

5. Slide the rotating seal ring (**472.50**) with the O-rings (**412.51**), (**412.62**), and (**412.10**), the thrust collar (**474.50**), the spring (**477.50**), and the seal driver (**54-3.60**) onto the shaft. Let the folded end of the spring snap into the rotating seal ring.
6. Finish the assembly of the shaft seal by attaching the impeller; see Chapter 9.10.4, "Mounting of the Impeller," page 24.

## Application Case C

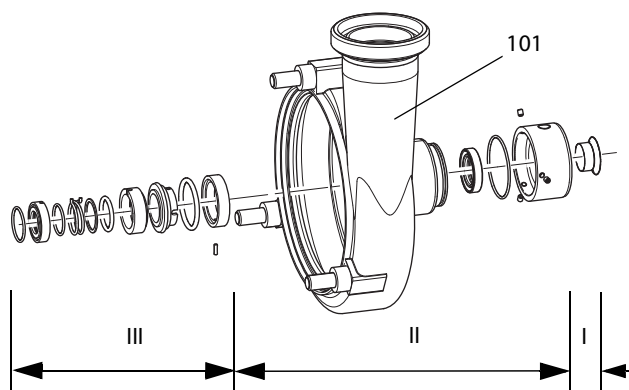


Fig. 35 Application case C

In the above figure, parts are grouped according to assembly steps:

- |     |                                     |
|-----|-------------------------------------|
| I   | Preassembly on the shaft            |
| II  | Preassembly of the pump casing      |
| III | Completion of assembly on the shaft |

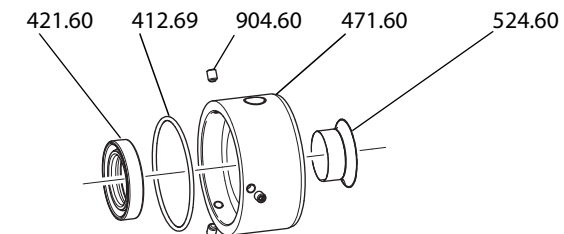


Fig. 36 Application case C, preassembly on the shaft (I) and preassembly of the pump casing (II)

To preassemble on the shaft (I):

1. **Caution!** Cutting injuries from sharp-edged shaft protective sleeves. Wear suitable protective gloves.
  - Slide the shaft protective sleeve (**524.60**) onto the shaft using an assembly tool (auxiliary pipe). Position on the shaft: See *Sectional Drawing*.

Preassembly of the shaft is now finished.

To preassemble the pump casing (II):

2. Insert an O-ring (**412.69**) into the groove on the pump casing (**101**).
3. Insert the rotary shaft seal (**421.60**) into the seal cover (**471.60**).
  - Note: Heed the installation direction for the rotary shaft seal. See *Sectional Drawing*.
4. Slide the seal cover onto the pump casing on the motor side. Align the drill holes for the sealing liquid connections vertically.
5. Apply a screw retaining compound to the set screws (**904.60**) and fasten the seal cover.

Preassembly of the pump casing is now finished.

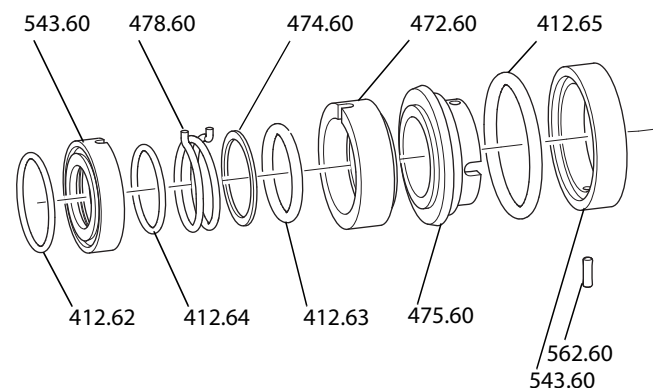


Fig. 37 Application case C, completion of assembly on the shaft (III)

To complete assembly on the shaft (III):

6. Apply a retaining compound to the cylindrical pin (**562.60**), and glue cylindrical pin into the spacer bushing (**543.60**).

Note: Glue in the cylindrical pin so that it will later not touch the shaft but still completely engage in the slot on the stationary seal ring (**475.60**).

7. Use a retaining compound to glue the spacer bushing into the seal chamber of the pump casing (**101**).
8. Mount the pump casing. See *Chapter 9.10.3, "Mounting of the Pump Casing,"* page 24.
9. Equip the stationary seal ring (**475.60**) with an O-ring (**412.65**).
10. Slide the stationary seal ring onto the shaft so that the cylindrical pin on the spacer bushing engages in the slot on the stationary seal ring.
11. Equip the rotating seal ring (**472.60**) with an O-ring (**412.63**).
12. Equip the rotating seal ring with the thrust collar (**474.60**) and the spring (**478.60**) and slide onto the shaft. Let the folded end of the spring snap into the slot on the rotating seal ring.
13. Equip the seal driver (**543.60**) with O-rings (**412.64**) and (**412.62**) and slide onto the shaft.
14. Finish the assembly of the shaft seal by attaching the impeller; see *Chapter 9.10.4, "Mounting of the Impeller,"* page 24.

#### Application Case D

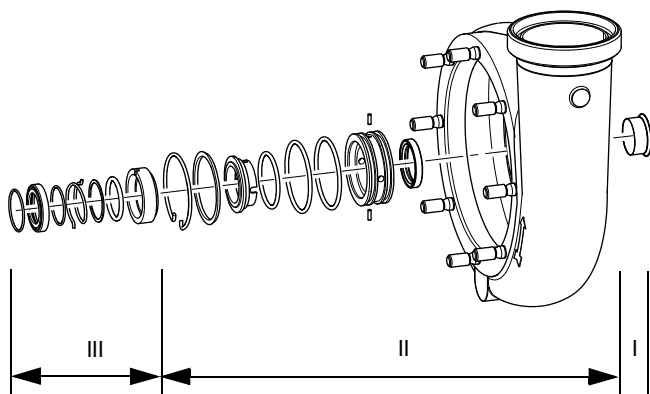


Fig. 38 Application case D

In the above figure, parts are grouped according to assembly steps:

I	Preassembly on the shaft
II	Preassembly of the pump casing
III	Completion of assembly on the shaft

To preassemble on the shaft (**I**):

1. **Caution!** Cutting injuries from sharp-edged shaft protective sleeves. Wear suitable protective gloves.
  - Slide the shaft protective sleeve (**524.60**) onto the shaft using an assembly tool (auxiliary pipe). Position on the shaft: See *Sectional Drawing*.

Preassembly of the shaft is now finished.

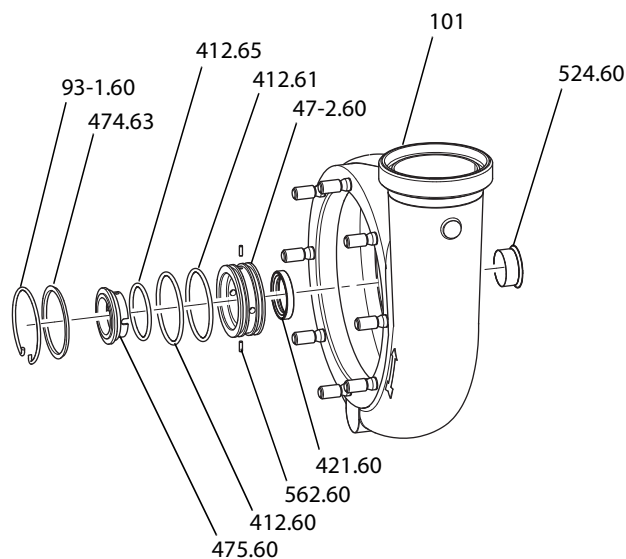


Fig. 39 Application case D, preassembly on the shaft (I) and preassembly of the pump casing (II)

To preassemble the pump casing (**II**):

2. Glue the cylindrical pin (**562.60**) into the mechanical seal chamber (**47-2.60**) with a retaining compound.
 

Note: Glue in the cylindrical pin so that it will later not touch the shaft but still completely engage in the slot on the stationary seal ring (**475.60**).
3. Install O-rings (**412.60**) and (**412.61**) from the outside and a rotary shaft seal (**421.60**) from the inside of the mechanical seal chamber.
 

Note: Heed the installation direction for the rotary shaft seal. See *Sectional Drawing*.
4. Equip the stationary seal ring (**475.60**) with an O-ring (**412.65**).
5. Guide the stationary seal ring into the mechanical seal chamber and install together in the pump casing (**101**).
 

Note: The cylindrical pins on the mechanical seal chamber must engage in the slots on the stationary seal ring.
6. Place the thrust collar (**474.63**) on the assembly in the pump casing and secure with snap ring (**93-1.60**).
 

Preassembly of the pump casing is now finished.
7. Mount the preassembled pump casing (**101**) on the shaft as described in *Chapter 9.10.3, "Mounting of the Pump Casing,"* page 24.

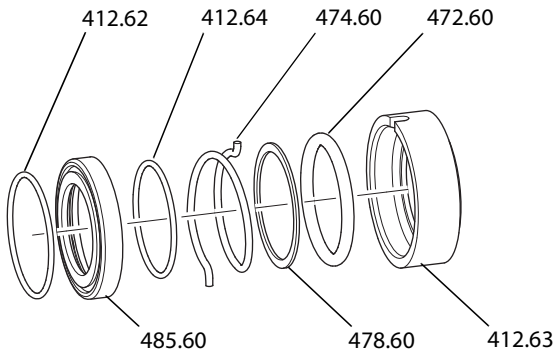


Fig. 40 Application case D, completion of assembly on the shaft (III)

To complete assembly on the shaft (III):

8. Equip the rotating seal ring (**472.60**) with an O-ring (**412.63**).
9. Equip the seal driver (**485.60**) with O-rings (**412.62**) and (**412.64**).
10. Slide the rotating seal ring with the thrust collar (**474.60**), the spring (**478.60**), and the seal driver onto the shaft.  
Note: Let the folded end of the spring snap into the slot on the rotating seal ring.
11. Finish the assembly of the shaft seal by attaching the impeller; see Chapter 9.10.4, "Mounting of the Impeller," page 24.

### Application Case E

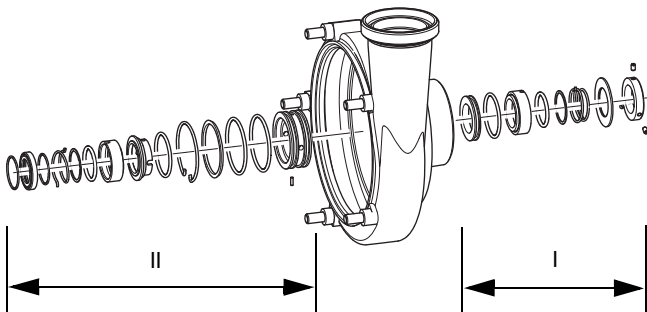


Fig. 41 Application case E

In the above figure, parts are grouped according to assembly steps:

I	Assembly of the shaft seal on the shaft on the motor side
II	Assembly of the shaft seal on the shaft on the pump side

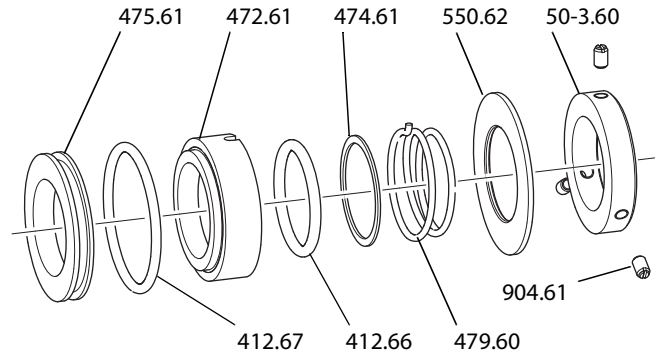


Fig. 42 Application case E, assembly of motor-side shaft seal (I)

To assemble the shaft seal on the motor side (I):

1. Only for FP...V: Secure the set collar (**50-3.60**) to the shaft using set screws (**904.61**).  
Apply a screw retaining compound to the set screws. Position on the shaft: See *Sectional Drawing*.
2. Slide the washer (**550.62**) onto the shaft.
3. Equip the rotating seal ring (**472.61**) with an O-ring (**412.66**).
4. Slide the spring (**479.60**) with the thrust collar (**474.61**) and the rotating seal ring (**472.61**) onto the shaft. Let the folded end of the spring snap into the slot on the rotating seal ring.
5. Mount the pump casing; see Chapter 9.10.3, "Mounting of the Pump Casing," page 24.
6. Insert the O-ring (**412.67**) into the stationary seal ring (**475.61**) and insert into the mechanical seal chamber (**47-2.60**).

Assembly of the shaft seal on the motor side is now finished.

To assemble the shaft seal on the pump side (II):

7. To assemble the shaft seal on the pump side, proceed as described in Chapter, "Application Case A," page 20.

### Application Case F

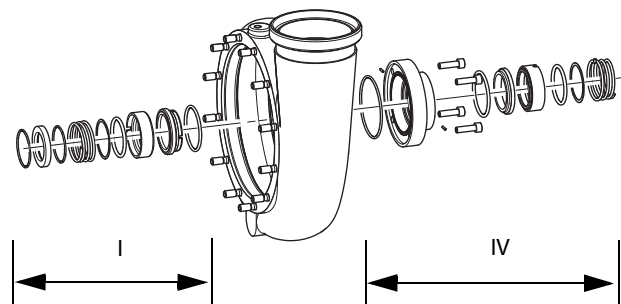


Fig. 43 Standard shaft seal, application case F

I	Pump-side shaft seal
IV	Motor-side shaft seal

To assemble the motor-side shaft seal (IV) on the shaft:

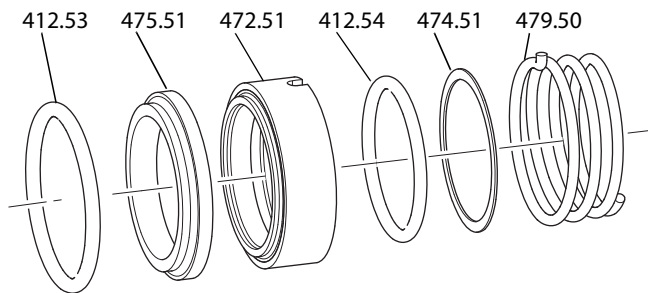


Fig. 44 Motor-side shaft seal (IV), application case F

- ▶ Slide the spring (479.50) with the thrust collar (474.51), the O-ring (412.54), the rotating seal ring (472.51), the stationary seal ring (475.51), and the O-ring (412.53) onto the shaft. Let the folded end of the spring snap into the rotating seal ring.

To assemble the pump-side shaft seal (I):

- ▶ Assemble the pump-side shaft seal (I) as described in Chapter, "Application Case B," page 21.

### 9.10.3 Mounting of the Pump Casing

#### Pump With Flange Connection

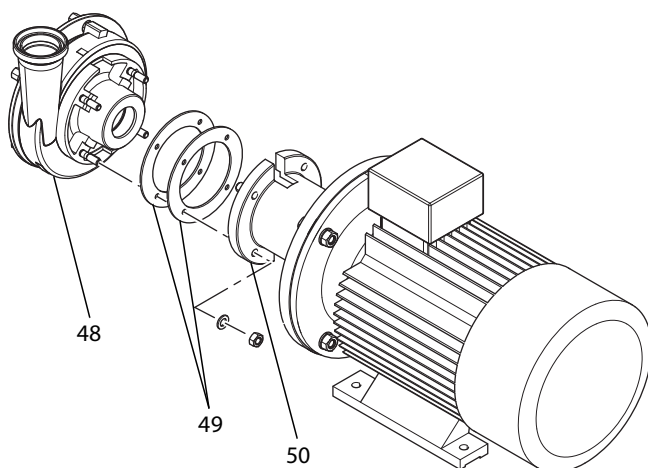


Fig. 45 Mounting of the pump casing with a flange connection

- ▶ Slide the preassembled pump casing (48) with the shims (49) over the shaft to the flange (50) and screw on (see Chapter 10.1, "Specifications," page 27).

#### Pump With Clamp Connection

1. Slightly spread the clamp connection with a wedge.
2. Only for double shaft seal: Slide the motor-side seal set onto the pump shaft.
3. Install the entire shaft seal housing with seals into the pump casing and secure to prevent slippage.
4. Slide the pump casing over the pump shaft into the clamp connection and slightly tighten the clamp bolt.
5. Slide the pump-side seal set onto the shaft.
6. Insert the key, the slotted plastic ring, and the impeller.

7. Insert the O-ring into the impeller nut, block the impeller to prevent it from twisting, and tighten the impeller nut.

Thread	Tightening Torque
M16	100 Nm
M24	200 Nm

Table 8 Tightening torques for impeller nuts

8. Adjust the clearances by sliding the pump head inside the clamp connection (see Chapter 9.9, "Checking of the Clearances," page 18). Align the surface of the outlet side (discharge line connection) horizontally while doing so.

9. Tighten the clamp bolt:

	Thread	Tightening Torque
Special motor	M10	36 Nm
Standard motor	M10	45 Nm
	M12	75 Nm

Table 9 Tightening torques for clamp connection

10. Continue with Chapter 9.10.5, "Pump Sealing," page 25.

### 9.10.4 Mounting of the Impeller

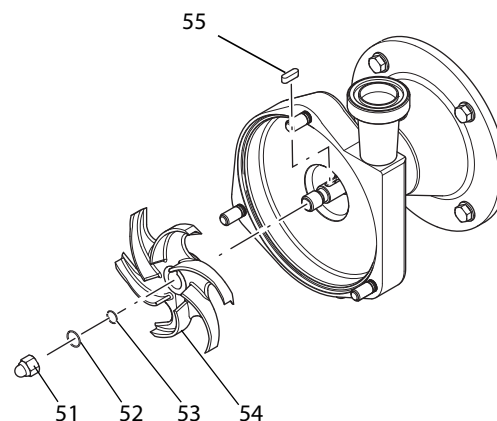


Fig. 46 Mounting of the impeller

1. Force open the plastic snap ring (53) and insert into the shaft groove.
2. Slide the key (55) and the impeller (54) onto the shaft.
3. **Caution:** Risk of injury when stopping the impeller by hand.
  - ▶ Block the impeller with a wooden wedge.
4. Screw the impeller nut (51) with the O-ring (52) onto the shaft and tighten (tightening torque = 100 Nm).

## 9.10.5 Pump Sealing

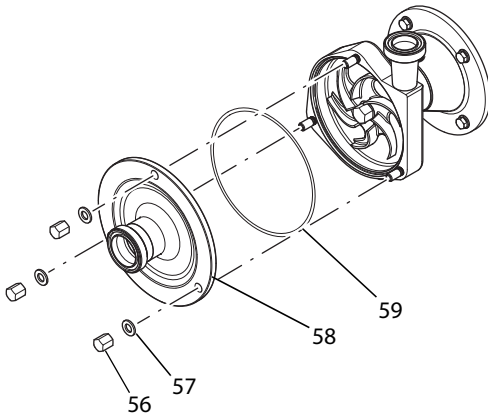


Fig. 47 Pump cover

- ▶ Slide the pump cover (58) with the O-ring (59) onto the pump casing and screw on with washers (57) and nuts (56).

## 9.11 Models FPE and FP..V: Mounting and Alignment of the Pump Shaft

Note: After the IEC motor has been replaced the pump shaft must be mounted and aligned.

### ⚠ CAUTION

#### Rotating Parts

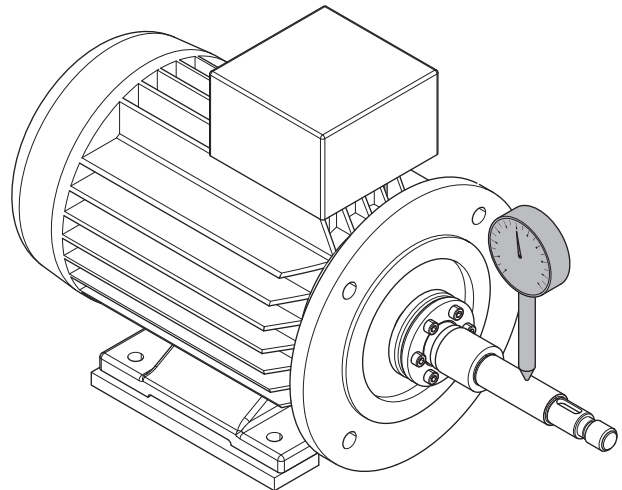
Bruising and serious injuries.

- ▶ Turn off the motor and prevent it from being able to be turned on accidentally.

1. Take the key out of the motor shaft pin.
2. For electric motors with outputs higher than 30 kW: Insert the supplied half-key.
3. Degrease the motor shaft pin and the drill hole on the pump shaft using a cleaner, e.g., OKS 2610 Universal Cleaner.
4. Grind the motor shaft pin and the edges of the key slot with grinding paper to eliminate unevenness and burrs.
5. Apply a sealing gel, e.g., Stucarit 309, to the motor shaft pin in the region of the shaft shoulder.
6. Slide the pump shaft with the shrink ring onto the motor shaft pin up to the shaft shoulder.
7. Tighten the screws crosswise on the shrink ring:

Thread	Tightening Torque
M5	6 Nm
M6	12 Nm
M8	30 Nm

8. Place a dial gauge onto the pump shaft to check the runout tolerance.



9. Check the runout of the pump shaft as a function of motor output.
  - Motor < 30 kW: max. runout tolerance = 0.06 mm
  - Motor > 30 kW: max. runout tolerance = 0.08 mm
10. Straighten the pump shaft if necessary.

## 9.12 Model L: Coupling Replacement

Only use couplings approved by Fristam. The coupling must be appropriate for the characteristic curve of the pump. If you have any questions, please contact Fristam.

### Procedure

1. Turn off the motor and prevent it from being able to be turned on accidentally.
2. Remove the coupling guard.
3. Remove the coupling tire.
4. Detach the motor from the base frame or the foundation and remove.
5. Dispose of the old coupling parts in an environmentally friendly manner.
6. Place new coupling parts (tires, flanges, possibly clamping rings) on the drive shaft and on the gear shaft.
7. Place the motor on the base frame or the foundation and slightly tighten the fastening screws.
8. Check the parallel and angular misalignment of the shafts.

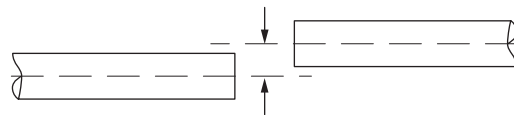


Fig. 48 Parallel misalignment

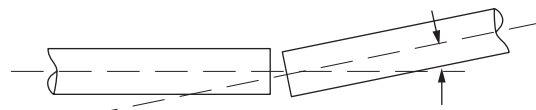


Fig. 49 Angular misalignment

9. Minimize deviations from the angular and parallel misalignment. Realign the shafts if necessary.
10. Screw the motor to the base frame or the foundation.
11. For information on the spacing between the two coupling flanges, please see the coupling installation manual. See "*Supplier Documentation*" in the attached documents.
12. Fasten the coupling flanges with the given spacing onto the shaft.
13. Fasten the coupling tire. Tighten the screws uniformly and crosswise. Heed the given tightening torques in the coupling installation manual.
14. Mount the coupling guard.



## 10 Appendix 1

### 10.1 Specifications

#### 10.1.1 Tightening Torques for Screws and Nuts

Material: Steel, Strength Class: 8.8

Thread	M6	M8	M10	M12	M16	M20
Tightening Torque [Nm]	11	27	54	93	230	464

Material: Stainless Steel, Strength Class: 70

Thread	M6	M8	M10	M12	M16	M20
Tightening Torque [Nm]	7.4	17.5	36	62	150	303

Material: Stainless Steel, Strength Class: 80

Thread	M6	M8	M10	M12	M16	M20
Tightening Torque [Nm]	10	24	49	80	203	393

#### 10.1.2 Noise Emissions

Pump Size	Noise Level dBA
711/712	75
721/722	71
741/742	79
751/752	78
3401/3402	71
3521/3522	74
3531/3532	79
3541/3542	78
3451/3452	81
3551/3552	81
1151/1152	89
1231/1232	79
1251/1252	92
101/102-200	80
101/102-250	82

Table 10 Noise emissions

The specified values apply to operation of the pump at the best efficiency point (see "Pump Characteristic Curve"). The noise level can differ greatly at other working points.

### 10.2 Maintenance Intervals

Model	Interval	Maintenance Task	Chapter
All with "Sealing and Quenching Liquid" option	Once a day	Check the sealing or quenching liquid.	See Chapter 9.3, "Inspection of Sealing and Quenching Liquid (Optional)," page 14.
L 2, L 3, L 4	Once a day	Check the oil level.	See Chapter 9.5, "Lubrication of Shaft Bearing," page 15.
KF 2, KF 3	5,000 h	Lubricate the shaft bearing.	See Chapter 9.5.4, "Model KF," page 16.
KF 1	6,000 h	Lubricate the shaft bearing.	See Chapter 9.5.3, "Model L1," page 15.
L 2	8,000 h	Change the oil.	See Chapter 9.5.2, "Models L 2, L 3, and L 4," page 15.
L 3	8,000 h	Change the oil.	See Chapter 9.5.2, "Models L 2, L 3, and L 4," page 15.
L 4	8,000 h	Change the oil.	See Chapter 9.5.2, "Models L 2, L 3, and L 4," page 15.
L1	19,000 h	Lubricate the shaft bearing.	See Chapter 9.5, "Lubrication of Shaft Bearing," page 15.
All	When necessary	Replace the shaft seal.	See Chapter 9.7, "Shaft Seal Replacement," page 17.
All	When necessary	Replace the motor.	See Chapter 9.6, "Motor Replacement," page 16.
FPE/FPV	When necessary	Replace the shaft.	See Chapter 9.11, "Models FPE and FP...V: Mounting and Alignment of the Pump Shaft," page 25.
All	According to manufacturer's specifications	Lubricate the motor bearings.	See Chapter 9.4, "Lubrication of Motor Bearings," page 15.

Table 11 Maintenance intervals

For information on motor maintenance intervals, please see the motor operator's manual.



### 10.3 Lubricant Table

Model	ARAL	BP	DEA/Texaco	ELF	ESSO	Mobil	Shell
KF bearing support Cylindrical roller bearing	Aralub HTR2	Energrease HTG	Paragon EP 2	GRX 500	HT Grease 275	Mobiltemp SHC 100	Darina Grease 2
L 1 Bearing block	Aralub HTR2	Energrease HTG	Paragon EP 2	GRX 500	HT Grease 275	Mobiltemp SHC 100	Darina Grease 2
L 2 Bearing block	Vitam DE 46	Energol HLP-D	Actis HLPD 46	Elfolna HLPD	HLPD-Oel 46	HLPD 46	Hydrol DO 46
L 3, L 4 Bearing block	Turboral 30W	Energol HD-S30	Cronos Super SAE 30	ELF Performance XR 30	Essolube HDX plus 30	Delvac 1300	Rotella MX

Table 12 Lubricant table

Other brand-name lubricants with equivalent qualities and viscosities may also be used.

### 10.4 Troubleshooting Table

Problem	Possible Cause	Remedy
<b>Pump either does not pump or pumps irregularly.</b>	Suction line blocked/clogged.	Open/clean suction line.
	Suction filter contaminated.	Clean suction filter.
	Discharge-side shut-off valve closed.	Open discharge line.
	Pump not completely filled with liquid.	Install pipe system so that casing is still filled with liquid when pump is off.
	Pump with geodesic suction head <sup>1</sup> ; liquid level falls at standstill.	Install foot valve in suction line.
	Suction line leaky (drawing in air).	Seal suction line.
	Foot valve blocked or contaminated.	Reestablish proper function of foot valve; clean.
	Suction head too high.	Lower pump; reduce suction head.
	Air pocket in suction line.	Lay suction line at steady incline.
	Excessive air or gas in pumping medium.	Install vent valve.
<b>Flow rate too high.</b>	Air ingress at shaft seal.	Check shaft seal installation. Replace elastomers.
	Cavitation at impeller inlet; resistance in suction line too high; suction head too high. NPSHa values not adapted to pump.	Optimize suction line; increase inlet height; lower media temperature; contact <i>Fristam</i> .
	Discharge-side valve opened too wide.	Throttle valve.
	Discharge line diameter too large.	Reduce nominal pipe size; insert orifice plate.
	Impeller diameter too large.	Trim impeller outside diameter. Reduce speed with frequency converter. Contact <i>Fristam</i> .

Table 13 Troubleshooting table

Problem	Possible Cause	Remedy
<b>Flow rate too low; discharge head too low.</b>	Selected pump too small.	Contact <i>Fristam</i> .
	Selected impeller diameter too small.	Contact <i>Fristam</i> . Replace impeller.
	Direction of rotation of motor incorrect.	Exchange connections on motor terminal box.
	Speed too low (voltage incorrect).	Correct connection according to motor rating plate.
	Nominal pipe sizes too small.	Use larger pipe diameters.
	Pipe resistances in suction and/or discharge line too high.	Optimize pipe system; reduce elbows and valves. Contact <i>Fristam</i> .
	Pipe clogged or full of deposits.	Clean pipes.
	Foreign objects/deposits in impeller.	Remove impeller and clean.
	Impeller incorrectly adjusted.	Check impeller clearance and readjust.
	Density of pumping medium too high. Viscosity of pumping medium too high.	Contact <i>Fristam</i> .
<b>Metal noise.</b>	Foreign objects in pump interior.	Disassemble, inspect, and repair.
	Impeller catching.	Readjust impeller clearance; tighten impeller nut using torque wrench.
	Pump/shaft seal running dry.	Immediately supply pumping medium; open suction valve.
<b>Flow noise.</b>	Operation contrary to design in overload or part-load range.	Adjust working point to design.
	Flow losses in suction line too high.	Increase nominal sizes; shorten line; prevent outgassing.
	Cavitation.	Check condition for NPSH rating; contact <i>Fristam</i> .
<b>Vibrations.</b>	Suction and discharge lines stressing pump impermissibly.	Support pipes so that pump is not stressed; possibly install vibration dampers; keep water hammers away from pump.
<b>Excessive heating of shaft bearing.</b>	Bearing damage.	Replace bearing.
<b>Motor power consumption too high.</b>	Flow rate too high.	Throttle discharge line or reduce speed with frequency converter.
	Impeller diameter too large.	Trim impeller diameter; contact <i>Fristam</i> .
	Viscosity and/or density of pumping medium too high.	Contact <i>Fristam</i> .
	Massive damage to shaft bearing; shaft deformed.	Disassemble, inspect, and have repaired by <i>Fristam</i> .

Table 13 Troubleshooting table

Problem	Possible Cause	Remedy
<b>Leakage at shaft seal.</b>	Impeller nut loose.	Remove impeller; inspect shaft shoulder. Check shaft seal; tighten impeller nut to required torque; possibly replace part.
	Shaft seal or rotary shaft seal mechanical damage/wear.	Replace shaft seal and elastomers; possibly switch materials. Contact <i>Fristam</i> .
	Shaft seal running dry; suction head too high; pumping media temperature too high.	Increase pump inlet pressure; decrease suction head; use double shaft seal; contact <i>Fristam</i> .
	Sealing water head too high.	Adjust using throttle valve.
	Sealing water head too low.	Replace rotary shaft seal.
	Water tubes clogged (resulting in damage to rotary shaft seal); sealing water not clean.	Clean water tubes; adjust water inlet and outlet; use drinking water-quality water with temperature of max. 70°C.
	Temperature of pumping medium too high.	Contact <i>Fristam</i> ; convert to double shaft seal.

Table 13 Troubleshooting table

<sup>1</sup>The "geodesic suction head" is the vertical distance between the suction-side liquid level and the center of the impeller.

## 10.5 Number Key

The number key is for the attached *Sectional Drawing*. When ordering replacement parts, please specify the Part Number and the Name.

Part Number	Name
101	Pump casing
108	Stage casing
160	Cover
13-1	Back casing panel
13-2	Housing insert
130	Casing part
132	Spacer
154	Intermediate wall
156	Outlet side
18-1	Spherical cap bearing
18-2	Vibration damper
182	Base
21-1	Synchronizing shaft
213	Drive shaft
23-1	Rotor
26-1	Bracket for mechanical seal chamber
230	Impeller
32-1	Angular contact ball bearing
32-2	Cylindrical roller bearing
32-3	Deep groove ball bearing
32-4	Tapered roller bearing
321	Radial ball bearing
322	Radial roller bearing
325	Needle bearing
330	Bearing support
331	Bearing block
341	Drive lantern
344	Bearing support lantern
350	Bearing housing
360	Bearing cap
40-4	Half-length taper grooved pin
400	Flat seal
410	Profile seal
411	Gasket
412	O-ring
421	Rotary shaft seal
422	Felt ring
433	Mechanical seal
45-1	Thrust ring
451	Stuffing box housing
454	Stuffing box ring
47-1	Spring with washer
47-2	Mechanical seal chamber
47-3	Wedge seal
47-5	Ring nut
471	Seal cover
472	Rotating seal ring
474	Thrust collar
475	Stationary seal ring
476	Stationary seal ring support
477	Mechanical seal spring
478	Right spring

Part Number	Name
479	Left spring
481	Bellows
482	Bellows support
484	Spring retainer
485	Seal driver
500	Ring
50-1	Split lock washer
50-2	V-ring
50-3.60	Set collar
504	Spacer ring
520	Sleeve
523	Shaft sleeve
524	Shaft protective sleeve
525	Spacer sleeve
54-1	Cover bushing
54-2	Bushing
54-3	Stationary bushing
540	Bushing
543	Spacer bushing
55-1	Serrated lock washer
550	Washer
551	Spacer washer
554	Washer
561	Grooved pin
56-1	Roll pin
56-2	Grooved pin with round head
560	Pin
562	Cylindrical pin
59-2	Dished-type lock washer
59-3	Shrink ring
59-4	Lantern
59-5	Membrane
642	Oil level sight glass
680	Enclosure
68-1	Support plate
68-2	Foam strip
68-3	Bracket for enclosure
68-4	Orifice plate
68-5	CF guard plate
681	Coupling guard
701	Bypass line
710	Pipe
71-1	Connection pipe
715	Hose pipe
722	Flange adapter
723	Flange
724	blind flange
733	pipe clamp
751	Valve housing
755	Valve bolt
756	Valve spring
759	Valve plate
800	Motor

Part Number	Name
801	Flange motor
87-1	Gearbox
87-2	Gear cover
87-3	Gear cap
87-4	Gear base
839	Contact
872	Gearwheel
89-1	Filler piece
89-2	Spherical cap frame
89-3	Motor Foot
89-4	Handle
89-5	Protective cap
89-6	Wheel
89-8	Flat bar steel
89-9	Motor bracket
89-10	Motor bracket
89-11	Spherical cap base support
892	Base plate
894	Console
897	Guide piece
90-1	Stud bolt
90-3	Tapered pin
90-4	Half-length taper grooved pin
90-5	Eyebolt
900	Screw
901	Hex cap screw
902	Threaded stud
903	Screw plug
904	Set screw
909	Adjusting screw
91-1	Slotted cheese head screw
913	Bleed screw
914	Socket screw
92-1	Star knob nut, long
92-2	Star knob nut, short
92-3	Cap nut
92-4	Rotor nut
92-5	Forcing screw
92-6	Rotor fastener
92-7	Nut with flange
920	Hex nut
921	Shaft nut
922	Impeller nut
923	Bearing nut
93-1	Snap ring
930	Retainer
931	Retaining washer
932	Snap ring
940	Key
941	Woodruff key
950	spring

## 10.6 EC Declaration of Conformity

The manufacturer: Fristam Pumpen KG (GmbH & Co.)  
Kurt-A.-Körber-Chaussee 55  
21033 Hamburg  
GERMANY

hereby declares that the following product:

- Centrifugal pumps types: FP, FPE, FP...V, FPH, FPEH, FPH...V, FSPE, FSP...V, FM, FZ, FC, CF, CFE
- Positive Displacement pumps types: FK, FKL, FL, FL2, FL3
- Powder mixer typ: PM
- Serial number: see title page of the operating instructions

conforms to the requirements of the Machinery Directive (2006/42/EC).

The machine also complies with all requirements of the Low Voltage Directive (2006/95/EC) and the EMC Directive (2004/108/EC).

The following harmonized standards have been applied:

- DIN EN 12100-1 Safety of machinery  
Basic concepts, general principles for design, Part 1: Basic terminology, methodology
- DIN EN 12100-2 Safety of machinery  
Basic concepts, general principles for design, Part 2: Technical principles

Authorized documentation representative: Horst Helms

Phone.: +49(040) 72556-107

Address: see address of the manufacturer

Hamburg, 27. January 2011



Horst Helms / Head of Quality Management

## 11 Appendix 2 – Assembly Instructions (Optional)

### 11.1 Safety Instructions

These assembly instructions are addressed solely to specialized employees.

### 11.2 Scope

These assembly instructions apply to pumps supplied without motors (optional) and preassembled.

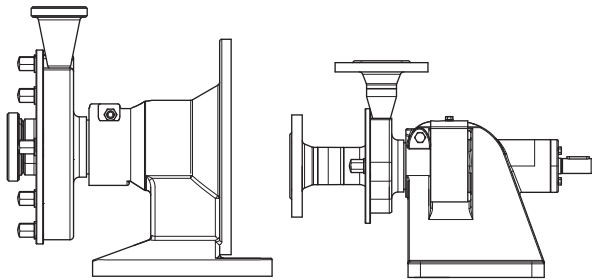


Fig. 50 Incomplete machine: pump without motor, coupling, or base frame illustrated using models KF and L

The following specifications in the "Original Operator's Manual" for complete machines do not apply in this case:

- Chapter 10.6, "EC Declaration of Conformity," page 32,
- Chapter 10.1.2, "Noise Emissions," page 27
- Chapter 2.4.4, "Rating Plate," page 6.

### 11.3 Rating Plate

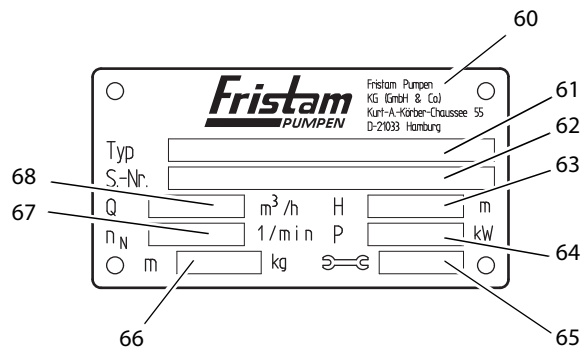


Fig. 51 Rating plate for pump without drive

60	Manufacturer
61	Type: pump series, pump size, model, version
62	SN: serial number of the pump
63	H: discharge head [m]; without drive: no indication
64	P: motor output [kW]; without drive: no indication
65	Year of manufacture
66	m: mass (pump without drive) [kg]
67	$n_R$ : rated speed [1/min]; without drive: no indication
68	Q: flow rate [m <sup>3</sup> /h]; without drive: no indication

### 11.4 Moving Without Motor

Transportation may only be performed by trained personnel.

The pump can be moved using an industrial truck or a crane.

Always move the pump in the installation condition.

#### 11.4.1 Safety Instructions

##### Falling or Unsecured Parts

Severe crush injuries.

- ▶ Always wear gloves when performing transportation-related work.

##### Incorrect Positioning of Pump for Transportation

Leakage of caustic, toxic, or contaminating liquids. Personal injury and material damage from contamination.

- ▶ Always move the pump in the installation condition.

##### Open, Unsealed Pipe Fittings

Material damage from contamination, impact, or moisture in the pump.

- ▶ Remove the pipe fitting covers just prior to connection to the pipes.

#### 11.4.2 Moving With Industrial Trucks

##### ⚠ WARNING

##### Unsecured Parts

Serious injuries from crushing, pinching of extremities, material damage.

- ▶ Before moving the pump secure it to prevent it from tipping over. Secure the pump to the pallet with tie-down straps, or screw the pump to the pallet.

##### Preparation

Ensure that the pump is adequately secured to the pallet, for example, with straps; see Fig. 52, "Moving with pallet truck," page 33.

##### Procedure

1. Pick up the pallet with the forks on the industrial truck.
2. Carefully move the pallet to the designated location and set down.

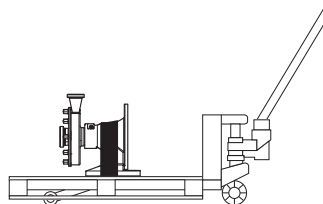


Fig. 52 Moving with pallet truck

### 11.4.3 Moving With Crane

#### **⚠ WARNING**

##### Falling Parts

Death from crushing, pinching of extremities, material damage.

- ▶ Only use suitable means of conveyance and hoists that are designed for the total weight of the pump.

Information on the pump weight can be found on the pump's rating plate as well as in the *Order-Related Documents* in the attached documents.

- ▶ Do not leave the pump in a raised position for longer than necessary.
- ▶ Ensure that the area below the pump is clear of people.

#### **⚠ WARNING**

##### Swinging Parts

Crushing and serious injuries.

- ▶ Start and stop the crane with pump smoothly.
- ▶ Ensure that the danger zone of the pump is clear of people.

##### Auxiliary Equipment

- Hoists: round slings tested in accordance with DIN EN 1492-1 and 1492-2
- Eyebolt and suitable eyebolt lifting devices

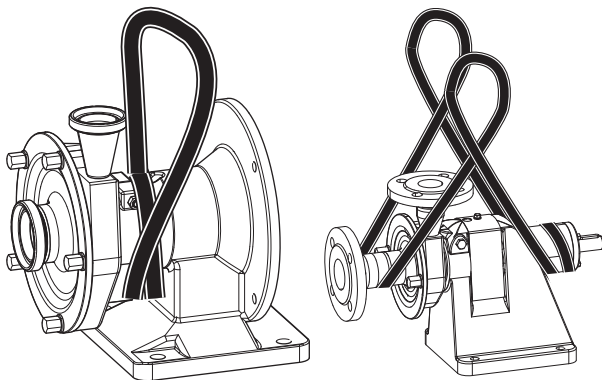


Fig. 53 Moving with crane

##### Preparation

- ▶ Remove load-securing devices.

##### To move the KF pump with the round sling:

##### Procedure

1. Wrap the round sling twice around the lantern neck (see Fig. 53, "Moving with crane," page 34).
2. Guide the other end of the round sling to the crane hook and hook on.
3. Position the center of gravity to ensure that the pump is lifted horizontally.
4. Lift the pump.

##### To move the L pump with the round sling:

##### Procedure

1. Wrap the round sling twice around the back end of the bearing block (see Fig. 53, "Moving with crane," page 34).
2. Lay the other end of the round sling around the suction port on the pump cover. Do not lay the round sling over any sharp edges or corners.
3. Guide both loops to the crane hook and rotate by 180° to ensure that the belt will not slip on the hook.
4. Position the center of gravity to ensure that the pump is lifted horizontally.
5. Lift the pump.

### 11.5 Installation Location

Please see the operator's manual Chapter 6.2, "Installation Location," page 11 for the basic installation location requirements.

### 11.6 Pump Installation

#### 11.6.1 Model KF

##### Prerequisites (Customer-Side)

- Suitable motor

#### NOTICE

##### Incorrectly Designed Motor

Destruction of pump.

- ▶ Only use motors that have been adapted to the pump characteristic curves. If you have any questions, please contact *Fristam*.

##### Procedure

1. Insert the key into the slot on the motor.
2. Slide the motor shaft into the compact bearing support.
3. Screw the motor to the compact bearing support. Tighten screws crosswise.

#### 11.6.2 Model L

##### Prerequisites (Customer-Side)

- Suitable gear motor
- Adequately sized coupling
- Common installation surface for gear motor and pump so that pump shaft can be aligned with gear motor shaft

NOTICE
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**Incorrectly Designed Motor and Coupling**

Destruction of pump and coupling.

- ▶ Only use motors and couplings that have been adapted to the pump characteristic curves. If you have any questions, please contact *Fristam*.
- 

Note: Please see the coupling supplier documentation for reference dimensions for the coupling.

**Procedure**

1. Mount the coupling parts on the pump shaft and the gear shaft.
2. Place the pump on the base frame or the foundation so that the pump shaft can be connected to the gear shaft with the coupling.
3. Screw the threaded fastener slightly into the pump base.
4. Check the parallel and angular misalignment of the pump and gear shafts.
5. Minimize deviations from the angular and shaft misalignment. If necessary, realign or add shims.
6. Screw the pump and gear to the base frame or the foundation.
7. Fasten the coupling according to the coupling manufacturer's specifications.
8. Install a noncontact, barrier-providing protective device (coupling guard) in accordance with *Section 1.4, entitled "Required Characteristics of Guards and Protective Devices," of the Machinery Directive 2006/42/EC*.
9. The pump is now installed. Do not commission the pump unless the requirements of the EC Machinery Directive are met for the complete machine.

Note: Continue with *Chapter 4, "Transportation," page 9*.



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<b>Chapter</b>		<b>Page</b>
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<b>2.</b>	<b>Principle of Operation</b>	<b>4</b>
<b>3.</b>	<b>Installation</b>	<b>7</b>
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**TO THE OWNER**

This Instruction Manual is your guide when dealing with your GL&V/Celleco equipment.

GL&V/Celleco recommends you study it carefully, and ensure its availability to those who install, maintain and operate the equipment on a daily basis. This document will be of no value to you if it is locked away when your personnel need it!

Furthermore it is important that you:

- keep this instruction manual and other documentation for the life of the equipment,
- incorporate any amendments in the text, and
- pass the documentation on to any subsequent holder or user of the equipment.

**GL&V/Celleco will not be responsible for any breakdown of the equipment caused by the owner's failure to follow the instructions in this document.**

**This Instruction Manual describes the authorized way to use the equipment. GL&V/Celleco will take no responsibility for injury or damage if the equipment is used in any other way.**

**NOTICE ON SAFETY PRECAUTIONS**

Before attempting to unpack, install and operate this unit, please read through the relevant parts of the manual. Pay particular attention to all dangers, warnings, cautions and notes. Failure to do so could result in serious injury to personnel or damage to the equipment.

**Use of Danger, Warning, Caution and Notes:**

Danger, Warning, Caution and Notes used in this manual have the following significance:

**Danger**

Failure to observe this information could result in immediate danger to life.

**Warning**

Failure to observe this information can result in major personal injury or loss of life.

**Caution**

Failure to observe this information can result in minor injury or damage to equipment.

**Note**

Information that requires special emphasis.

**1 Order Specification**

**Customer:**

**Order No:**

**Product:**

**Application:**

**Main Spec.:**

**Dimension Drawing:**

**Foundation Drawing:**

**Flow Sheet:**

**Motor Voltage:**

**Other Notes:**

## 2 Principle of Operation

The Cleanpac 350 is a 5" diameter hydrocyclone. The cleaners have o-rings that seal the feed and the accept. The reject outlet is equipped with a sight glass that enables observation of the reject flow. The lower cone is equipped with a service valve that enables unplugging while the cleaners are operating.

The bank units come in horizontal and vertical assemblies, which may have one, two or four rows of cleaners. For safety reasons there are retainer clamps, which ensure that the cleaner cannot be blown out of the unit in case of over pressure due to a faulty startup.

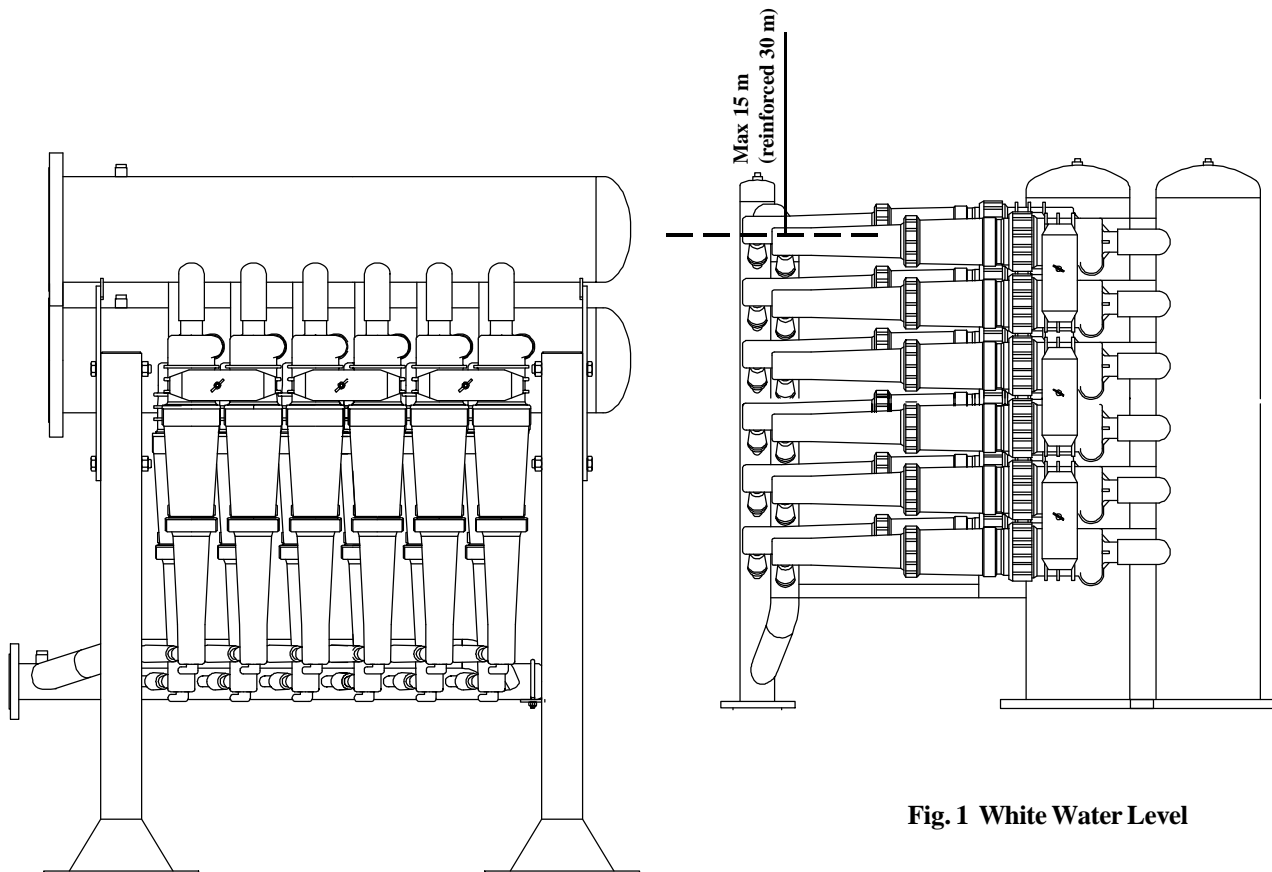


Fig. 1 White Water Level

The capacity of the CLP 350 cleaner is dependent on the pressure drop between the feed and accept headers:

Pressure Drop ( $F_p - A_p$ )	Capacity	
	Standard Inlet Head	High Flow Inlet Head
100 kPa (14 psi)	365 l/min (96 USGPM)	430 l/min (114 USGPM)
120 kPa (17 psi)	400 l/min (106 USGPM)	470 l/min (125 USGPM)
150 kPa (21 psi)	450 l/min (118 USGPM)	525 l/min (139 USGPM)

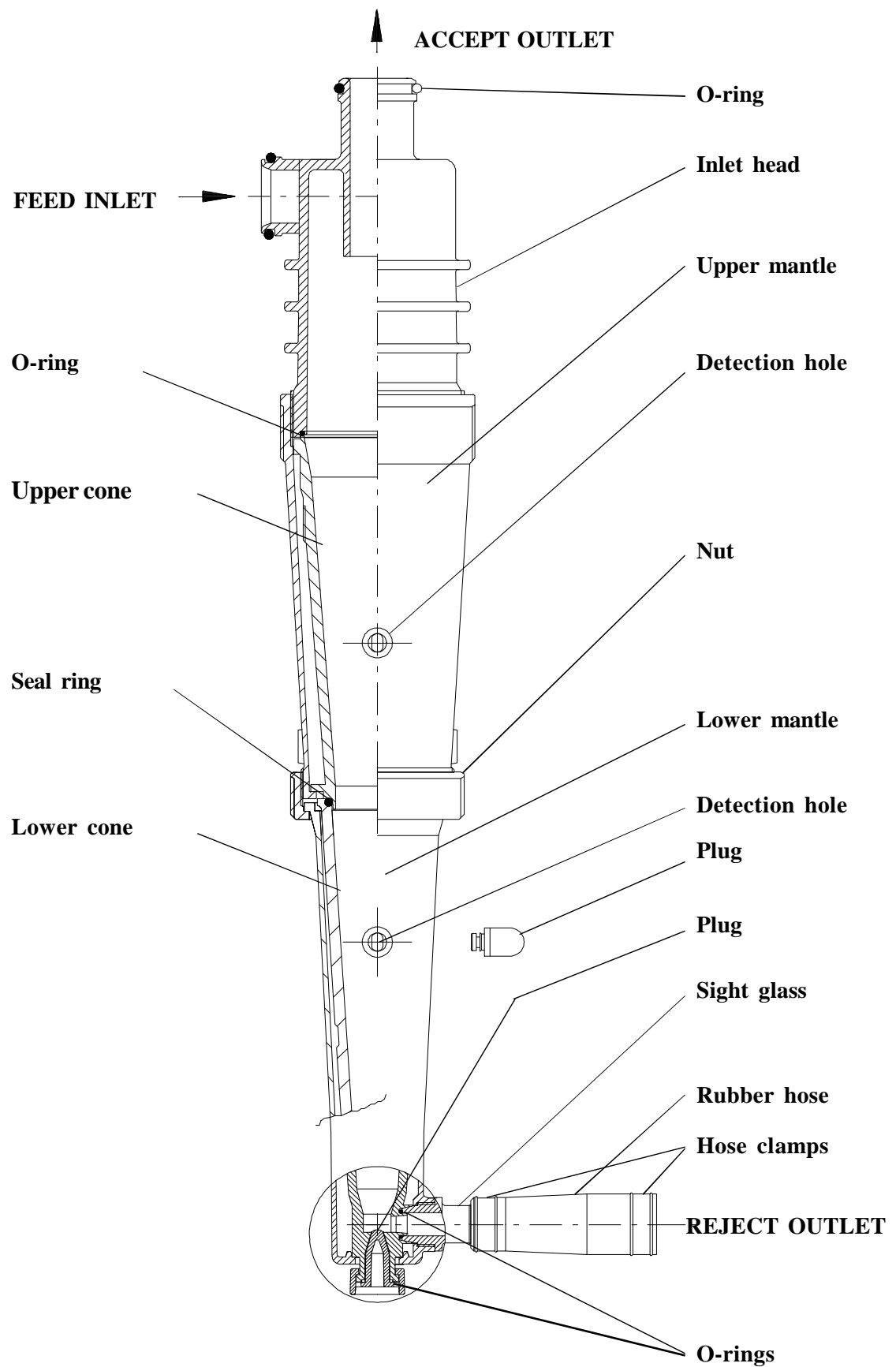
Max. accept pressure allowed for a standard performance CLP 350 Bank is 150 kPa.

Max. accept pressure allowed for a reinforced performance of CLP 350 Bank is 300 kPa.

Min. and recommended accept pressure for CLP 350 Bank, that is not connected to a RCC unit, is 35 kPa.

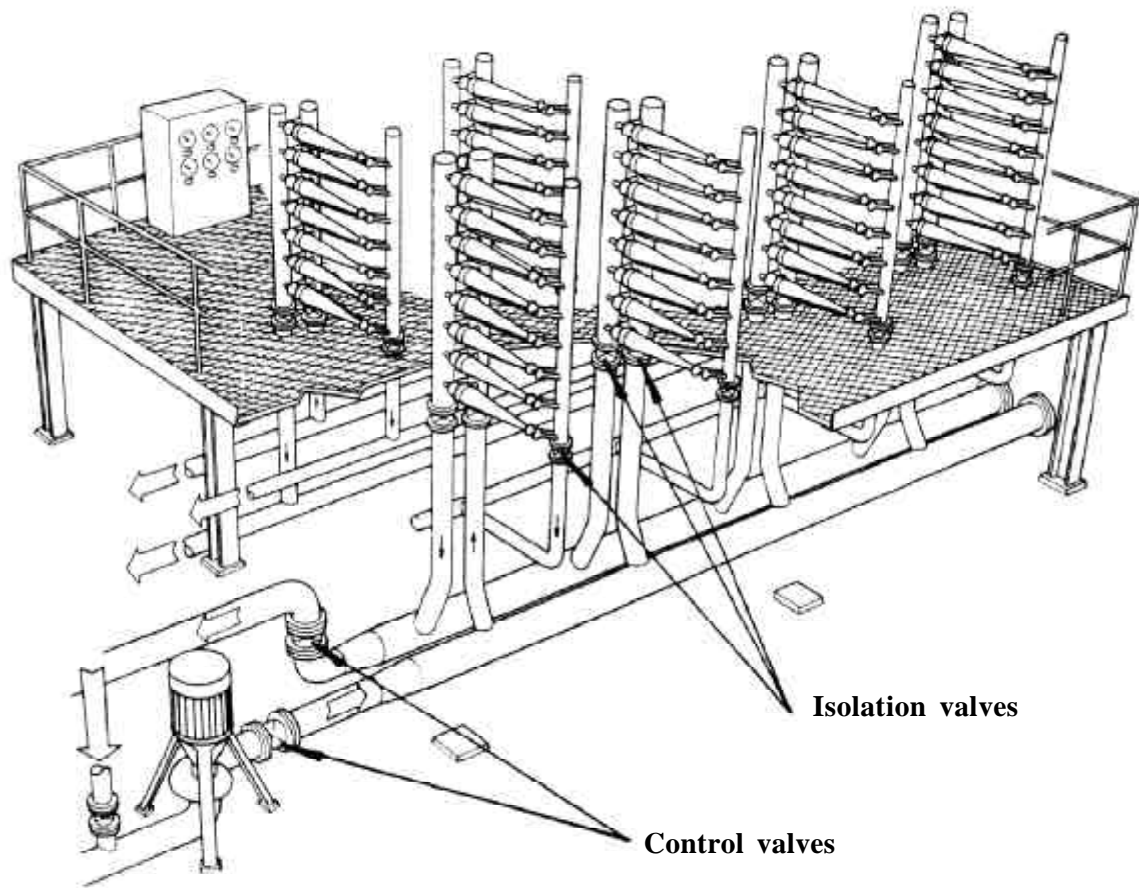
2 Principle of Operation

CLEANPAC 350 BANK CLEANER



### 3 Installation

Plant erection should be done in accordance with instructions stated on the certified drawings. Note that a control valve is to be installed on each header serving several banks apart from possible bank isolation valves.



Do not use pipe connections for lifting purposes. When lifting a horizontal bank, use the holes on the framework. When lifting a vertical bank, ropes should be tied to the interconnecting plates.

If the plant is placed more than 5 meters above the white water level, a vacuum breaker valve should be installed.

### 3 Installation

All cleaner units should be equipped with pressure transmitters on the feed, accept and reject headers. The cleaner units are supplied with 1" diameter pipe couplings to accept Paper Machine Component (PMC) pneumatic pressure transmitters. If another type or brand of transmitter is used, they should be installed adjacent to the existing PMC couplings. Pressure transmitters should be connected to a gauge panel that is close to each cleaner stage to aid in adjusting the correct operating pressures.

The location of the pressure transmitters are specified on the certified drawings provided by GL&V/Celleco. No attempt should be made to locate these transmitters elsewhere and correct for elevation as this only leads to confusion and instrument error.

All instruments should be of the transmitter-receiver (1:1 repeater) type to isolate the gauges from the vibration common in most piping installations.

Each PMC transmitter should have a clean, dry regulated air supply set at 35 kPa above the calibrated range of the transmitter. For example, a 0-100 kPa transmitter should have a 140 kPa air supply. GL&V/Celleco strongly recommend against the use of improperly sized PMC transmitters due to their consistent inaccurate readings. For example, a 0-700 kPa transmitter should not be used with a 140 kPa air supply to cover a 0-100 kPa gauge.

The use of a locally mounted diaphragm stock gauges is not recommended by GL&V/Celleco. Aside from the vibration problem, most of these are found to be temperature sensitive, which in turn leads to inaccurate pressure readings on this type of gauge.

If the final stage is equipped with a RCC unit, or if the final stage does not require a control valve, then a reject pressure transmitter is not required on the reject line of that stage.



### 3 Installation

#### Tools

The following tools are provided for mounting a bank cleaner:



**Tool No. 1** is used for securing the inlet head to ease removal of the upper cone.

**Part No. 6088 5662-01**

**Tool No. 2** is used for loosening of the upper shell and the lower nut. The lower nut should only be hand tightened.

**Part No. 6088 3650-01/6088 3557-01**

A standard flat head screwdriver is used for the hose clamps.

#### Mounting Procedure

1. Put both O-rings on the feed and accept connections of the cleaner head and lubricate with silicone.

#### Caution

**Note that only silicone lubricants should be used. Other lubricants may contain petroleum distillates, which will cause deterioration of the O-rings and seals.**

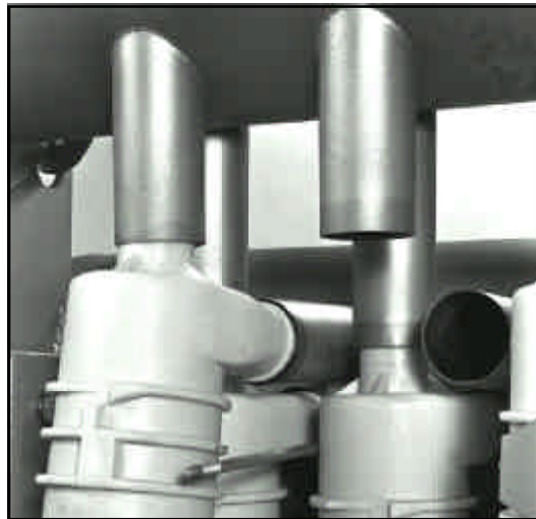
### 3 Installation

2. Mount the rubber hoses to the reject pipe connections on the reject header.
3. Lubricate the feed and accept pipe connections on the headers and insert the accept end of the cleaner into the accept connection on the accept header.

Make sure that the o-ring does not roll over.



4. Press the inlet part of the cleaner into the feed connection of the feed header.



5. Insert the sight glass into the rubber hose mounted on the reject header.



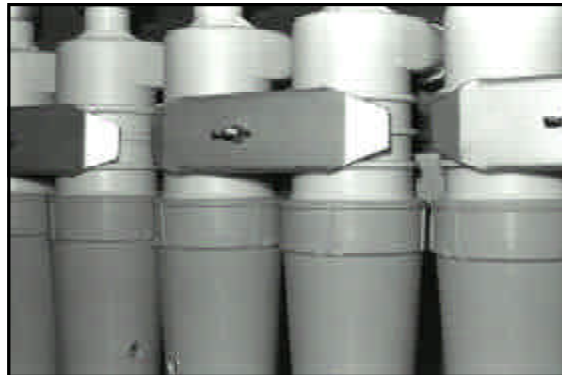
### 3 Installation

6. Press the cleaner into final position making sure that the lug heel fits into the notch in the support plate. For types 2 and 4 the outer cleaners should fit into the corresponding slots on the inner cleaner.



7. Install the retainer clamp and tighten the wing nut.

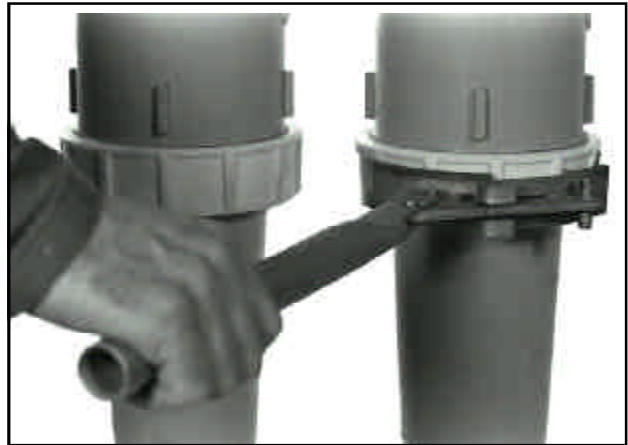
Note that the retainer clamp is asymmetrical.



8. Tighten the clamps on the rubber reject hoses.

## 4 Replacing the Lower Cone

1. Loosen the lower nut. Use Tool No. 2 if needed.
2. Loosen the hose clamp on the sight glass.
3. Lift out the lower part of the cleaner.
4. Unscrew the sight glass of the lower shell and remove the inner cone from the outer blue shell.
5. Replace worn out parts.



### 6. Cleanout Plug Design

Before mounting the cleanout plug, insert the new inner lower cone into the outer blue shell making sure that the sight glass o-ring is in place.

Fix the inner cone in the blue shell by inserting the sightglass into the reject opening. The sight glass should be hand tightened only! Install the seal on the upper part of the cone and mount the cleanout plug.

## 4 Replacing the Lower Cone

Continued from page 12.



A



B



C



D

### 7. Ball Valve Design

Place the end cap into the blue shell. Drop down the ball so that the shaft is coming out of the hole. Insert the new inner lower cone making sure that the sight glass o-ring is in place. Fix the inner cone in the blue shell by inserting the sight glass into the reject opening according to picture C. The sight glass is to be hand tightened only! Mount the handle and the washer. Lock the nut. Install the seal on the upper part of the cone.

8. Mount the complete lower cone by inserting the sight glass into the rubber reject hose. Align the lower cone with the upper cone being sure that the seal does not roll over. Hand tighten the lower cone nut to the upper cone.
9. Tighten the hose clamps on the reject hose.

## 5 Replacing the Upper Cone or Inlet Head

1. Remove the cleaner from the bank by loosening the finger nut and remove the retainer clamp securing the cleaner to the unit. Loosen the hose clamp on the sight glass. Remove the cleaner from the bank structure.

2. Mount **Tool No. 1** in a vice or weld to a work table. Remove the head from the upper cone using **Tool No. 2**.

3. Loosen the lower nut by hand (or with **Tool No. 2**).



4. Inspect the cleaner head and make sure it is clean.

5. Reassemble with the new head or upper head. Make sure that the o-ring is in place.



## 6 Maintenance

The cleaner installation is to be inspected regularly every shift.

Check the cleaner for plugging by observing the flow through the sight glass. If plugged, see instructions in Section 7.

The operating pressures of the cleaner system should not be adjusted on a shift-to-shift or day-to-day basis. The primary stage provides the efficiency and capacity needed to satisfy the stock flow and cleanliness to the head box. The second, third and successive stages recover the fiber rejected from the primary stage and minimize sewer losses.

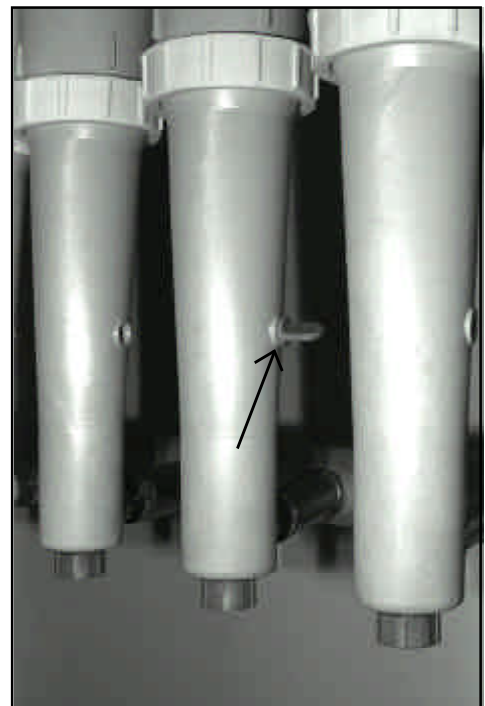
Once the pressures have been set by a GL&V/Celleco representative, the pressure control valves should be left alone. The system should be tested (feed, accepts and rejects) for consistency and operating pressures should be recorded at least once a week.

There are detection vents in the outer blue shell of the upper and the lower cones. When the upper or the lower cone wears out, water will leak through the outer blue shell and through the detection vents.

A red plug with a sealing o-ring is provided to be inserted into the detection vent to prevent stock spills and to "flag" the cleaner for maintenance during the next shutdown.

Be observant of possible leakage at the o-ring connections.

At service, inspect the o-rings with regard to aging, attacks of chemicals and deformation (stiffness). Change when necessary.





## 7 Trouble-shooting

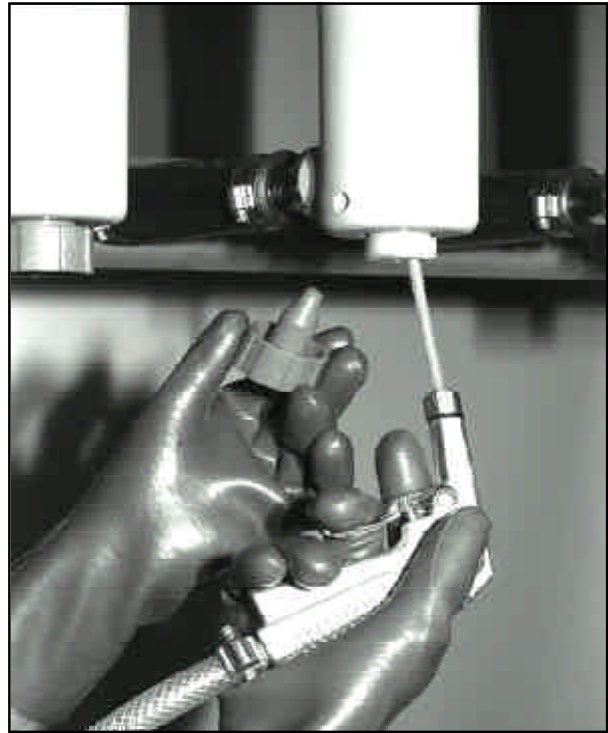
The most common problems encountered are:

- A. a plugged cleaner,
- B. premature upper cone wear,
- C. premature lower cone wear,
- D. low reject rate causing premature cone wear.

### Plugged Cleaner

Shutting the bank down to unplug a cleaner is not necessary. It is very probable that the personnel unplugging the cleaner will get wet with water and stock. Take care to protect the personnel with proper protective gear. This is especially important since stock can reach temperatures that causes burns. Employ proper safety precautions since chemicals in the stock are harmful. To unplug the lower cone, perform the following:

1. Prepare a clean out lance by connecting a 1/4" O.D. tube to a 400 kPa water source. The tube should be about 45 cm long and should contain a valve for control.
2. Unscrew the plastic plug on the bottom of the plugged cleaner. Removing the plastic plug may cause the cleaner to clear itself and splash stock on personnel. Wear rain suits and other protective gear. If the cleaner does clear itself, allow the rejects to flow out of the cleaner for a few seconds. Replace the plug and see that rejects move through the sight glass normally.
3. If the cleaner is still plugged, insert the clean-out lance into the opening at the bottom of the cleaner. Turn on the water and lance out the material that plugs the cleaner. Gently work the lance into the cleaner about 3 cm at a time turning the water on and off to loosen the plug. Watch the flow through the reject sight glass. When the flow resumes, remove the lance and replace the plastic plug.



If the cleaner plugs again shortly after unplugging it, there may be some debris in the cleaner that is larger than the reject opening or the bottom plug opening. This large piece of debris cannot get out without removing the lower cone. Mark this cleaner and remove the lower cone and clean out the debris on the next scheduled shutdown. Remember that the longer a cleaner operates plugged, the faster it wears out.



## 7 Trouble-shooting

### Upper Cone Wear

Premature cone wear in the upper cone is caused by running the cleaner with the lower cone plugged. Small bits of metal, concrete, tile, nuts, bolts, welding rods, slag, etc. are all capable of getting into the system during construction. This material will settle on white water chest and silo floors. Every time a pump is restarted, more debris is kicked up from the chest or silo floor and gets into the cleaners. Once inside the cleaner, this debris will plug the reject opening. The lower cone will become completely filled with sand. This plug will extend into and fill part of the upper cone. The upper cone will then start to wear due to the swirling action and abrasiveness of the sand.

To prevent premature wear in the upper cone, check for plugged cleaners on a regular shift-to-shift basis and unplug any cleaners that do not show flow in the sight glass.

### Lower Cone Wear

Premature cone wear in the lower cone is caused by foreign material that is small enough to enter the cleaner, but larger than the cleaner's reject opening.

Inside the cleaner, this debris will either plug the reject opening and cause wear in the upper cone, as mentioned earlier, or spin inside the lower cone thus causing wear. Usually, a grooved or ring wear pattern will be evident.

To prevent premature wear in the lower cone, flush the piping and clean out all white water chests before start-up. To prevent any further debris from the stock entering the cleaners, a trash screen should be installed on the thick stock line between the machine and blend chests, and on the broke line.

### Low Reject Rate

Other than foreign material, a very low reject rate can cause premature cone wear due to holding the debris in the cleaner longer than it is necessary. Low reject rate will also impair efficiency.

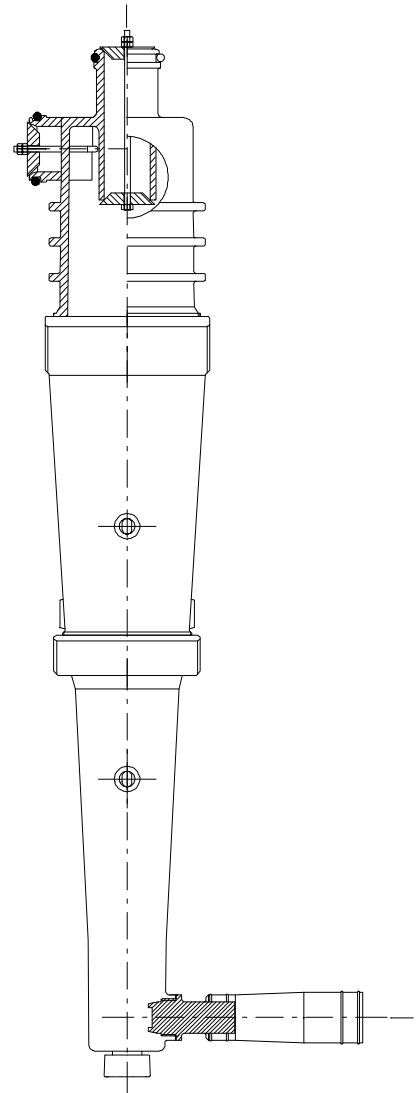
## 8 Blank-off Unit

Blank-off units are provided when all of the cleaners in a single stage are not needed. The unit is supplied in two different designs, one for blank-off of cleaners (part No. 6088 5629-05) and one for blank-off of the feed and accept connections in the bank structure (part No. 6091 1941).

### Installing a Blank-off Unit with Part No. 6088 5629-05:

1. Blank the feed orifice using the small hooked bolt and one nylon disc. Install two nuts making sure that they will not vibrate loose.
2. The accept orifice is blanked by using the long bolt and two nylon discs. Put one disc on the bolt and position the bolt in the way that the bolt head and one disc are inside the cleaner. Put the other disc onto the threaded end keeping this disc on the outside of the cleaner. Install with two nuts making sure that these will not vibrate loose.
3. The reject orifice is easily blanked by using a filled reject plug in place of the normal clear sight glass.

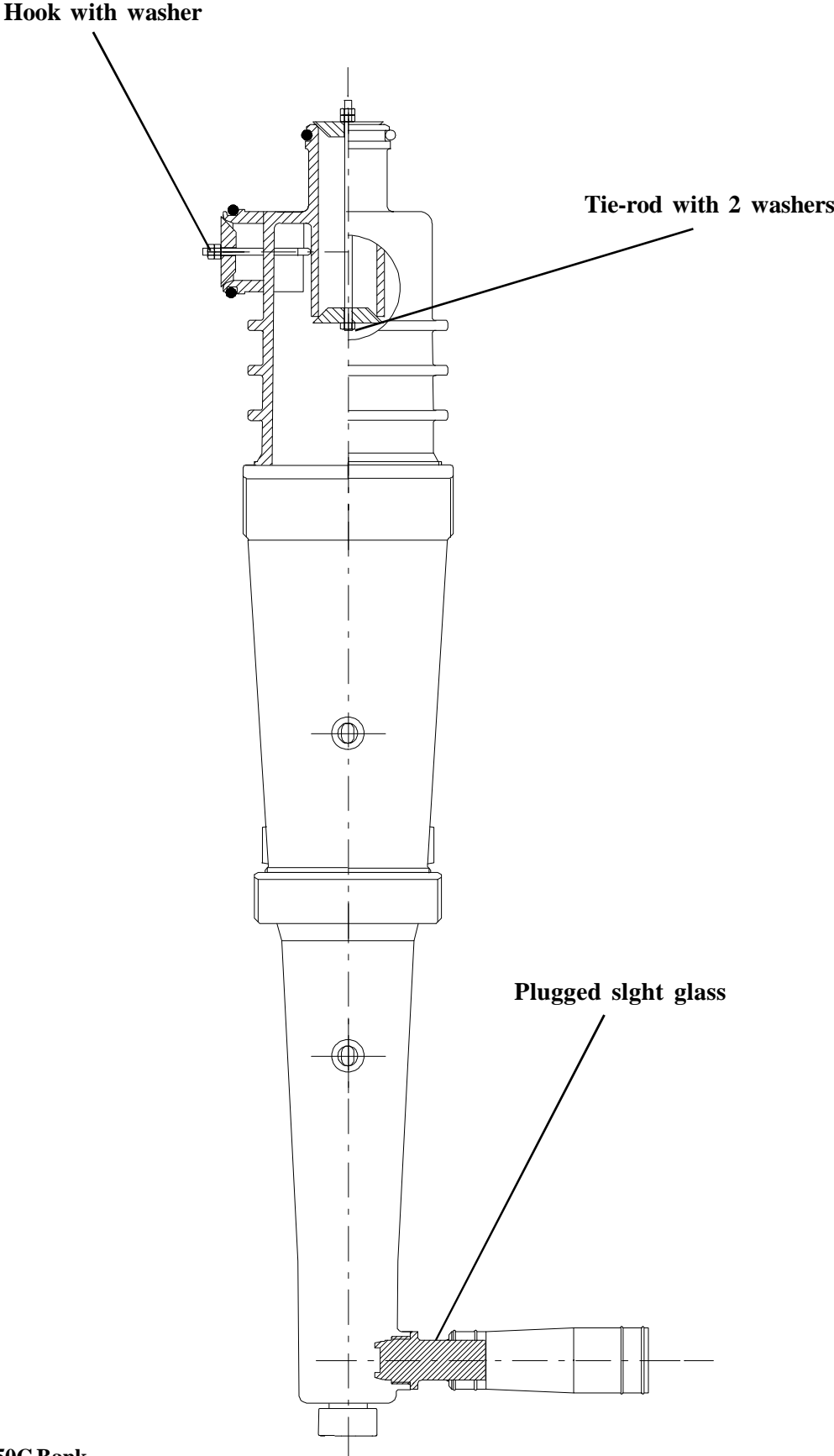
### Blank-off unit, Part No. 6088 5629-05\*



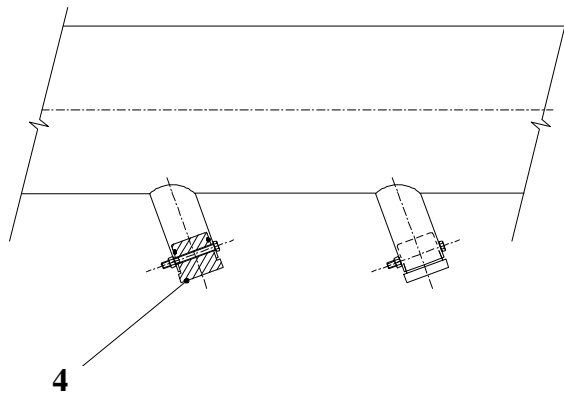
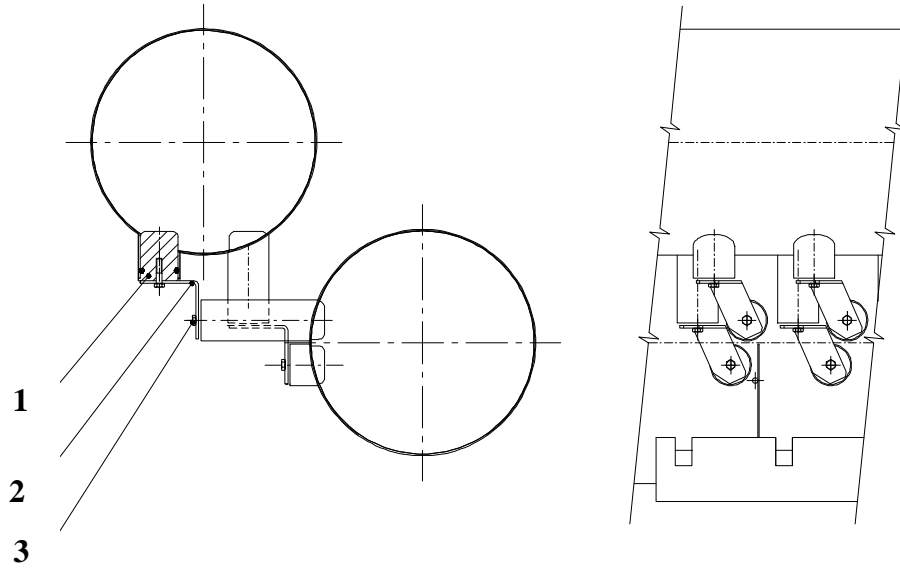
\*Detailed drawing on page 19.

**8 Blank-off Unit**

**Details for Blank-off Unit, Part. No. 6088 5629-05**



**Blank-off unit, Part No. 6091 1941**



- 1. Plug**
- 2. Plate**
- 3. Bolt**
- 4. Reject Plug**

## 9 Safety Instructions

### CAUTION

No parts of the cleaner may be dismantled during operation, except for the cleaning plug in the lower part of the cleaner.

At temp. above 45°C (113°F), be aware of the burning danger.

Do always use safety gloves and safety glasses when cleaning during operation.

Because O-rings and gaskets age, especially at high working temperatures, leakage can arise; therefore, the plant should not be placed close to any busy passage in the factory.

# **Operation and Maintenance Manual**

## **CLEANPAC 350-350 C BANK**

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**Advertencia:** es importante que antes de realizar el montaje del manómetro verifique la idoneidad de su utilización, ya que al tratarse de un elemento de presión y pese a los elementos de seguridad incorporados, estos no cubren las deficiencias de la instalación o su correcta especificación.

Antes de realizar el montaje del instrumento, se deben tener en cuenta una serie de precauciones en lo relativo a su uso:

Cuando está sometido a ligeras vibraciones mecánicas debe elegirse un modelo lleno de glicerina para amortiguar la aguja y el mecanismo de transmisión y obtener una lectura más precisa, si las vibraciones son intensas, debe montarse en una zona alejada de las mismas mediante el uso de un tubo capilar.

En el caso de que las vibraciones sean dinámicas ( producidas por pulsaciones leves en el seno del fluido) procederemos a la colocación de un amortiguador de pulsaciones, fijo o regulable según las características de la instalación.

Ante la posibilidad de golpes de ariete que puedan superar el rango marcado como final de escala deberemos acoplar un limitador de presión para protegerlo de las mismas o como medida de seguridad.

Cuando la temperatura del fluido supera los 65 °C, aconsejamos el uso de un tubo sifón y en casos de altas temperaturas un enfriador de aletas.

Cuando se trabaje con fluidos peligrosos, riesgo de explosión o tóxicos, como medida de seguridad recomendamos la instalación de un limitador de flujo, de forma que por si por alguna incidencia se produjera un escape, fisura o rotura del tubo Bourdon, el limitador únicamente permitiría la fuga de un caudal fijo y conocido de fluido.

Si el fluido de proceso es viscoso, con sólidos en suspensión, agresivo ó alimentario, debe acoplarse un separador ( o sello químico) , cuyo diseño y materiales sean adecuados al fluido y proceso.

El montaje de todos estos elemento puede realizarse “ in situ” en el proceso y no requiere intervención de nuestro personal, a excepción de cuando los manómetros están montados en separador, que por tener un líquido interno de transmisión, deben realizarse en fábrica.

La posición del manómetro siempre debe ser vertical, a menos que en el momento del pedido y de su fabricación se haya especificado otra posición ( esta vendrá indicada en la esfera ). Hay que tener en cuenta que la calibración del instrumento se realiza en posición vertical, por lo que un cambio en la orientación afectaría a la precisión de la lectura..



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El conexionado debe realizarse con el debido cuidado para no dañar las roscas. Se debe tomar el instrumento con la mano y ajustarlo a la conexión de la instalación dando dos o tres giros. En este momento, asegurándonos de que rosca adecuadamente, debemos acabar de apretarlo con una llave según se indica en las figuras 1.2 y 1.3, nunca con las manos o con una llave que no actúe sobre el rácor del instrumento ( figura 1.1)



Fig. 1.1

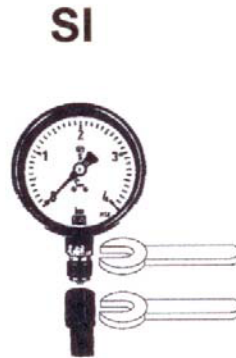


Fig. 1.2

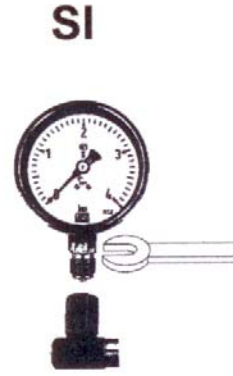


Fig. 1.3

En el caso de conexión GAS con tuerca loca ( figura 1.2) , apretar con una llave la tuerca loca y con otra el rácor del instrumento procurando que esté en la orientación que deseamos y siendo la tuerca la que gire . Tener en cuenta que para rosca BSP la estanqueidad se obtiene por el asiento del rácor, por lo que se debe montar una junta plana para su cierre.

Para conexiones NPT, el cierre estanco se obtiene por el ajuste de las roscas para lo que se recubrirá la conexión del racor con cinta teflón ( u otro material según las características de la instalación y fluido ) y el montaje debe realizarse según la figura 1.3

En el caso de que el manómetro esté montado en un panel ( tipos 40 ó 60) o sobre montaje mural ( tipo 30) la conexión se realizará mediante dos llaves ( según la figura 1.2) para no aplicar esfuerzo de apriete sobre el dispositivo de fijación del aparato

En caso de ir lleno de glicerina, una vez instalado el manómetro en la línea, se procederá a referenciar la presión interior del manómetro a la presión exterior. Para ello deberá cortarse un tetón que viene previsto para tal fin y que se encuentra habitualmente en la parte superior del manómetro. De no realizarse esta operación la presión generada en el interior de la cámara por el efecto de los cambios de temperatura ambiente podrían afectar a la precisión de lectura del instrumento o hacer saltar la válvula pudiendo entrar elementos extraños que ensucien la glicerina o dañen el mecanismo de transmisión.

Es importante que cuando un instrumento tenga acoplado un elemento separador o sello químico, con o sin capilar, el proceso de acoplamiento a la instalación se realice actuando únicamente sobre la tuerca de la parte inferior del separador, según indica la figura 3.2

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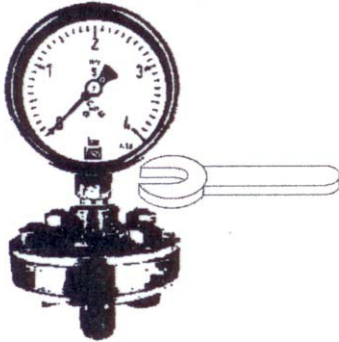


Fig. 3.1

**SI**

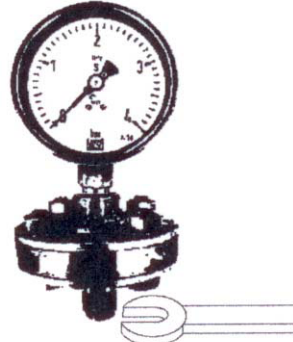


Fig. 3.2

La presión se transmite de la membrana al tubo Bourdon mediante un líquido transmisor estanco, que si pierde su estanqueidad a causa de la manipulación de la unión roscada entre el separador y el capilar o instrumento, este no funcionará.

Contactos eléctricos:

Conexionado según esquemas de HT 08.01, asegurándose de que los voltajes e intensidades son adecuados a los mismos.

Debe asegurarse de que las características de protección eléctrica de los contactos son las adecuadas al fluido y condiciones ambientales de la instalación.

La regulación de los puntos de alarma se realizará con la llave que se suministra, presionando y girando los contactos hasta la posición deseada.

Consultar normas aplicables en la hoja técnica.

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## MANTENIMIENTO

El mantenimiento que precisa este tipo de instrumentos se reduce al líquido de llenado, elementos de seguridad y correcto funcionamiento.

- Cambio de aceite de amortiguación cuando esté sucio y no permita la correcta visión de la aplicación. MEI suministra este aceite como recambio.
- Comprobar que el tapón de seguridad esté en perfecto estado, ya que los agentes externos pueden endurecer la goma y ésta no actuar a la presión prefijada. Así mismo es importante cambiar el visor si por alguna circunstancia se agrieta o rompe.
- Su correcto funcionamiento se puede detectar a primera instancia comprobando que la posición de la aguja es la lógica de la escala en relación al proceso (cuando la aguja está en cero o en una posición fija).

Para corregir estos errores debemos reparar o recalibrar el instrumento. Si se posee banco de calibración y se trata de un error uniforme a lo largo de toda la escala, el ajuste se puede realizar mediante la colocación de la aguja en su posición correcta (mediante el tornillo de regulación que poseen algunas agujas, girando en sentido horario se desplazará en sentido ascendente y viceversa, o sacando y volviendo a poner la aguja –para ello se requieren herramientas especiales).

Si no posee banco de calibración o la descalibración detectada no es constante en toda la escala, debe remitir el aparato a fábrica..

En cualquier caso debe remitirse el aparato a fábrica con su accesorio cuando se trata de separadores, amortiguadores o limitadores.

Recomendamos que los instrumentos se verifiquen como mínimo una vez al año, según condiciones de trabajo.

Mantenimiento específico para los contactos eléctricos: regularmente debe comprobarse el funcionamiento simulando su actuación.

Mediante la llave de regulación, llevar la pata del contacto hasta sobrepasar la posición de la aguja indicadora de presión para que cambie el contacto.

En caso de detectar fallos, aunque sean intermitentes, aconsejamos cambiar el contacto, ya que se trata de un elemento de seguridad.

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### **AVERÍAS FRECUENTES:**

#### **La aguja indicadora no vuelve al origen al eliminar la presión del circuito.**

Este problema se presenta habitualmente por tres razones:

El manómetro ha recibido un golpe que ha hecho que el engranaje, utilizado en el mecanismo multiplicador que transforma la deformación del elemento sensible en giro de la aguja indicadora, salte uno de los dientes del engranaje, o bien que la inercia de la masa del manómetro a deformado el elemento sensible.

El manómetro a sufrido una sobrepresión que ha deformado el elemento sensible.

Hemos de pensar que ese elemento ha de deformarse elásticamente y de forma proporcional a la presión recibida y que por esa razón la forma del elemento y sus espesores son de vital importancia.

Por ejemplo en los tubos Bourdon, la sección del tubo es elíptica y el tubo tiene una forma de C. Cuando la presión aumenta el tubo tiende a cambiar su forma de C en I para de esa forma aumentar su volumen , pero si eso no es suficiente el siguiente paso es cambiar la sección de elipse a circunferencia para obtener el mismo objetivo.

Lamentablemente hay un punto de deformación de la C, a partir del cual el muelle ya no recobra su forma original y por lo tanto pierde sus características elásticas, lo mismo le pasa si varía la elipse de su sección..

Hay que tener en cuenta que la sobre-presión ejercida por un golpe de ariete (incremento o decremento brusco de la presión) puede llegar a ser de 20 veces la presión nominal de la línea, por lo que al cerrar o abrir una válvula o bomba, la presión de una línea a 10 bar de presión puede llegar a 200 bar y por lo tanto deformar permanentemente el elemento de medida.

Para eliminar estos problemas podemos poner antes del manómetro un amortiguador de la presión, un limitador o restringir de alguna manera el acceso de la presión al manómetro.

El orificio de conexión se obtura o el fluido en el interior del manómetro deja de comportarse como un fluido compresible (empieza a solidificarse)

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## Tipos de manómetros:

La gran variedad de manómetros existentes en el mercado, se ha originado por sus innumerables aplicaciones en la industria. Sin embargo el tipo más utilizado es el manómetro de Bourdon y sus variantes, aunque es necesario tener presente el intervalo de presiones en el que se trabaja y la exactitud que se requiera.

### Manómetro Bourdon

El principio de medida en el que se basa este instrumento es el sensor conocido como tubo Bourdon. El sistema de medida está formado por un tubo aplanado de bronce o acero, cerrado, en forma de "C" de  $\frac{3}{4}$  de circunferencia para la medición de bajas presiones, o enrollado en forma de espiral para la medición de bajas presiones y que tiende a enderezarse proporcionalmente al aumento de la presión; este movimiento se transmite mediante un elemento transmisor y multiplicador que mueve la aguja indicadora sobre una escala graduada. La forma, el material y el espesor de las paredes dependen de la presión que se quiera medir.

El conjunto de medida está formado por un tubo Bourdon soldado a un racord de conexión, Por lo general este conjunto es de latón, pero en el caso de altas presiones y también cuando hay que medir presiones de fluidos corrosivos se hacen de aceros especiales.

La exactitud de este tipo de manómetros depende en gran parte del tubo, por esa razón sólo deben emplearse tubos fabricados con las normas más estrictas y envejecidos cuidadosamente por los fabricantes

El elemento de transmisión incorpora una biela para su ajuste.

La norma aplicable para los manómetros Bourdon es la UNE-EN 837-1

El almacenamiento y transporte del aparato deberá realizarse con el normal cuidado al tratarse de elementos muy sensibles a los golpes y vibraciones.

Los manómetros industriales pueden dividirse según distintas características:

**Por su diámetro**, es decir por el tamaño de la esfera en la que puede leerse la indicación de la presión para la que está diseñado el aparato. Los más corrientes son los siguientes diámetros nominales en mm.: 40, 50, 63, 80, 100, 160 y 250 mm.

Los diámetros 40 y 50 mm. Son habitualmente utilizados en conducciones para presiones comprendidas entre 2,5 bar y 60 bar, y en modelos muy económicos con conexiones en latón, cajas protectoras en ABS y precisiones del 2,5%, aunque es posible su fabricación en otros rangos de presión, materiales y precisiones. Industrias típicas que utilizan estos manómetros son: reguladores de presión, neumática, industria contra incendios, etc.

El diámetro 63 mm. Es habitual en la industria para conexiones de  $\frac{1}{4}$ , y el diámetro 100 para conexiones de  $\frac{1}{2}$ . Es corriente su utilización en todos los materiales dependiendo de la aplicación a cubrir, desde aparatos en caja de ABS o acero, hasta manómetros fabricados íntegramente en acero inoxidable, pasando por los manómetros llenos de glicerina con conexiones en latón y caja protectora en acero inoxidable.

Los diámetros 160 y 250 mm. Son habitualmente utilizados para aplicaciones de laboratorio y lo más común es que se fabriquen en acero inoxidable y/o en precisiones elevadas (0,5%, 0,25%,...etc.)

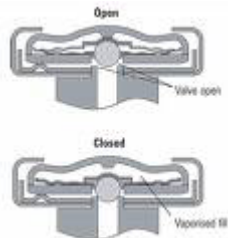
Pero insistimos en que cualquier variación de medidas, materiales, precisión y rango son en principio posibles, otra cosa es que sean tan poco frecuentes que se conviertan en prototipos.

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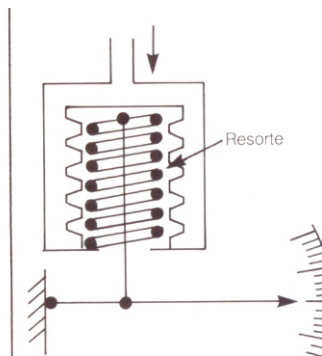
**Por su elemento sensible**, es decir por el componente mecánico elástico utilizado como elemento que genere la deformación proporcional a la presión.

Habitualmente la elección de ese componente está en función del rango de presión a medir

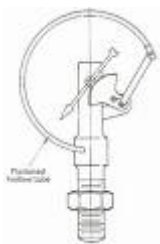
Cápsula o membrana para presiones comprendidas entre 5 mbar y 600 mbar



Fuelle : formado por un fuelle metálico con o sin resorte, y utilizado para medir presiones relativamente bajas ( hasta 7 bar) y presiones absolutas



Tubo bourdon para presiones comprendidas entre 1 bar y 60 bar



Tubo helicoidal para presiones superiores o iguales a 100 bar



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**Por los materiales utilizados en su fabricación:**

Sistema de medida en latón y el resto en los materiales más baratos posibles tales como ABS o acero

Mixtos con sistemas de medida en latón y cajas protectoras en acero inoxidable, habitualmente utilizados llenos de glicerina para amortiguar las vibraciones mecánicas

Inoxidable: con sistemas en Inoxidable AISI 316 y cajas protectoras en acero inoxidable llenas o no de líquido amortiguador ( glicerina\* )

\* cuando los manómetros llevan contactos eléctricos suele utilizarse como líquido amortiguador la silicona que no es conductiva.

**Por si llevan líquido amortiguante:** en este caso se diferencia entre manómetros secos ( sin líquido amortiguante) y manómetros con glicerina .

**Manómetros de columna líquida:**

Este tipo de manómetros es la forma más sencilla de dispositivo para medir presiones, donde la altura, carga o diferencia de nivel, a la que se eleva un fluido en un tubo vertical abierto conectado a un aparato que contiene un líquido, es una medida directa de la presión en el punto de unión y se utiliza con frecuencia para Mostar el nivel de líquidos en tanques o recipientes.

Puede utilizarse el mismo principio con indicadores de tubo en U, en el cual, conocida la densidad del líquido empleado en él, la carga o altura constituye una medida de la presión relacionándola con la correspondiente a la atmosférica. La figura 1a muestra el manómetro fundamental de tubo en U. Otro dispositivo equivalente (figura 1b) , cuando es necesario ( como en el caso de la presión de un gas) que la presión se mida por la altura o carga de algún fluido distinto de aquel cuya presión se busca.

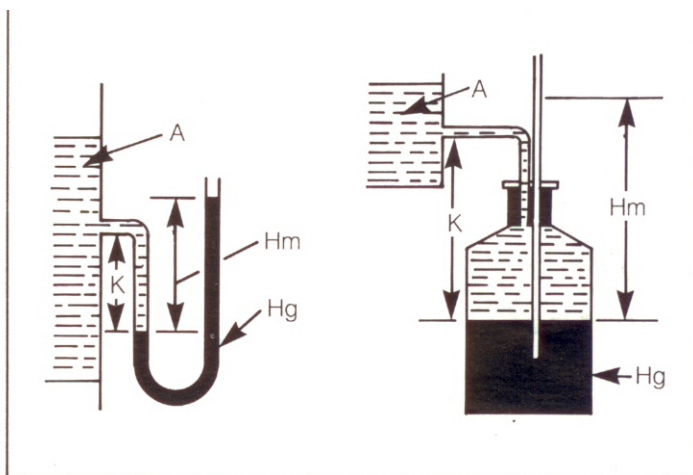


Figura 1a. Manómetros abiertos

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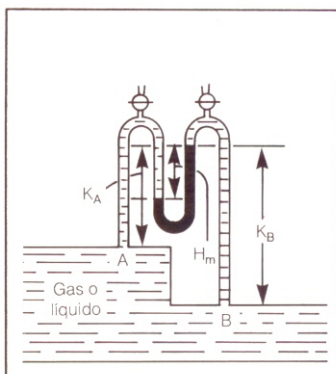


Figura 1b. Tubo diferencial en U

La mayoría de estos manómetros pueden ser utilizados como manómetros abiertos o como manómetros diferenciales, cuando indican la diferencia entre dos presiones diferentes de la atmosférica. El fluido manométrico que forma la columna líquida en estos indicadores puede ser cualquier líquido que no se mezcle con el fluido a presión. Para altos vacíos o presiones elevadas y grandes diferencias de presión el líquido del medidor debe ser de una gran densidad por esto casi siempre se utiliza como fluido manométrico el mercurio y para las bajas presiones líquidos de menor densidad como el agua, alcohol, kerosén, etc.

Los manómetros abiertos dan lecturas en altura, cm. de mercurio o altura de fluido manométrico, luego para el calculo de la presión manométrica del fluido de proceso ( punto A de la figura 1a) se recurre a fórmulas como la siguiente:

$$d_a = ( H_m d_m - K d_m ) g / g_c$$

Donde :

$d_a$  es la densidad del fluido A

$d_m$  es la densidad del mercurio

K es la distancia entre el fluido manométrico y el fluido cuya presión se quiere averiguar.

g es la aceleración local debida a la gravedad

$g_c$  es una constante adimensional

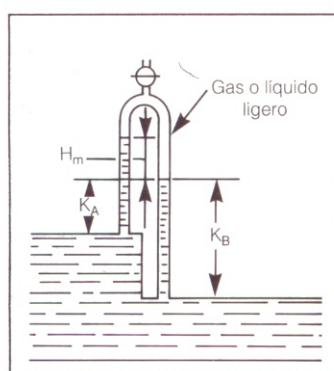


Figura 3. Tubo diferencial invertido, en U

Dentro de los manómetros diferenciales tenemos el tubo en U diferencial, el cual mide la diferencia de presiones entre los orificios de toma A y B ( figura 3) en altura de fluido manométrico , luego la diferencia de presión se expresa mediante la siguiente ecuación

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$$d_a - d_b = ( H_m(d_m - d_a) + k_a d_a - k_b d_b) g / g_c$$

donde

$k_a$ ,  $k_b$  son las distancias verticales de la superficie del fluido manométrico por encima de A y B respectivamente.

$d_a$ ,  $d_b$  son las densidades de los fluidos en A y B.

Otro tipo, es el tubo en U diferencial invertido ( figura 3), en el que el fluido que llena el tubo en U puede ser un gas o un fluido ligero, y el cual es frecuentemente usado para medir diferencia de presiones en líquidos cuando las columnas abiertas líquidas son extraordinariamente elevadas, o cuando el líquido a presión no puede exponerse a la atmósfera.

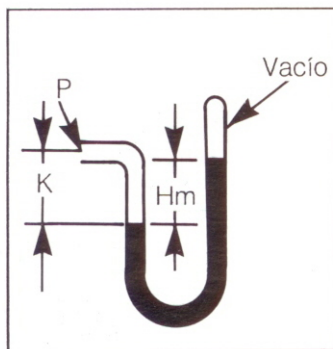


Figura 4

Por último están los manómetros de columna líquida que miden directamente la presión absoluta del fluido, siempre que el espacio encima del mercurio sea el “vacío total o el vacío perfecto”, luego en una medida con referencia a una presión nula, como los tubos en U cerrados ( figura 4) o el barómetro de mercurio que registra directamente la presión absoluta de la atmósfera en función de la altura de la columna de mercurio ( figura 5). La presión barométrica normal es 760 mm Hg a 0°C ( equivalente a 14,7 lb/pulg<sup>2</sup> o a 1 atm )

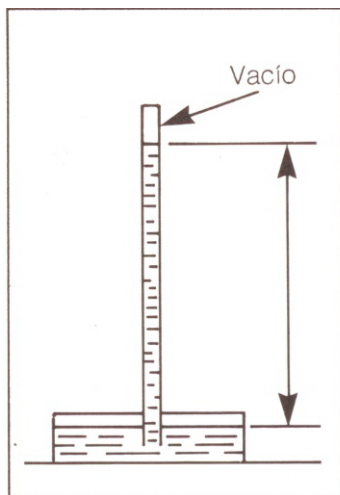


Figura 5. Barómetro de Mercurio

Cuando la presión se mida en términos de una altura de columna de líquido, que no sea de mercurio o de agua ( para los cuales ya se conoce el valor de la presión estándar o normal) es fácil convertir la altura de un líquido a otro por medio de las siguientes expresiones:

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$$p = dgh/g_c$$

en donde;

d = densidad del liquido

h = altura de la columna

Obteniendo la relación de esta expresión para dos sustancias diferentes se tendrá la relación entre las alturas de las dos columnas de liquido.

Altura fluido 1/ altura fluido 2 = densidad fluido 2 / densidad fluido 1.

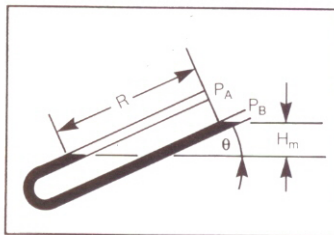
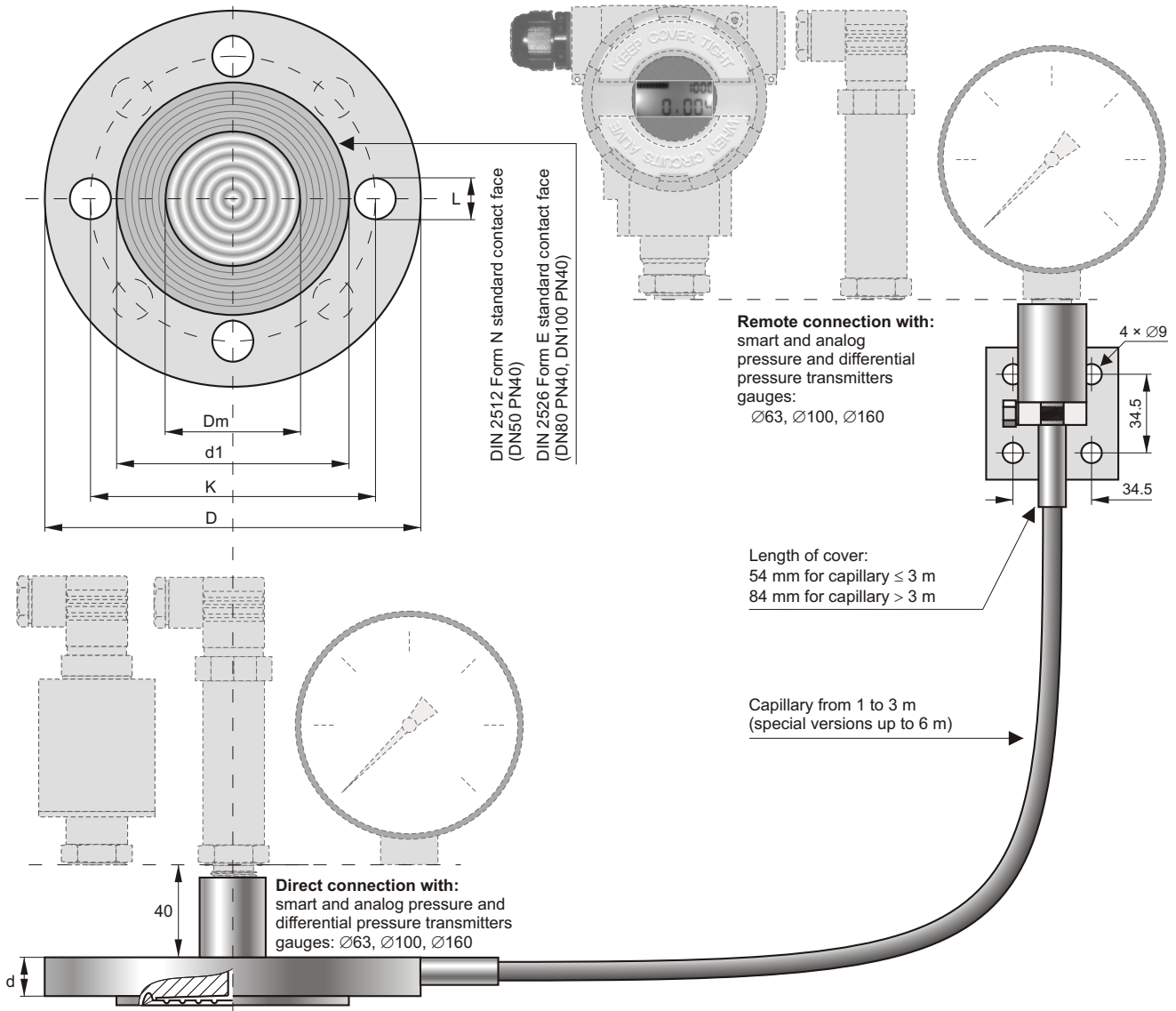


Figura 10. Tubo en U inclinado

Una variante de este tipo de manómetros son los manómetros de columna inclinada usados para medir diferencias de presiones muy pequeñas, ya que estos tienen la ventaja sobre los manómetros de columna de liquido por la amplificación de la lectura. El tubo en U inclinado ( figura 10) se utiliza porque la longitud de la altura o carga puede multiplicarse varias veces por la inclinación de la columna liquida y la escala será mas ancha. Si la lectura R se toma como se indica y  $R_0$  es la lectura cero.  $H_m$  estará dado por  $H_m = ( R - R_0 ) \text{ sen } \theta$  y el calculo de  $( d_A - d_B )$  es de la misma forma que para el tubo en U vertical

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# Flanged seals with flush diaphragm S-P



## Diaphragm seal dimensions

Version	Diaphragm diameter <b>Dm</b>	Contact face diameter <b>d1</b>	Diameter of bolt circle <b>K</b>	External diameter <b>D</b>	Thickness <b>d</b>	Diameter of holes <b>L</b>	Number of holes
<b>DN50 PN40/ 2" ANSI 150</b>	59	102	125	165	22	18	4
	59	92	120,5	150	20	20	4
<b>DN80 PN40</b>	88	138	160	200	24	18	8
<b>3" ANSI 150</b>	75	127	152,5	190	24	20	4
<b>DN100 PN40</b>	88	162	190	235	24	22	8
<b>4" ANSI 150</b>	89	158	190,5	230	24	20	8

## Application

The diaphragm seal is a pressure-transmitting, diaphragm-type device. The pressure signal is sent to the cooperating pressure measuring device (pressure transmitter, pressure gauge) through manometric liquid filling the space between the separating diaphragm of the seal and the pressure measuring device. The diaphragm seal task is to isolate the pressure measuring device from damaging impacts caused by either medium or installation:

- low or high temperature, increased viscosity, impurities;
- vibrations of the installation (remote diaphragm seal).

**Recommended minimum measuring range (bar),  
depending on the type of the set: pressure measuring device - diaphragm seal**

Pressure measuring device	Diaphragm seal type	Diaphragm seal version		
		DN50 / 2"	DN80 / 3"	DN100 / 4"
Smart transmitters*	direct	0.25	0.1	0.1
	remote (2 m)	1	0.25	0.25
PCE-28	direct	0.1	0.1	0.1
	remote (2 m)	1	0.25	0.25
PC-50	direct	0.1	0.1	0.1
	remote (2 m)	1	0.25	0.25
Ø63 gauge	direct	1	1	1
	remote (2 m)	2.5	1	1
Ø100 gauge	direct	6	1	1
	remote (2 m)	6	1	1
Ø160 gauge	direct	6	1	1
	remote (2 m)	6	1	1

\* The ranges given in the table for the smart transmitters should be taken as set ranges.

**Recommendations**

The essential metrological problem at diaphragm seals operational use is an absolute thermal zero error, resulting from the thermal expansion of the manometer liquid. The expansion effect must be compensated for with the separating diaphragm flexibility.

To minimise this effect, it is advisable to:

- use capillaries as short as possible, in this way the volume of manometer liquid will be reduced;
- use the greater diameter seals, in order to maximise the separating diaphragm flexibility;
- locate the capillaries in the places, in which the temperature fluctuations will be minimal.

**Additional absolute zero error resulting from ambient temperature fluctuations,  
depending on the type of the set: pressure transmitter - diaphragm seal**

Diaphragm seal type	Absolute zero error per 10°C for the diaphragm seal		
	DN50 / 2"	DN80 / 3"	DN100 / 4"
direct	0.5 mbar	0.4 mbar	0.4 mbar
remote (2 m capillary)	3 mbar	1 mbar	1 mbar

An additional zero error, resulting from temperature fluctuations in a medium, depends on the temperature gradient in the oil-based diaphragm sealing system. The error value is, in any case, significantly smaller than the error value shown in the table.

**Temperature range of measured medium**

Remote diaphragm seal			Direct diaphragm seal
Manometric liquid	Underpressure measurements	Overpressure measurements	
high-temperature (DC)	-10...150°C	-10...315°C	-30...150°C
low-temperature (AK)	not recommended for measurement of pressures < 0.5 bar ABS	-60...200°C	

Note: When operating with an ambient temperature of < -15°C, heating of capillaries filled with DC fluid is recommended.

**Special versions**

**Maximum pressure for PN40 – 40 bar**

**Maximum pressure for ANSI 150 – 150 psi**

**Material of diaphragm and flange 316Lss**

- Other standard ANSI or DIN
- Filled with edible oil (medium temp. -10...150°C)
- Direct diaphragm seal for medium temp. over 150°C
- Others

**Important:**

- contact face in diaphragm seal DN50 have a milled slot for a gasket (acc. to DIN 2512 FormN). Version without any slot available on request. (acc. to DIN 2526 FormE)
- standard outlet capillary from flange:
  - direct mounted diaphragm seal - axial
  - remote mounted diaphragm seal - radial

**Ordering procedure**

direct diaphragm seal: **pressure measuring device / S-P – DN..... / special version (description)**

remote diaphragm seal: **pressure measuring device / S-PK – DN..... / K = ..... m / ..... / special version (description)**

Transmitter or gauge  
– see the code in the  
appropriate catalogue sheet

Diaphragm seal version

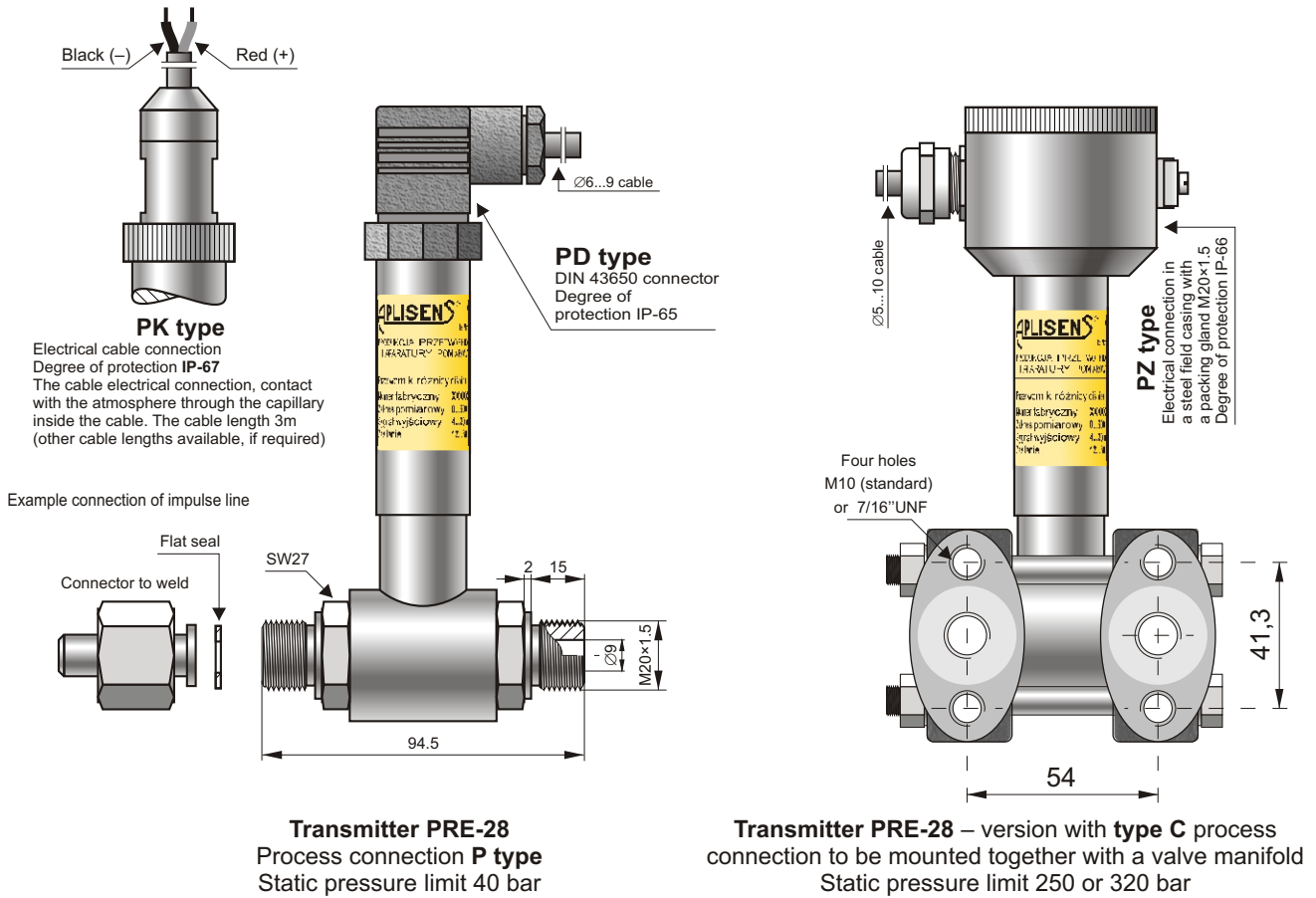
Capillary length

Type of manometric liquid –  
**DC** (high-temperature),  
**AK** (low-temperature)

**Example:** PCE-28 pressure transmitter, EEx version, measuring range 0 ÷ 1 bar, cable connection, direct flanged seal with flush diaphragm

**PCE-28 / EEx / 0 ÷ 1 bar / PK / S-P – DN50**

# Differential pressure transmitter PRE-28



- ✓ **Overloads up to 320 bar total static pressure**
- ✓ **Accuracy 0.25%**
- ✓ **Any range from 0...16 mbar up to 0...25 bar**
- ✓ **ATEX Intrinsic safety ( Gas and Dust)**
- ✓ **Marine certificate DNV** NEW

### Application

The PRE-28 transmitter is applicable to the measurement of differential pressure of gases, vapours and liquids.

### Construction

The active element is a piezoresistance silicon sensor separated from the medium by separating diaphragm and a specially selected type of manometric fluid. The special desing of the active sensing element ensures withstanding the pressure surges and overloads of up to 320bar. The electronics is placed in a casing with a degree of protection IP65, IP67, depending on the type of electrical connection applied.

### Calibration

Potentiometers can be used to shift the zero position and the range by up to 10%, without altering the settings.

### Installation

The transmitter with P type process connection is not heavy, so it can be installed directly onto impulse lines. For fitting in any desired position on a Ø25 pipe the Aplisens mounting bracket (Fi25 mounting bracket, page 65) is recommended.

The version with C type process connection can be fitted directly to a 3- or 5-valve manifold. The factory-mounted transmitters with VM type valve manifold (page 52) are recommended. A transmitter without a valve manifold can be fitted in any position on a 2" pipe or on a wall using the C-2" mounting bracket (page 65).

When the special process connections are required for the measurement of levels and pressures (e.g. at food and chemical industries), the transmitter is provided with an Aplisens diaphragm seal. The differential pressure transmitters with diaphragm seals are described in detail in the further part of the catalogue.

### Technical data

<b>Materials:</b> Wetted parts:	type P process conn.	316Lss	<b>Hysteresis, repeatability</b>	0.05%
	type C process conn.	316ss		<b>Thermal compensation range:</b>
Diaphragm	Hastelloy C 276		<b>Operating temperature range:</b>	-25+80 C
Casing	304ss		<b>Medium temperature range:</b>	-25+120 C (direct measurement)
Option:	316ss			Over 120C – measurement with the use of impulse line or diaphragm seals

**CAUTION:** the medium must not be allowed to freeze in the impulse line or close to the process connection of the transmitter.

## Technical data

Any measuring range 0...16 mbar ÷ 0...25 bar

	Measuring Range			
	100 mbar	1 bar	2 bar	25 bar
Overpressure Limit Static Pressure Limit (repeated, without hysteresis)	250 bar (option 320 bar) (40 bar for P type process connection)			
Accuracy	0.4%		0.25%	
Long term stability	0.2% / year		0.1% / year	
Thermal error	Typically 0.3% / 10°C max 0.4% / 10°C		Typically 0.2% / 10°C max 0.3% / 10°C	
Zero shift error for static pressure*	0.1% / 10 bar			

\* Zeroing the transmitter in conditions of static pressure can eliminate this error.

**Output signal** 4...20 mA, two wire transmission  
0...10 V, three wire transmission

**Power supply** 10.5...36 V DC (EEEx 12...28 V)  
– two wire transmission  
15...30 V DC – three wire transmission

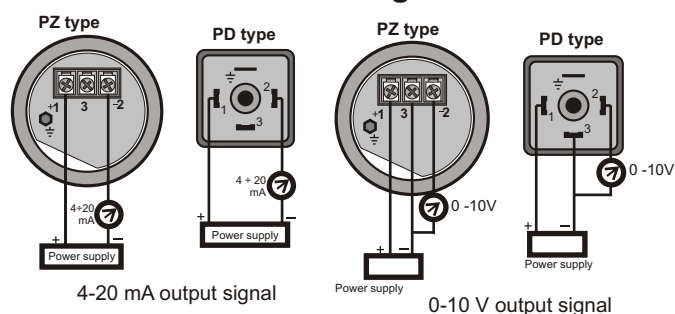
**Error due to supply voltage changes** 0.005% (FSO) / V

$$\text{Load resistance } R[\Omega] \leq \frac{U_{\text{sup}}[\text{V}] - 10.5\text{V}}{0.02\text{A}} \cdot 0.85$$

(for current output)

**Load resistance**  $R \geq 5 \text{ k}\Omega$   
(for supply output)

## Electrical diagrams



## Ordering procedure

Model	Code	Description
PRE-28		Differential pressure transmitter.
Versions *	/EEExia..... /Tlen..... /MR.....	Ex II 1/2G Ga/Gb Ex ia IIC T4/T5/T6, I M1 Ex ia I, II 1D Ex ia D20 T105C (only for transmitters with 4...20mA output) version for oxygen service ( sensor filled with Fluorolube fluid). Marine Certificate DNV
Measuring range	/.....÷..... [required units]	Measuring range in relation to 4mA and 20mA (or 0 and 10V) output. Units: bar, MPa, kPa, etc.
Output signal	⇒ (without marking)..... /0...10V..... /(other).....	4...20mA (power supply 10,5÷36VDC) 0...10V DC (power supply 15÷30VDC) other output signal and power supply (e.g for NE or NN version)
Casing, Electrical connection,	⇒ /PD..... PZ..... PZ/316..... PK..... (if other length of cable is required, please specify it /K=...[m])	Housing IP65 with DIN43650 connector PG-11 packing gland. 304SS housing, Ip66, packing gland M20x1,5. 316SS housing, Ip66, packing gland M20x1,5. Housing IP67 with thread M12x1 and connector 304SS housing, IP67, cable electrical connection, 3m of cable
Process connections	⇒ /C..... /P..... /code of diaphragm seal.....	Thread 1/4NPT F on the cover flanges, diaphragms material Hastelloy C 276, cover flanges material SS316L. Allows mounting with a valve manifold. Thread M20x1,5 (male) with Ø9hole, diaphragms material Hastelloy C 276, wetted parts SS316L Diaphragm seal (see chapter of diaphragm seals) mounted on Hi side of transmitter, Lo side 1/4NPT Female
Accessories	⇒ /C-2"..... /FI25..... /RedSpaw P..... /RedSpaw C..... /Red d/P 1/2".....	Mounting bracket for 2" pipe (to C process conn.), mat. zincd steel Mounting bracket for 2" pipe (to P process conn.), mat. stainless steel Connector to weld impulse pipes dia. 12 and 14 mm, material 15HM(SO) or SS 316(S) . Only process connection P type, Connector to weld impulse pipes dia. 12 and 14 mm, material 15HM. Only process connection C type. Adapter for differential pressure transmitters with C type process connection, output thread 1/2NPT F. Material 316 LSS
Other specification	/.....	Description of required parameters
The most typical specification is marked by "⇒" mark.		

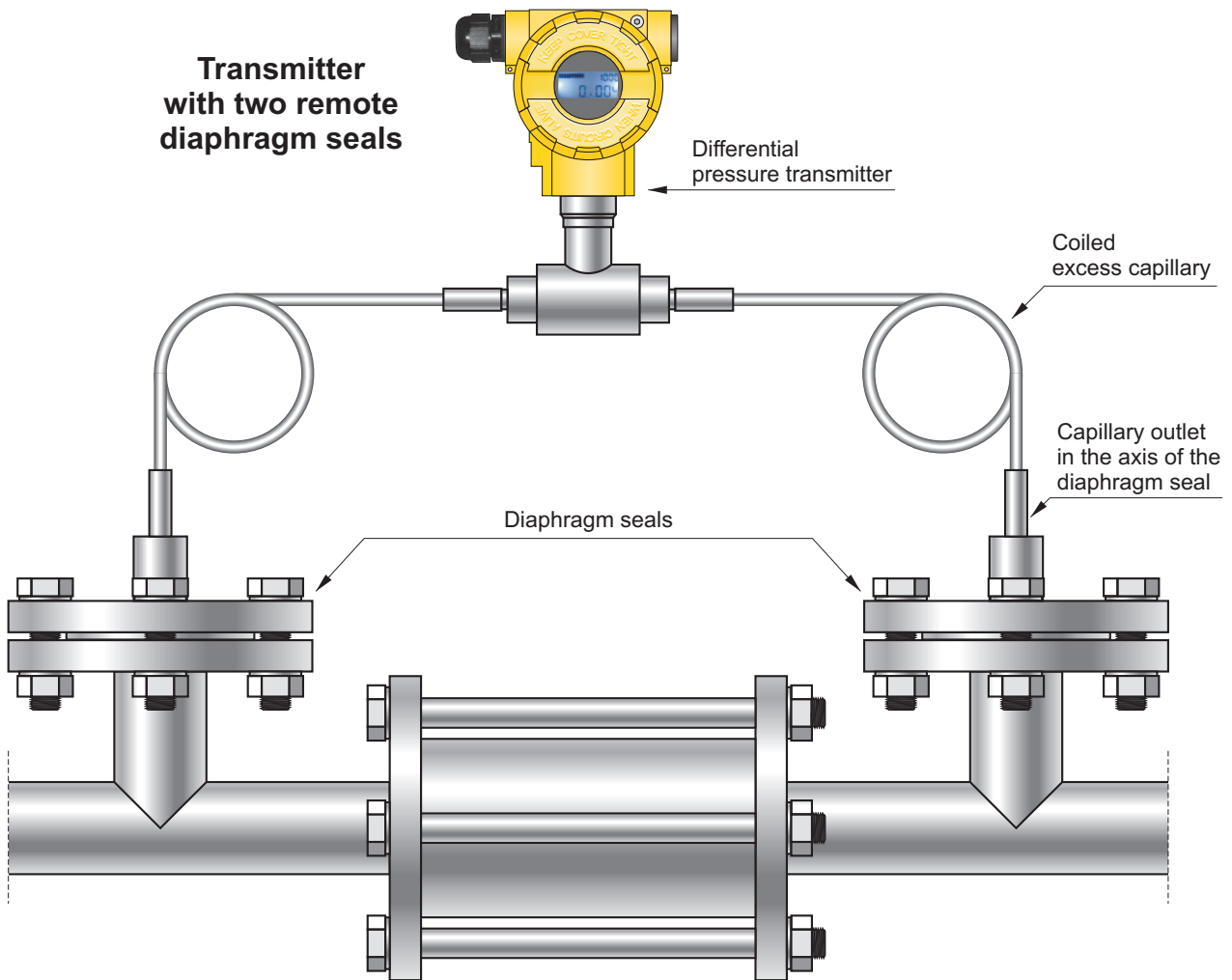
**Example:** Differential pressure transmitter, version EEExia, measuring range 0..160mbar, output signal 4..20mA, C type process connection, electrical process connection with DIN43650 connector

PRE-28/EEExia/0÷160mbar/PD/C

# Smart differential pressure transmitter with two diaphragm seals model APR-2200ALW or APRE-2200



- ✓ Several applications, including hydrostatic measurement of: levels in pressure tanks, density and phase boundaries
- ✓ Ability to configure measuring range locally
- ✓ Digital PROFIBUS PA signal
- ✓ 4...20 mA output signal + HART protocol
- ✓ Accuracy 0.1%
- ✓ ATEX certificates (intrinsic safety, explosion proof)
- ✓ Fully welded active measuring element which guarantees tightness of oil system for many years.



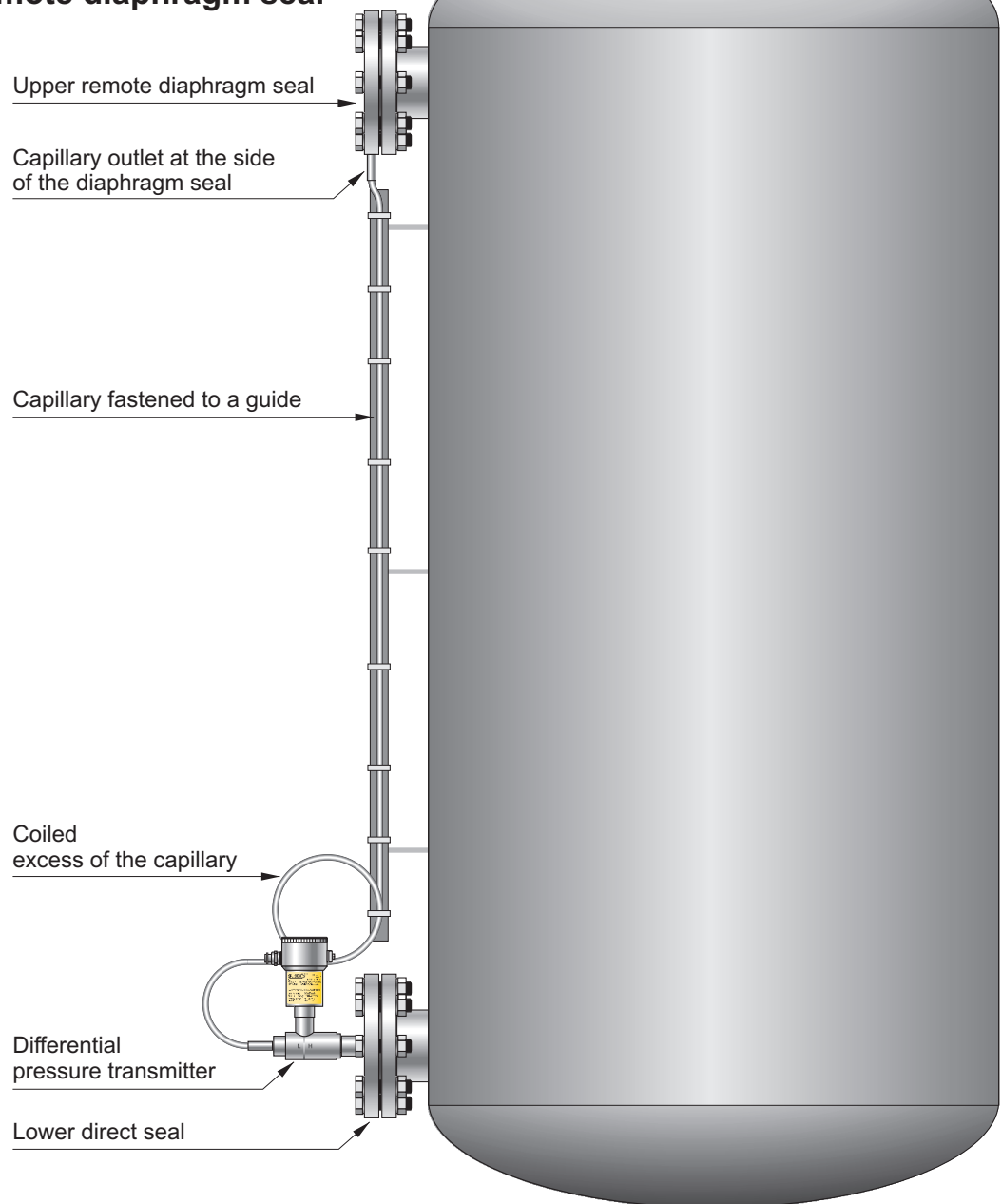
**Example of a filter loss measurement**

### Recommendations

The version of the transmitter with two remote diaphragm seals is recommended for the measurement of pressure differences when the hydrostatic pressure of the manometric fluid in the capillaries (which depends on the vertical spacing of the seals) is significantly less than the measuring range of the transmitter. The best metro-

logical results are obtained when the applied capillaries are identical, as short as possible, and terminated with identical seals. At such a configuration additional temperature errors, related to the remote sealing, affect both of the measurement chambers of the differential pressure transmitter in the same way, and thus cancel each other out.

## Transmitter with two types of diaphragm seal: one – direct diaphragm seal and the other – remote diaphragm seal



### Example of measurement of the level in a pressure tank

#### Recommendations

The transmitter with a direct diaphragm seal (connected to the positive measurement chamber) and a remote diaphragm seal (connected to the negative chamber) is recommended for hydrostatic measurements of: levels, densities, phase boundaries and pressure differences (with differentiated height of pulse source points\*).

In such a configuration, at ambient temperature changes, two opposite phenomena appear concurrently.

Thermal expansion causes the change in the volume (and hence also the change in density) of the manometric fluid in the capillary, which results in a change of the hydrostatic pressure related to the vertical spacing of the seals. This phenomenon is

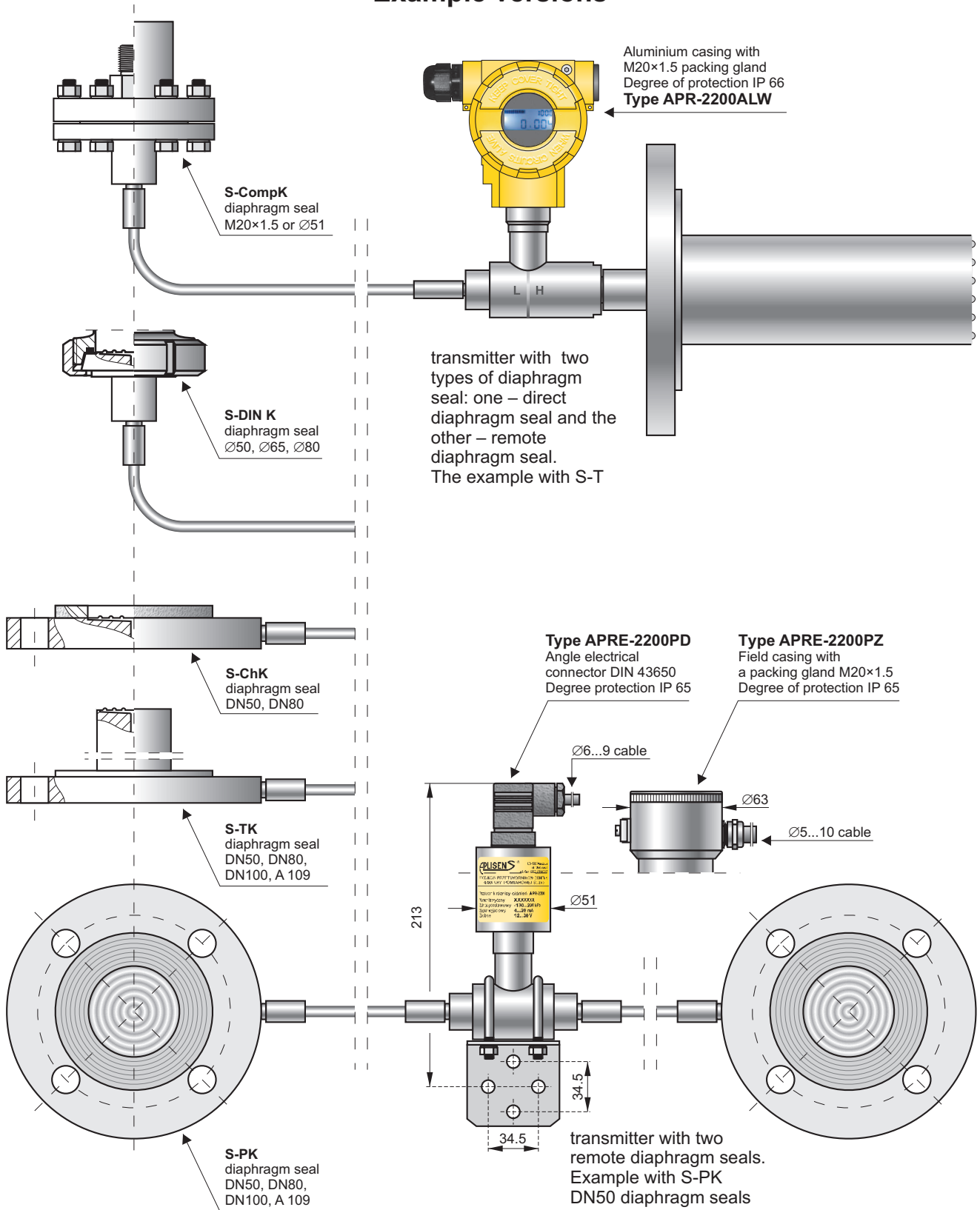
counteracted by the elastic reaction of the diaphragm of the upper diaphragm seal, which is displaced by the change in volume of manometric fluid. Based on tests and experiments, the Aplisens transmitters are provided with carefully selected seal diaphragms, which guarantee compensation of the errors resulted from the ambient temperature changes.

The best metrological results are obtained using assembly, which include DN 80, DN 100, A 109 and S-Comp diaphragm seals or S-Mazut, S-DIN and S-Clamp diaphragm seals with a diameter of at least 65 mm, where the length of the capillary is  $(1...1.3) \times$  (vertical spacing of seals). It is recommended using identical diaphragm seals at the both upper and lower connection points.

\* The difference in height of pulse source points, at which the hydrostatic pressure of the manometric fluid is comparable to or greater than the range of the transmitter.



**Example versions**



Note: The appropriate configuration of the complete set of pressure transmitter, diaphragm seals and capillaries, as well as the proper selection of manometric fluid, depends on several factors, including the physical and chemical properties, temperature range of the medium, the vertical spacing of the diaphragm seals, the measuring range, static pressure range, range of ambient temperatures and the technical specifications for mechanical connection of the diaphragm seals to the pressure devices.



### Application and construction

The differential pressure transmitter is applicable to the measurement of pressure differences of: gases, vapours and liquids in cases where it is necessary to use seals and the pressure pulse source points may be several metres apart. Typical applications include the hydrostatic measurement of: levels in closed tanks, densities and phase boundaries, and the measurement of a filter loss, pressure differences between media in pasteurisers etc. The available range of the diaphragm seals allows measurement at great majority of media. The active element is a piezoresistant silicon sensor separated from the medium by a distance sealing system. The special design of the measuring unit means that it can withstand pressure surges and overloads of up to 40 bar. The electronic circuits are enclosed in a casing with a degree of protection IP 65 or IP66.

### Configuration

The settings of the following metrological parameters can be changed:

- ♦ the units of pressure in which the range is configured,
- ♦ start and end points of the range, time constant,
- ♦ inverted characteristic (output signal  $20 \div 4 \text{ mA}$ ).

### Communication

The transmitter is configured and calibrated using a KAP-03 communicator, some other communicators (HART) or a PC using an RS-HART converter and Aplisens RAPORT-02 configuration software.

The data interchange with the transmitter enables the users the transmitter identification, as well as reading of the currently measured differential pressure value, output current and percent of range width.

### Measuring ranges

Nominal measuring range (FSO)	Minimum set range	Vertical spacing of diaphragm seals	Maximum set range width, considering the actual vertical spacing of the diaphragm seals (m)	Static pressure limit
-160...160 mbar	0.1 m H <sub>2</sub> O	≤ 1.7 m	$[1.6 + (\text{vertical spacing of seals} \times 0.94)] \text{ m H}_2\text{O}$	40 bar
-0.5...0.5 bar	0.5 m H <sub>2</sub> O	≤ 6 m	$[5 + (\text{vertical spacing of seals} \times 1.04)] \text{ m H}_2\text{O}$	40 bar
-1.6...2 bar	1.5 m H <sub>2</sub> O	≤ 15 m	$[20 + (\text{vertical spacing of seals} \times 1.04)] \text{ m H}_2\text{O}$	40 bar
-1.6...16 bar	1 bar	≤ 15 m	16 bar	40 bar

CAUTION: The maximum vertical diaphragm seal spacing shown in the table applies to level measurement, ensuring that it is possible to set the zero point of the transmitter when the tank is empty. For measurements of density or phase boundaries (in the sugar, chemical or refinery industries) the vertical spacing of the diaphragm seals can be larger.

### Metrological parameters

**Accuracy** ≤ ±0.1% (FSO)

The other parameters as given in the sheet for the smart differential pressure transmitter APR-2000ALW/APRE-2000.

**Sealing effect errors** – as given in the relevant diaphragm seal sheet in chapter III (Diaphragm Seals), concerning the distance seal.

NOTE: The additional absolute zero error due to ambient temperature can be compensated by configuring the transmitter, seals and capillaries in accordance with the recommendations on pages 38 and 39.

**Electrical parameters** – as given in the sheet for the APR-2000ALW/APRE-2000 differential pressure transmitter.

### Operating conditions

**Operating temperature range (ambient temperature)** -25...85°C  
APR-2200ALW/Ex and APRE-2200/Ex -25...80°C

**Medium temperature range** – as given in the appropriate diaphragm seal sheet (remote seal)

### Special versions, certificates:

**Exia** – ATEX Intrinsic safety

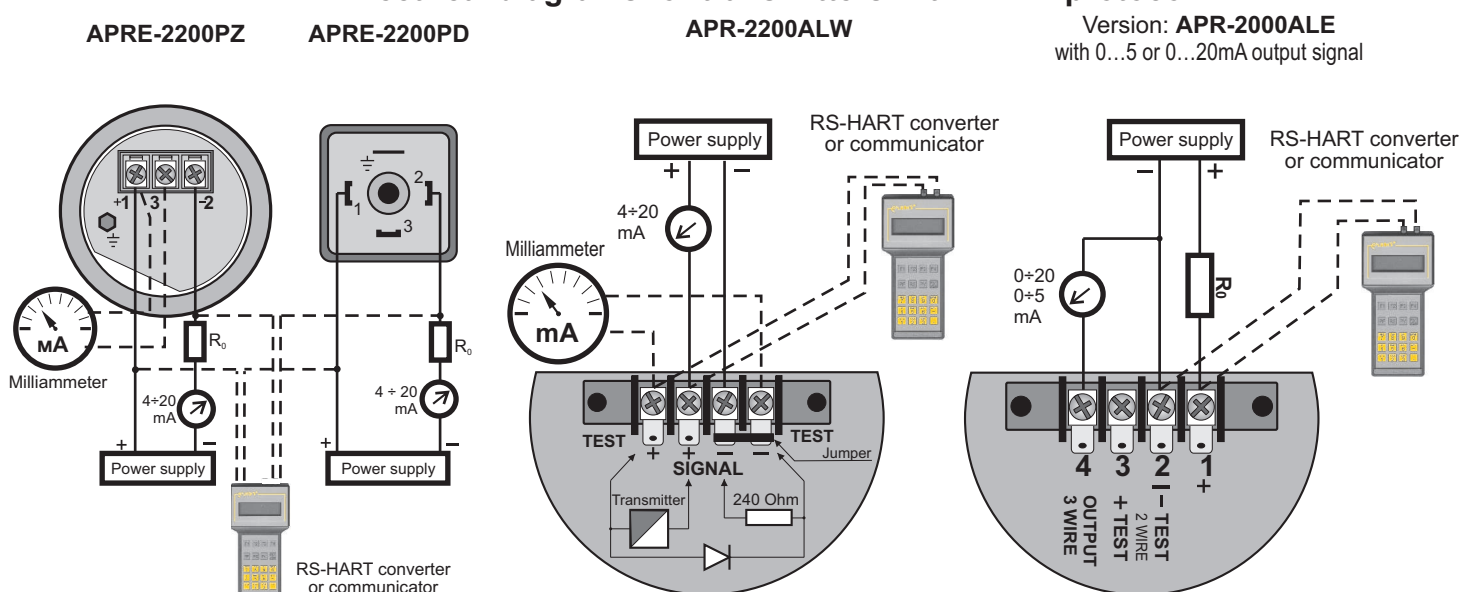
**Exd** – ATEX explosion proof

**100 bar, 160 bar** – static pressure limit – 100 bar or 160 bar

**Non-standard basic range**

**Others**

### Electrical diagrams for transmitters with HART protocol



## SMART DIFFERENTIAL PRESSURE TRANSMITTER APR-2200AL/Profibus PA/W

### Construction

The transmitter electronic system performs the digital processing of measurement and generates the output signal with the communication module according to Profibus PA standard. The transmitter function performance bases on profile 3.0 of Profibus PA standard.

The casing is made of high-pressure casting of aluminium alloy, IP-65 rated. The casing design allows using a local liquid crystal graphical display, 90° turn of display, 0–355° turn of casing relative to the sensor, and the choice of direction at cable insertion.

The measuring ranges, according to the table, page 41.

### Communication

The communication with the transmitter is achieved in two ways:

- ◇ cyclic – the transmitter sends primary measured value (4 bytes IEEE754) and status containing the information on the current state of transmitter and measurement validity (1 byte).
- ◇ acyclic – this way of communication is used to device configuration and to read both primary measured value and the status.

### Configuration

Full configuration of transmitter settings, adjustment of the display mode, transmitter zeroing and calibration in relation to pressure standards proceeds with the PDM (Process Device Manager) software, by Siemens. The EED program library, worked out by Aplisens for cooperation with this transmitter, is helpful in the configuration.

Other commercial configuration software (e.g. Commuwin by Endress and Hauser, DTM/FDT tools) make transmitter configuration possible in the range of basic commands.

Enclosed to APR-2200AL/Profibus PA is GSD file comprising the description of the transmitter basic properties such as transmission rate, type and format of input data, list of additional functions. GSD file is necessary for the software serving as a device for network configuration and makes the correct connection the appliance to Profibus network possible. The universal file GSD, designed for standard pressure transmitters made according to profile at revision 3 Profibus standard, may also be applicable to APR-2200AL/Profibus PA.

The pressure transmitter APR-2200AL/Profibus PA does not have the hardware address switch This address may be adjusted with accessible configuration software.

### Measurements in the areas under explosion hazard

For pressure measurements in the areas under explosion hazard the Atex intrinsically safe transmitters, are available

### Metrological parameters

Accuracy  $\leq \pm 0.1\%$  (FSO)

Other parameters: as for APR-2200ALW.

Sealing effect errors: as given on the relevant diaphragm seal sheet in chapter Diaphragm Seals, in relation to the distance seal

NOTE: The additional absolute zero error due to ambient temperature can be compensated by configuring the transmitter, diaphragm seals and capillaries in accordance with the recommendations on pages 38, 39.

### Electrical parameters

Power supply (from DP/PA coupler )

10,5  $\pm$  28V DC

12.05  $\pm$  28V DC - when display illumination switched on

Power supply from intrinsically safe coupler according to FISCO requirements.

$V_i = 17,5VDC$

$I_i = 0,38A$  for IIB

$I_i = 0,36A$  for IIC

Current consumption

14mA

### Output parameters

**Output signal** Digital communication signal Profibus – PA (according to EN 50170)

**PA function** slave

**Physical layer** IEC61158-2

**Transmission range** 31,25kBit/S

**Modulation** Manchester II

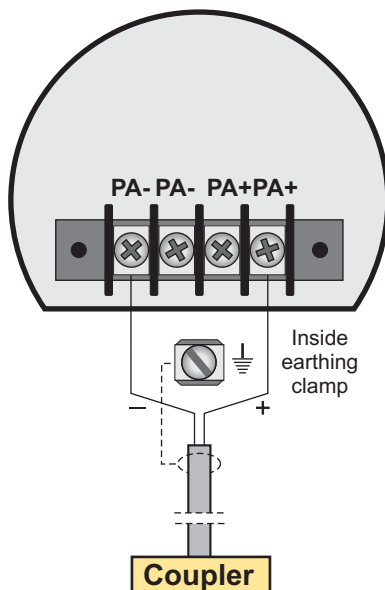
### Operating conditions

**Operating temperature range (ambient temp.):** –25..85°C

**EEx version:** –25..65°C

**Medium temperature range:** as given on the appropriate diaphragm seal

### Electrical diagrams



### Ordering procedure

(See next page)

#### Examples:

##### Ordering code to APRE-2200:

Smart differential pressure transmitter APRE-2200, nominal measuring range -1,6 $\pm$ 2 bar, on the (+) side a DN80 PN40 direct diaphragm seal, 100mm tube, on the (-) side a DN80 PN40 remote diaphragm seal, capillary length 8m.

**APRE-2200PD / -1,6 $\pm$  2 bar/ (+) S-T DN80; T=100mm/ (-)S-PK DN80; K=8m**

##### Ordering code to APR-2200ALW:

Smart differential pressure transmitter APR-2200ALW with display, nominal measuring range -0,5 $\pm$  +0,5 bar, with two remote diaphragm seals, capillaries length 2x K=2,5m

**APR-2200ALW / -0,5 $\pm$  0,5bar/ (+) S-PK DN80; K=2,5m/ (-)S-PK Dn80/ K=2,5m**

##### Ordering code to APR-2200AL/ProfibusPA:

Smart differential pressure transmitter APR-2200AL/ProfibusPA, nominal measuring range -0,5 $\pm$  +0,5 bar, with two remote diaphragm seals, capillaries length 2x K=2,5m

**APR-2200AL/Profibus PA / -0,5 $\pm$  0,5/ (+) S-PK DN80; K=2,5m/ (-)S-PK DN80; K=2,5m**

## Ordering procedure APR-2200ALW



Model	Codes	Description	
APR-2200		Smart differential pressure transmitter.	
Casing, Output signal, ⇒	ALW.....	Aluminum housing, IP66/IP67, with display, output 4–20mA + Hart	
	ALE.....	Aluminium housing, IP66/IP67, with display, output 4–20mA + Hart 0 – 20mA+ Hart, 0 – 5mA+ Hart,	
	AL/Profibus PA.....	Aluminium housing, IP66/IP67, without display, output Profibus PA	
	AL/Profibus PA/W.....	Aluminium housing, IP66/IP67, with display, output Profibus PA	
	ALW/SS..... ...	316ss stainless steel housing, IP66/IP67, with display, output 4–20mA + Hart	
Versions, Certificates*  (* ) more than one option is available	/EEx ia.....	Ex II 1/2G Exia IIC T5 ( not available for ALE version)	
	/EEx d.....	Ex II 1/2G Exia/d IIC T5/T6 Ex II 1/2D ExiaD 20/TD A21T85/T100 ( not available for ALE version)	
	/100bar.....	Static pressure limit – 100bar	
	/160bar.....	Static pressure limit – 160bar	
Nominal measuring range ⇒  (* not-standard ranges available on request)	-160+160mbar.....	Range	min set range
	-0.5+0.5bar.....	-160+160mbar (-16+16kPa)	0,1 mH <sub>2</sub> O
	-1.6+2bar.....	-0.5+0.5bar (-50+50kPa)	0,5mH <sub>2</sub> O
	-1.6+16bar.....	-1.6+2bar ( -160+200kPa)	1,5mH <sub>2</sub> O
		-1.6+16bar ( -160+1600kPa)	1bar
Measuring set range	/...÷... [ required units].....	Start and end of calibrated range in relation to 4mA and 20mA output	
Process connections	/(+ ).....	Direct diaphragm seal or remote diaphragm seal mounted on the (+) side of the transmitter- code as given in the relevant diaphragm seal sheet	
	/(- ).....	Remote diaphragm seal mounted on the (-) side of the transmitter – code as given in the relevant diaphragm seal sheet ( chapter III – seals)	
Electrical connection	⇒ (without marking).....	Packing gland M20x1,5	
	/US.....	Thread 1/2NPT Female	
Accessories	⇒ /F125.....	Mounting bracket type F125 for 2" pipe, material 304ss	
Other specification	/.....	Description of required parameters	

## Ordering procedure APRE-2200

Model	Codes	Description	
APRE-2200		Smart differential pressure transmitter.	
Casing, Output signal, ⇒	PD.....	Housing IP65 with DIN43650 connector, without display, output 4–20mA +Hart, packing gland M20x1,5.	
	PZ.....	304SS housing, IP66/IP67, without display, output 4–20mA + Hart packing gland M20x1,5	
	PZ/316.....	304SS housing, IP66, without display, output 4–20mA + Hart	
Versions, Certificates*  (* ) more than one option is available	/EExia.....	II 1/2G Ga/Gb Ex ia IIC T4/T5/T6 I M1 Ex ia I II 1D Ex iaD 20 T110°C	
	/100bar.....	Static pressure limit – 100bar	
	/160bar.....	Static pressure limit – 160bar	
	Nominal measuring range ⇒  (* not-standard ranges available on request)	-160+160mbar.....	Range
-0.5+0.5bar.....		-160+160mbar (-16+16kPa)	0,1 mH <sub>2</sub> O
-1.6+2bar.....		-0.5+0.5bar (-50+50kPa)	0,5mH <sub>2</sub> O
-1.6+16bar.....		-1.6+2bar ( -160+200kPa)	1,5mH <sub>2</sub> O
		-1.6+16bar ( -160+1600kPa)	1bar
Measuring set range	/...÷... [ required units].....	Start and end of calibrated range in relation to 4mA and 20mA output	
Process connections	/(+ ).....	Direct diaphragm seal or remote diaphragm seal connected to the (+) side of the transmitter- code as given in the relevant diaphragm seal sheet	
	/(- ).....	Remote diaphragm seal connected to the (-) side of the transmitter – code as given in the relevant diaphragm seal sheet ( chapter III – seals)	

To simplify the mathematical operations we introduce the density coefficient of the medium  $X\rho$ .

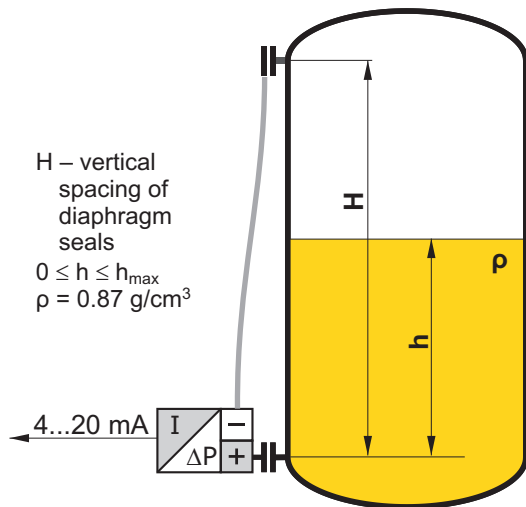
$$X\rho = \frac{\rho_{\text{medium}} [\text{g/cm}^3]}{\rho_{\text{water at 4}^\circ\text{C}} [\text{g/cm}^3]}$$

Since the density of water at 4°C is 1 g/cm<sup>3</sup>, the **density coefficient  $X\rho$  is numerically equal to the density of the medium expressed in g/cm<sup>3</sup>**. To determine the hydrostatic pressure of a column of liquid in mm H<sub>2</sub>O, it is sufficient to multiply the height of the column  $h$  [mm] by the density coefficient of the liquid  $X\rho$ . Since it is easy to determine the hydrostatic pressure in mm H<sub>2</sub>O and the transmitter can be configured in those units, in the descriptions of measurement methods given below we will make use of pressures expressed in mm H<sub>2</sub>O and the density coefficient  $X\rho$ .

### Configuration of the transmitter to measure the level of liquid in a tank

#### The measurement task:

To convert a variation in the level of a liquid with density  $\rho = 0.87 \text{ g/cm}^3$  between 0 and  $h_{\text{max}}$  to a variation in the output signal from 4 to 20 mA.



1. Install the transmitter in its working position on an empty tank.
2. Make the electrical connections of the transmitter, providing for the ability to use HART communication.
3. Connect the KAP-02 communicator, identify the transmitter and select the “configuration” function.

4. On the configuration menu select the “Reranging” procedure.
5. On the “Reranging” menu:
  - a) change the units of measurement to mm H<sub>2</sub>O at 4°C;
  - b) enter the values for the start ( $X\rho \times h_{\text{min}}$  [mm]) and end ( $X\rho \times h_{\text{max}}$  [mm]) of the measurement range, namely 0 and ( $0.87 h_{\text{max}}$  [mm]) respectively;
  - c) to compensate for the hydrostatic pressure of the manometric fluid, the start of the measurement range should be set using regulated pressure; when subject to the action of only the manometric fluid (empty tank) the transmitter will shift the start and end-points of the range, compensating for the value of that pressure.

When the transmitter has been configured in this way it is ready to be used to carry out the given measurement task.

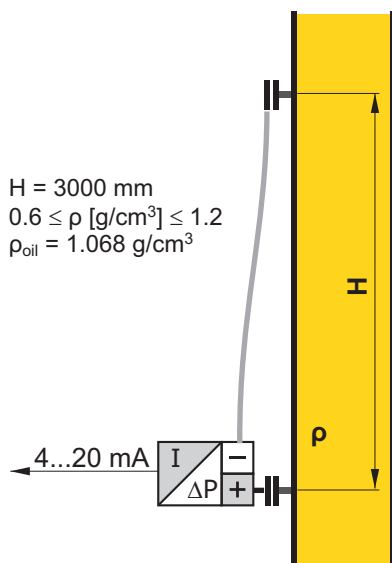
If it is not possible to empty the tank to configure the transmitter, the hydrostatic pressure of the manometric fluid should be calculated by multiplying the vertical spacing of the diaphragm seals by the density coefficient of the oil in the capillaries. This pressure should be taken into account when entering the values for the start and end of the range:

$$\text{Start [mm H}_2\text{O]} = -H [\text{mm}] \times X\rho_{\text{oil}}$$

$$\text{End [mm H}_2\text{O]} = h_{\text{max}} [\text{mm}] \times X\rho_{\text{measured liquid}} - H [\text{mm}] \times X\rho_{\text{oil}}$$

$\rho_{\text{oil}}$  for DC-550 oil is equal to 1.068 g/cm<sup>3</sup>  
 $\rho_{\text{oil}}$  for AK-20 oil is equal to 0.945 g/cm<sup>3</sup>

### Configuration of the transmitter to measure density of liquids



#### The measurement task:

To convert a variation in liquid density from  $\rho_{\text{min}} = 0.6 \text{ g/cm}^3$  to  $\rho_{\text{max}} = 1.2 \text{ g/cm}^3$  to a variation in the output signal from 4 to 20 mA, with the vertical spacing of the diaphragm seals equal to  $H = 3000 \text{ mm}$ . The sealing system is filled with DC-550 oil with density  $\rho_{\text{oil}} = 1.068 \text{ g/cm}^3$ .

1. Calculate the value of the start of the range as follows:  
 $H_{[\text{mm}]} \times (X\rho_{\text{min}} - X\rho_{\text{oil}}) = 3000 \times (0.6 - 1.068) = -1404 [\text{mm H}_2\text{O}]$
2. Calculate the value of the end of the range as follows:  
 $H_{[\text{mm}]} \times (X\rho_{\text{max}} - X\rho_{\text{oil}}) = 3000 \times (1.2 - 1.068) = 396 [\text{mm H}_2\text{O}]$
3. Set the zero point of the transmitter with the diaphragm seals positioned at the same level.
4. Install the transmitter in its working position.
5. Make the electrical connections to the transmitter, providing for the possibility of using HART communication.

6. Connect the KAP-02 communicator, identify the transmitter and select the "configuration" function.
7. On the configuration menu select "Reranging" procedure.
8. On the "Reranging" menu:
  - a) change the measurement units to mm H<sub>2</sub>O at 4°C;
  - b) enter the calculated values for the start (-1404) and end (396) of the range.

When the transmitter has been configured in this way it is ready to be used to carry out the given measurement task.

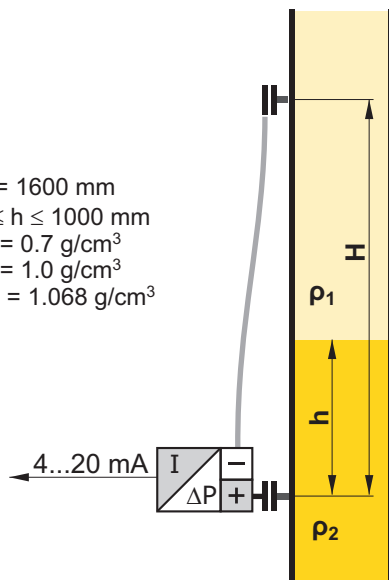
Note: If it is possible to fill the space between the seals with a liquid whose density corresponds to the start of the measurement range, the start of the range of the transmitter can be set using regulated pressure.

### Measurement of phase boundary

The height of the phase boundary of liquids of different densities is determined by measuring the average density of the medium between the seals.

#### Example:

Calculate the measurement range start and end points for an APRE-2200 transmitter configured to measure phase boundary height in the range 0–1000 mm between liquids of density  $\rho_1 = 0.7 \text{ g/cm}^3$  and  $\rho_2 = 1.0 \text{ g/cm}^3$ , where the vertical spacing of the seals  $H = 1600 \text{ mm}$ . The sealing system uses DC-550 oil with a density of  $1.068 \text{ g/cm}^3$ .



To determine the start of the measurement range, calculate the pressure difference at the transmitter when the tank is filled with the lighter liquid only:

$$1600 \text{ [mm]} \times (0.7 - 1.068) = -588.8 \text{ [mm H}_2\text{O]}$$

To determine the end-point of the range, add the increase in pressure resulting from the appearance of a 1 metre column of the heavier liquid:

$$-588.8 \text{ [mm H}_2\text{O]} + (1.0 - 0.7) \times 1000 \text{ [mm]} = -288.8 \text{ [mm H}_2\text{O]}$$

### Additional remarks

The settings of the transmitter can be adjusted with reference to laboratory results from density measurements carried out on samples of the liquid being measured. This is most often necessary when the measurement takes place in a pipeline segment where the flow velocity of the measured liquid reaches several m/s.

Increasing the vertical spacing of the diaphragm seals widens the range and often improves measurement accuracy.

In planning the spacing of the diaphragm seals, ensure that the pressure difference at the transmitter lies within the basic range.

The maximum vertical spacing of the diaphragm seals ( $H$ ) depends on the transmitter's basic range and the boundary values for the density of the measured liquid ( $\rho_{\min}$ ;  $\rho_{\max}$ ).

If  $\rho_{\min} < \rho_{\text{oil}} < \rho_{\max}$ , the seal spacing  $H$  should satisfy the following conditions:

$$H \text{ [mm]} \leq \frac{\text{lower boundary of range [mm H}_2\text{O]}}{X\rho_{\min} - X\rho_{\text{oil}}}$$

$$H \text{ [mm]} \leq \frac{\text{upper boundary of range [mm H}_2\text{O]}}{X\rho_{\max} - X\rho_{\text{oil}}}$$

#### Example:

Determine the maximum vertical spacing of the seals for the **APRE-2200 / -10...10 kPa** transmitter when measuring the density of liquid between 0.6 and 1.2 g/cm<sup>3</sup>. The sealing system uses AK-20 silicone oil with a density of 0.945 g/cm<sup>3</sup>.

The lower boundary of the range of the transmitter is -10 kPa = -1020 mm H<sub>2</sub>O

$$H \text{ [mm]} \leq \frac{-1020}{0.6 - 0.945} \Rightarrow H \text{ [mm]} \leq \frac{-1020}{-0.345} \Rightarrow H \text{ [mm]} \leq 2957$$

The upper boundary of the range of the transmitter is +10 kPa = 1020 mm H<sub>2</sub>O

$$H \text{ [mm]} \leq \frac{1020}{1.2 - 0.945} \Rightarrow H \text{ [mm]} \leq \frac{1020}{0.255} \Rightarrow H \text{ [mm]} \leq 4000$$

In the example, both conditions are satisfied when the spacing of the seals is not more than 2957 mm.