

**RE 91 455/04.00**

replaces: 01.94

**Fixed Displacement Pump A4FO**

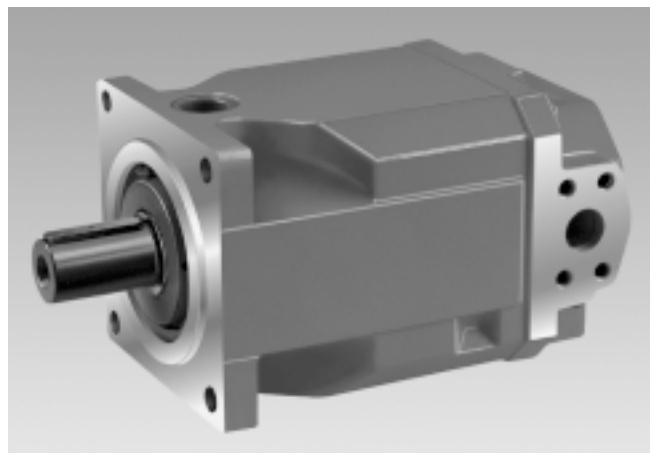
for open circuits

Sizes 16...500

Series 1, Series 3

Nominal pressure up to 400 bar

Peak pressure up to 450 bar



A4FO

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**Features**

- A4FO axial piston fixed displacement pumps of swashplate design are used for hydraulic drives in open loop circuits.
- Flow is proportional to the drive speed and to the displacement.
- Good suction characteristic
- Low noise level
- Long service life
- Pump combinations possible
- Through drive for mounting other pumps

– Further Informations:  
Variable Pump A4VSO

RE 92 050



## Ordering Code

Fluid / Design	16	22	28	40	71	125	250	500	
Mineral oil, HFD-Fluid	●	●	●	●	●	●	●	●	
HFA-, HFB-, HFC-Fluid	–	–	–	–	●	●	●	●	E-
High-Speed Design	–	–	–	–	–	–	●	●	H-

### Axial piston unit

Fixed swashplate design	A4F
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### Operation

Pump in open circuits	0
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### Size

≙ Displacement $V_g$ (cm <sup>3</sup> )	16	22	28	40	71	125	250	500
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### Series

	sizes 16...40, 125...500	3
	size 71	1

### Index

	sizes 16...40	2
	sizes 71...500	0

### Direction of rotation

viewed on shaft end	clockwise	R
	anti-clockwise	L

### Seals

NBR (nitril-caoutchouc), shaft seal in FKM (fluor-caoutchouc)	sizes 16...40	N
	sizes 71...500	P
FKM (fluor-caoutchouc)	sizes 71...500	V

### Shaft end

	16	22	28	40	71	125	250	500	
splined shaft SAE	●	●	●	–	–	–	–	–	S
splined shaft SAE	–	–	–	●	–	–	–	–	T
Splined shaft DIN 5480	–	–	–	–	●	●	●	●	Z
parallel shaft, with key DIN 6885	–	–	–	–	●	●	●	●	P

### Mounting flange

	16	22	28	40	71	125	250	500	
SAE 2-hole	●	●	●	●	–	–	–	–	C
ISO 4-hole	–	–	–	–	●	●	●	–	B
ISO 8-hole	–	–	–	–	–	–	–	●	H

### Service line connections

	sizes 16...40	sizes 71...500	
Pressure and suction port SAE at side (opposite side) (metric fixing screws)	●	–	12
Pressure and suction port SAE at side, rotated by 90° (metric fixing screws)	–	●	25
2nd pressure port B <sub>1</sub> opposite B - when delivered plugged with a flange			

● = available

○ = in preparation

– = not available



## Technical Data

### Fluid

To review the application of A4FO pumps with the selected hydraulic fluid, detailed fluid compatibility and application data can be found in data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90223 (fire resistant fluids, HF).

When using HF- or environmentally acceptable hydraulic fluids possible limitations for the technical data have to be taken into consideration. If necessary please consult our technical department (please indicate type of the hydraulic fluid used for your application on the order sheet).

Sizes 16...40 of fixed pump A4FO are not suitable for operation with HFA, HFB or HFC-fluids.

### Operating viscosity range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at operating temperature) be selected from within the range:

$$v_{\text{opt}} = \text{operating viscosity } 16 \dots 36 \text{ mm}^2/\text{s}$$

referred to the tank temperature (open circuit).

### Viscosity limits

The limiting values for viscosity are as follows:

*Sizes 16...40*

$$v_{\text{min}} = 5 \text{ mm}^2/\text{s},$$

short term at a max. permissible temperature of  $t_{\text{max}} = 115^\circ\text{C}$

$$v_{\text{max}} = 1600, \text{ short term on cold start } (t_{\text{min}} = -40^\circ\text{C})$$

*Sizes 71...500*

$$v_{\text{min}} = 10 \text{ mm}^2/\text{s},$$

short term at a max. permissible leakage oil temp. of  $t_{\text{max}} = 90^\circ\text{C}$

$$v_{\text{max}} = 1000 \text{ mm}^2/\text{s}, \text{ short term on cold start } (t_{\text{min}} = -25^\circ\text{C})$$

Please note that the max. fluid temperature is also not exceeded in certain areas (for instance bearing area).

At temperatures of  $-25^\circ\text{C}$  up to  $-40^\circ\text{C}$  special measures may be required for certain installation positions. Please contact us.

### Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the tank (open circuit) in relation to the ambient temperature.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range ( $v_{\text{opt}}$ ) (see shaded section of the selection diagram). We recommend that the highest possible viscosity range should be chosen in each case.

Example: At an ambient temperature of  $X^\circ\text{C}$  the operating temperature is  $60^\circ\text{C}$ . Within the operating viscosity range ( $v_{\text{opt}}$ ; shaded area), this corresponds to viscosity ranges VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and pump speed and is always higher than the tank temperature. However, at no point in the circuit may the temperature exceed  $115^\circ\text{C}$  for sizes 16...40 or  $90^\circ\text{C}$  for sizes 71...500.

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperatures please consult us.

### Filtration

The finer the filtration the better the achieved cleanliness level of the pressure fluid and the longer the life of the axial piston unit.

To ensure the functioning of the axial piston unit a minimum cleanliness level of

9 to NAS 1638

18/15 to ISO/DIS 4406 is necessary.

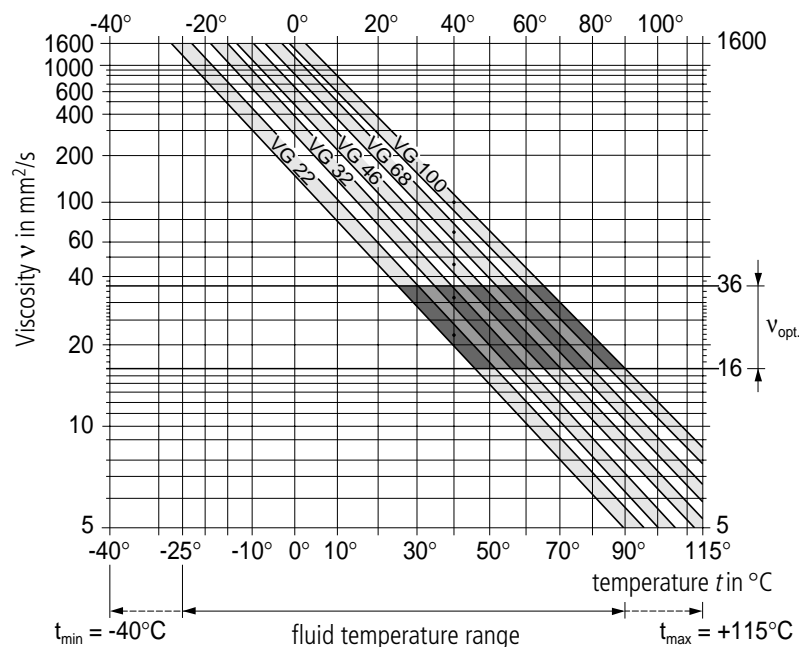
At very high temperatures of the hydraulic fluid ( $90^\circ\text{C}$  to max.  $115^\circ\text{C}$ , not permissible for sizes 71...500) at least cleanliness level

8 to NAS 1638

17/14 to ISO/DIS 4406 is necessary.

If above mentioned grades cannot be maintained please consult us.

### Selection diagram



## Technical Data

valid for operation with mineral oils

### Sizes 16...40

#### Working pressure range inlet

Absolut pressure at port S (suction port)

 $p_{abs. min}$  \_\_\_\_\_ 0,8 bar $p_{abs. max}$  \_\_\_\_\_ 2 bar

#### Working pressure range outlet

Maximum pressure at port A or B (pressure data to DIN 24312)

Nominal pressure  $p_N$  \_\_\_\_\_ 400 barPeak pressure  $p_{max}$  \_\_\_\_\_ 450 bar

Note:

When mounting further pumps at the through drive of the A4FO the max. input torque of the drive shaft has not to be exceeded (as to page 15). This may necessitate a limitation of the max. admissible pressure values.

#### Direction of flow

clockwise operation    anti-clockwise operation

Sizes 16...40

**S to B****S to A**

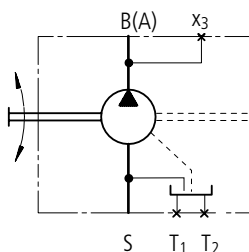
#### Symbol

A, B    service line port

S    suction port

 $T_1, T_2$     drain port

(plugged)

 $x_3$     gauge port

### Sizes 71...500

#### Working pressure range inlet

Absolut pressure at port S (suction port)

 $p_{abs. min}$  \_\_\_\_\_ 0,8 bar $p_{abs. max}$  \_\_\_\_\_ 30 bar

#### Working pressure range outlet

Maximum pressure at port A or B (pressure data to DIN 24312)

Nominal pressure  $p_N$  \_\_\_\_\_ 350 barPeak pressure  $p_{max}$  \_\_\_\_\_ 400 bar

#### Flushing of the bearings (Sizes 125...500)

For informations about operating conditions, flushing quantities and notes on bearing flushing see data sheet RE 92 050 (A4VSO).

#### Direction of flow

clockwise operation    anti-clockwise operation

Sizes 71...500

**S to B****S to B**

#### Symbol

 $B, B_1$     service line port

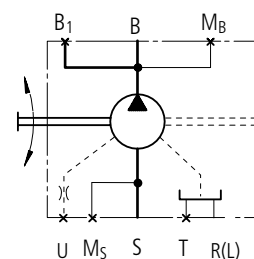
S    suction port

 $T, R(L)$     drain port

(1 port plugged)

 $M_B$     gauge port working pressure $M_S$     gauge port suction pressure

U    flushing port (sizes 125...500)



#### Case drain pressure

Perm. case drain pressure (housing pressure)

 $p_L$  \_\_\_\_\_ 2 bar abs.

The leakage oil chamber is connected to the suction chamber. A case drain line is therefore not necessary.

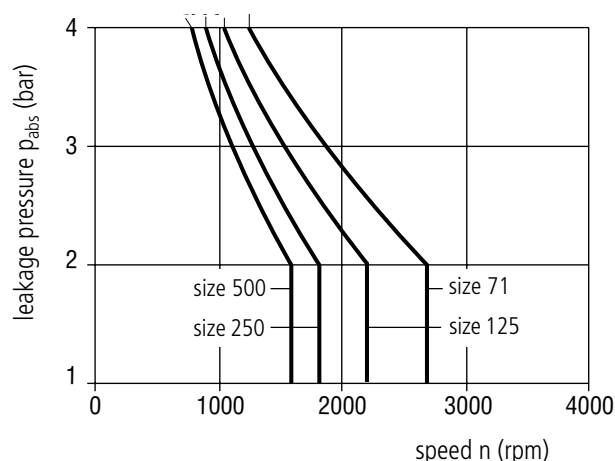
#### Leakage pressure

The max. permissible leakage pressure (housing pressure) is dependent on speed (see diagram). The pressure in the housing must be equal to or greater than the external pressure on the shaft sealing ring.

Max. leakage pressure (housing pressure)

 $p_L$  \_\_\_\_\_ 4 bar abs.

A case drain line to the tank is necessary.



## Technical Data

**Table of values** (theoretical values, without considering  $\eta_{mh}$  and  $\eta_v$ ; values rounded)

Size			16	22	28	40	71	125	250/H*	500/H*
Displacement	$V_g$	cm <sup>3</sup>	16	22	28	40	71	125	250	500
Max. speed <sup>1)</sup>	$n_{max}$	rpm	4000	3600	3000	2750	2200	1800	1500/1900	1320/1500
Max. permissible speed (speed limit) with increased inlet pressure	$n_{max perm.}$	rpm	4800	4500	3750	3400	2700	2200	1800/2100	1600/1800
Output flow at $n_{max}$ <sup>2)</sup>	$q_{V max}$	L/min	62	77	81	107	152	218	364/461	640/728
Power at $q_{V max}$ ; $\Delta p = 400$ bar	$P_{max}$	kW	43	53	56	73	91 <sup>3)</sup>	131 <sup>3)</sup>	219/277 <sup>3)</sup>	385/437 <sup>3)</sup>
Max. torque at $\Delta p = 400$ bar	$T_{max}$	Nm	102	140	178	254	395 <sup>3)</sup>	696 <sup>3)</sup>	1391 <sup>3)</sup>	2783 <sup>3)</sup>
Case volume	L		0,3	0,3	0,3	0,4	2,0	3,0	7,0	11,0
Moment of inertia, about drive axis	$J$	kgm <sup>2</sup>	0,0017	0,0017	0,0017	0,0030	0,0121	0,0300	0,0959	0,3325
Weight (approx.)	$m$	kg	13,5	13,5	13,5	16,5	34	61	120	220

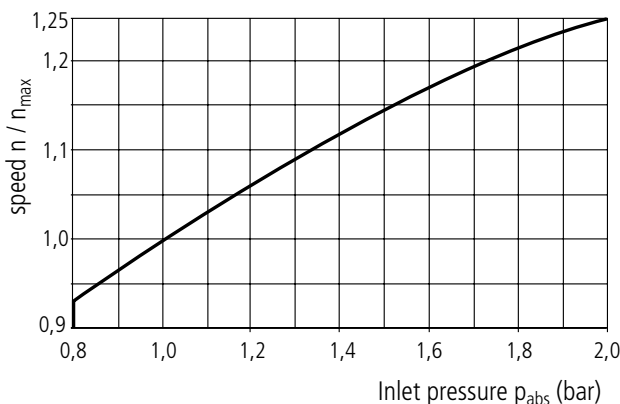
<sup>1)</sup> The values shown are valid for an absolute pressure ( $p_{abs}$ ) of 1 bar at the suction inlet S and when operated on mineral oil.

<sup>2)</sup> 3 % volumetric loss included

<sup>3)</sup>  $\Delta p = 350$  bar H\*: High-speed-design

### Maximum permissible speed (speed limit)

Maximum permissible speed with increased inlet pressure  $p_{abs}$  at suction port S (note: max. perm. speed  $n_{max perm.}$  (speed limit))



### Calculation of size

Flow  $q_v = \frac{V_g \cdot n \cdot \eta_v}{1000}$  in L/min

Torque  $T = \frac{1,59 \cdot V_g \cdot \Delta p}{100 \cdot \eta_{mh}} = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_{mh}}$  in Nm

Power  $P = \frac{T \cdot n}{9549} = \frac{2 \pi \cdot T \cdot n}{60 \cdot 1000} = \frac{q_v \cdot \Delta p}{600 \cdot \eta_t}$  in kW

$V_g$  = displacement per revolution in cm<sup>3</sup>

$\Delta p$  = differential pressure in bar

$n$  = speed in rpm

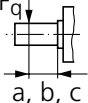
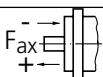
$\eta_v$  = volumetric efficiency

$\eta_{mh}$  = mechanical-hydraulic efficiency

$\eta_t$  = overall efficiency

### Input drive

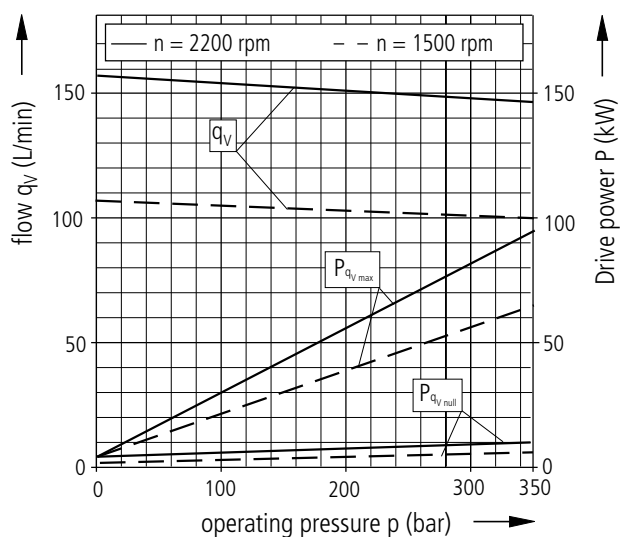
Permissible axial and radial force on drive shaft

Size				16	22	28	40
Distance of $F_q$ (from shaft collar)		a	mm	17,5	17,5	17,5	17,5
		b	mm	30	30	30	30
		c	mm	42,5	42,5	42,5	42,5
max. permissible radial force at distance	a	$F_{q\ max}$	N	2800	2500	2050	3600
	b	$F_{q\ max}$	N	1600	1400	1150	2891
	c	$F_{q\ max}$	N	1150	1000	830	2416
max. permissible axial force		$- F_{ax\ max}$	N	1557	1557	1557	2120
		$+ F_{ax\ max}$	N	417	417	417	880

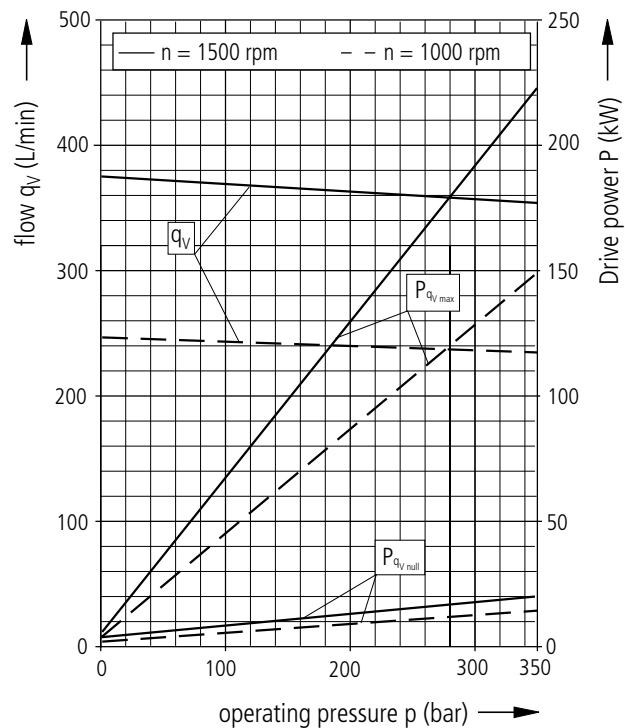
Size			71	125	250	500
Max. axial force at housing pressure $p_{\max}$ 1 bar abs.		$\pm F_{ax \max}$ N	1400	1900	3000	4000
Max. axial force at housing pressure $p_{\max}$ 4 bar abs.		$+ F_{ax \max}$ N	810	1050	1850	2500
		$- F_{ax \max}$ N	1990	2750	4150	5500
Max. shearing force		$F_{q \max}$ N	1700	2500	4000	5000

# Input Power and Flow

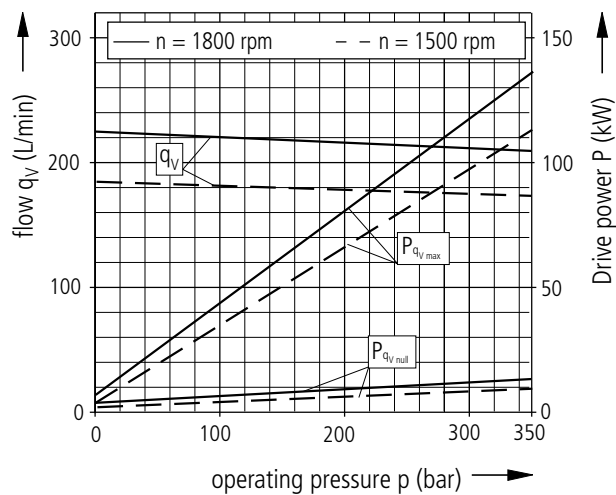
Size 71



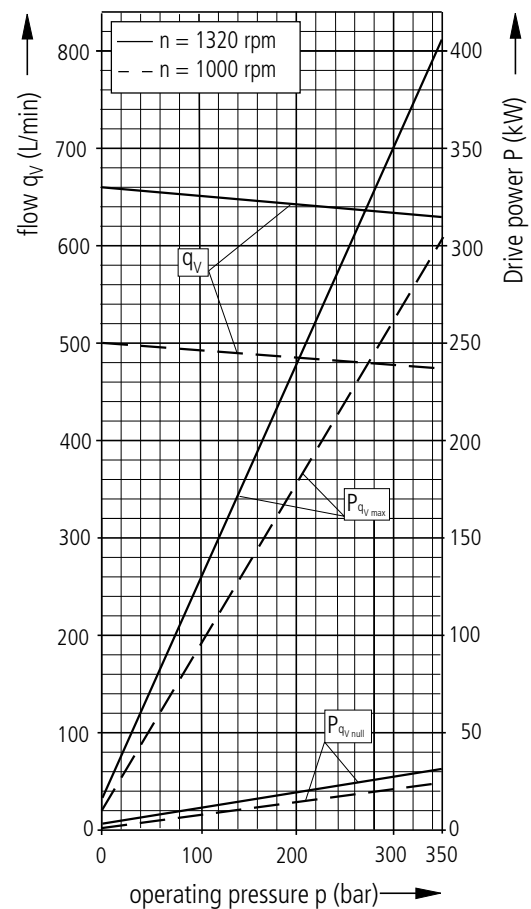
Size 250



Size 125



Size 500



Total efficiency: 
$$\eta_t = \frac{q_V \cdot p}{P_{q_{V,max}} \cdot 600}$$

Volumetric efficiency: 
$$\eta_v = \frac{q_V}{q_{V,theor}}$$

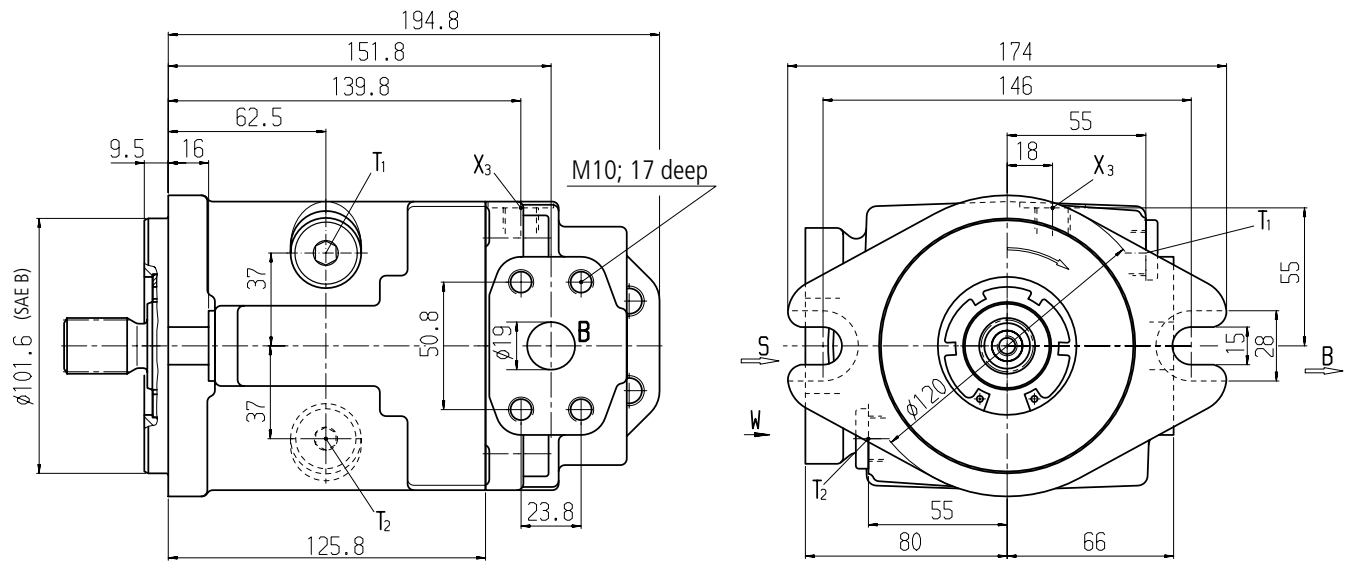
(Fluid: hydraulic oil ISO VG 46 DIN 51519,  $t = 50^\circ\text{C}$ )

## Unit Dimensions, Sizes 16, 22, 28

Prior to finalising your design, please obtain a certified drawing.

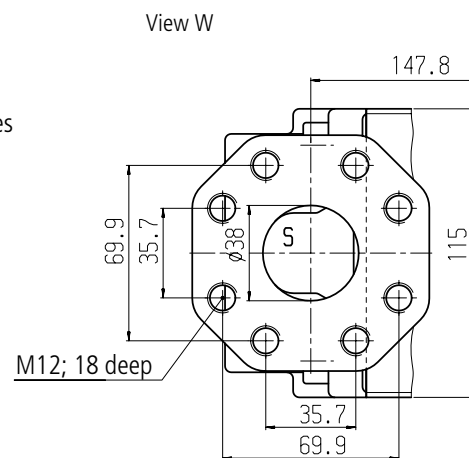
### Clockwise operation

(port plate is rotated via 180° for anti-clockwise operation)



### Connections

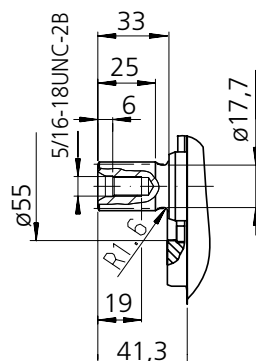
B (A)	Service line ports	SAE $\frac{3}{4}$ " 420 bar (6000 psi) high pressure series
S	Suction port	SAE $1\frac{1}{2}$ " 35 bar (500 psi) standard series
T <sub>1</sub> , T <sub>2</sub>	Case drain port, oil filling	M18x1,5; 12 deep
X <sub>3</sub>	Gauge port	M14x1,5; 12 deep



### Shaft ends

#### S

Splined shaft SAE  $\frac{7}{8}$ " (SAE B),  
pressure angle 30°,  
13 teeth, 16/32 Pitch,  
flat root, side fit,  
tolerance class 5  
ANSI B92.1a-1976



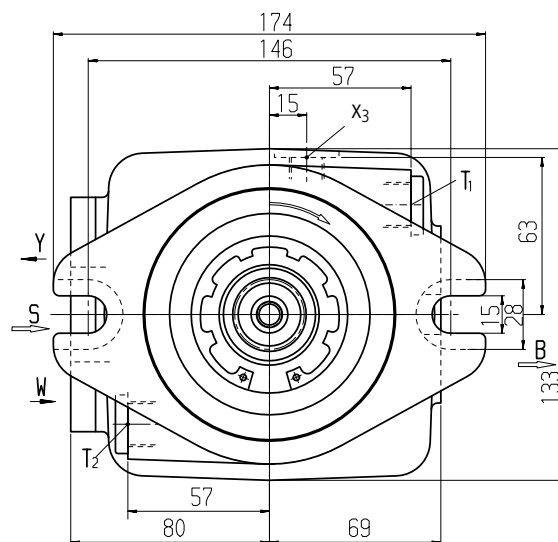
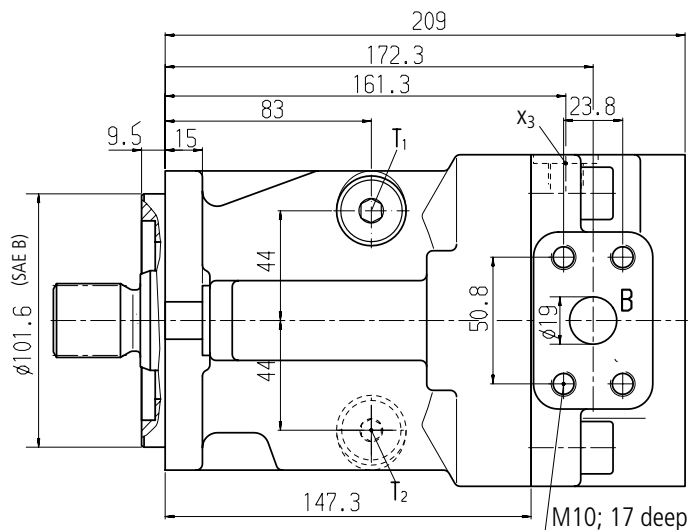


## Unit Dimensions, Size 40

Prior to finalising your design, please obtain a certified drawing.

### Clockwise operation

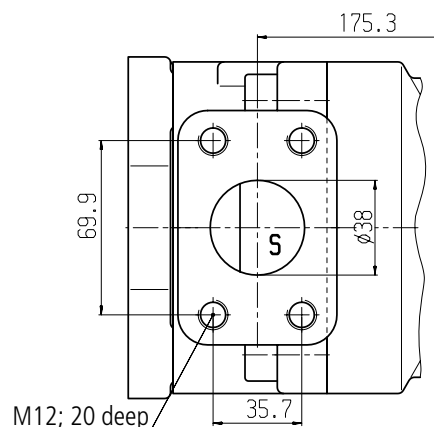
(port plate is rotated via 180° for anti-clockwise operation)



View W

### Connections

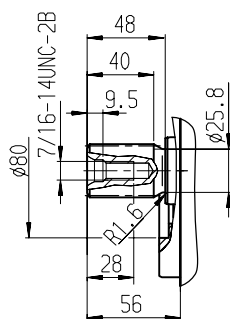
B (A)	Service line ports	SAE 3/4" 420 bar (6000 psi) high pressure series
S	Suction port	SAE 1 1/2" 35 bar (500 psi) standard series
T <sub>1</sub> , T <sub>2</sub>	Case drain port, oil filling	M18x1,5; 12 deep
x <sub>3</sub>	Gauge port	M14x1,5; 12 deep



### Shaft ends

#### T

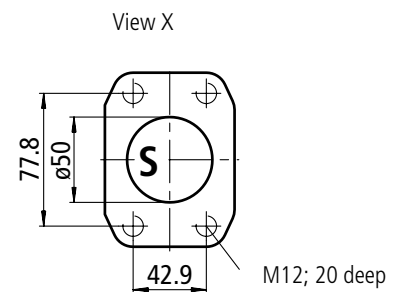
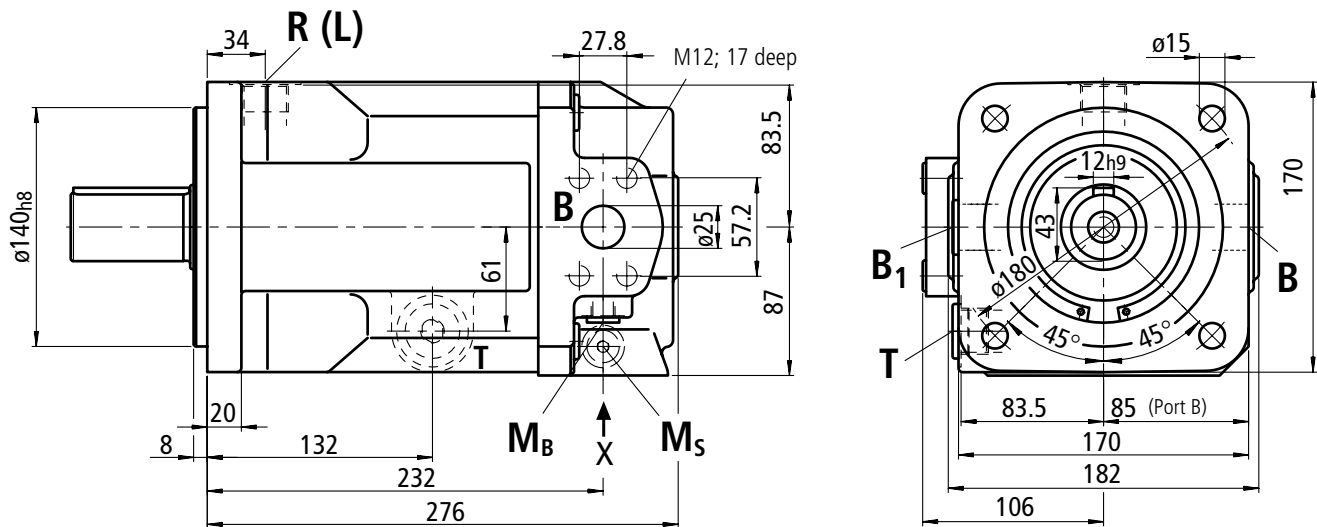
Splined shaft SAE 1 1/4" (SAE C)  
pressure angle 30°,  
14 teeth, 12/24 Pitch  
flat root side fit,  
tolerance class 5  
ANSI B92.1a-1976



### Unit Dimensions, Size 71

Prior to finalising your design, please obtain a certified drawing.

### Clockwise and anti-clockwise operation



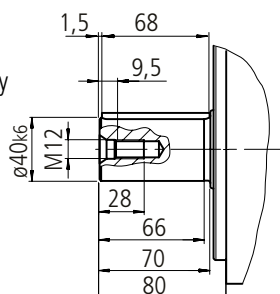
## Connections

B	Service line port	SAE 1" (high pressure series)
B <sub>1</sub>	2nd service line port (plugged with a flange)	SAE 1" (high pressure series)
S	Suction port	SAE 2" (standard series)
R (L)	Case drain port, oil filling	M27x2
T	Oil drain (plugged)	M27x2
M <sub>B</sub>	Gauge port operating pressure (plugged)	M14x1,5
M <sub>S</sub>	Gauge port suction pressure (plugged)	M14x1,5

### Shaft ends

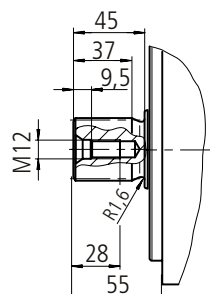
**P**

Parallel shaft with key  
AS 12x8x68  
DIN 6885



# Z

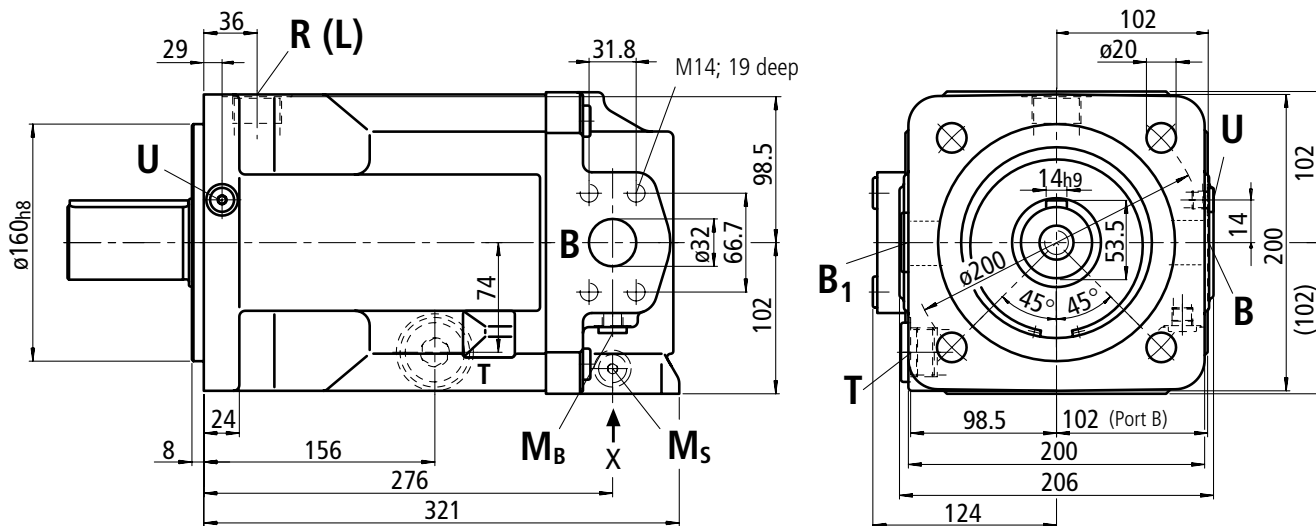
Splined shaft  
W40x2x30x18x9g  
DIN 5480



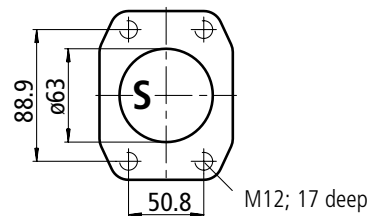
## Unit Dimensions, Size 125

Prior to finalising your design, please obtain a certified drawing.

### Clockwise and anti-clockwise operation



View X



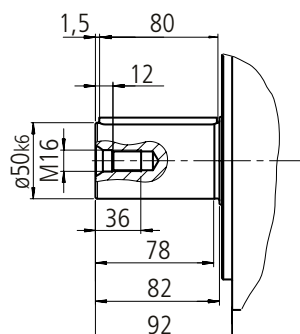
### Connections

B	Service line port	SAE 1 $\frac{1}{4}$ " (high pressure series)
B <sub>1</sub>	2nd service line port (plugged with a flange)	SAE 1 $\frac{1}{4}$ " (high pressure series)
S	Suction port	SAE 2 $\frac{1}{2}$ " (standard series)
R (L)	Case drain port, oil filling	M33x2
T	Oil drain (plugged)	M33x2
$M_B$	Gauge port operating pressure (plugged)	M14x1,5
$M_S$	Gauge port suction pressure (plugged)	M14x1,5
U	Flushing port (bearing flushing) (plugged)	M14x1,5

### Shaft ends

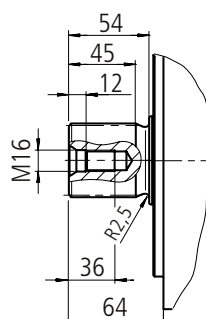
#### P

Parallel shaft with key  
14x9x80  
DIN 6885



#### Z

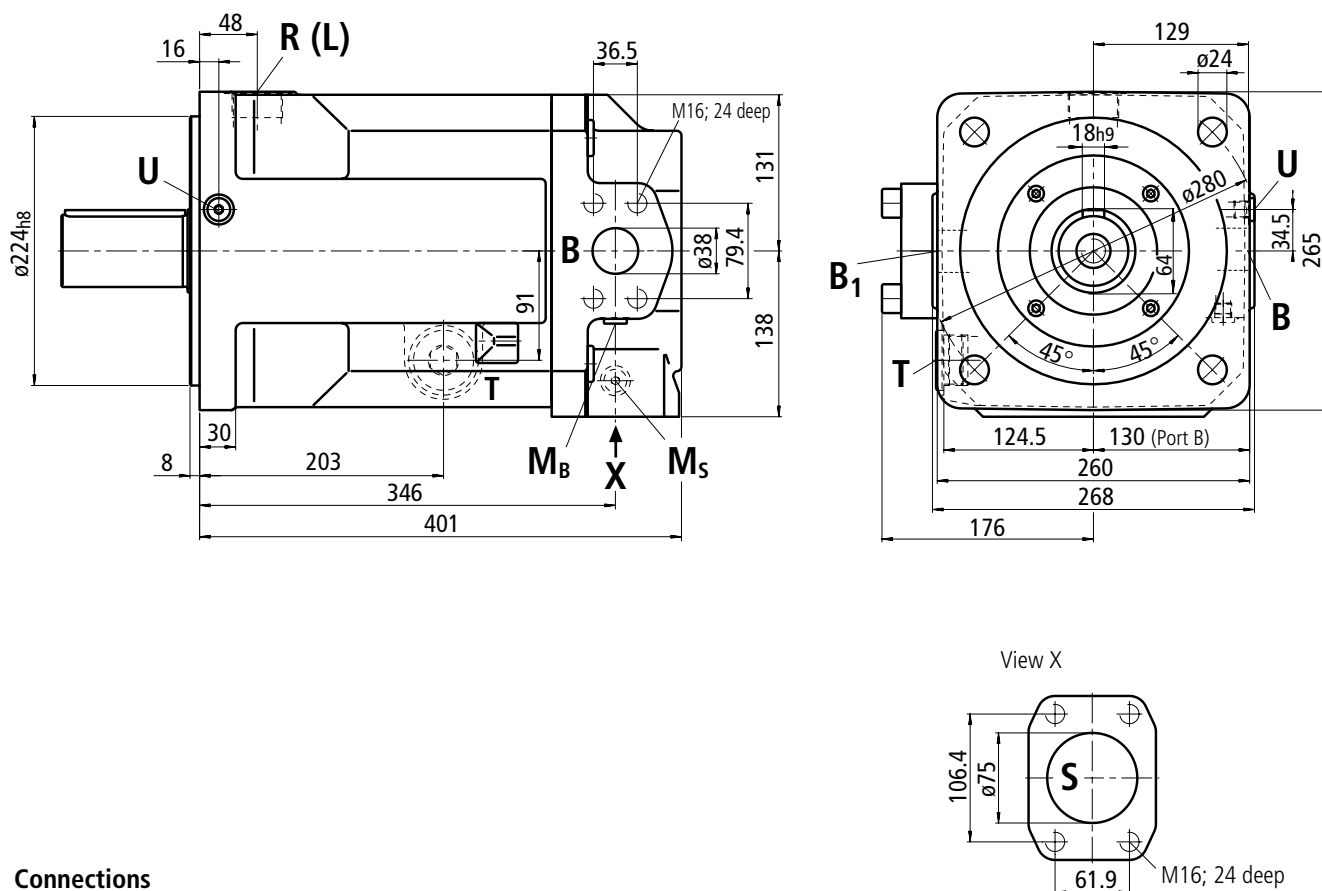
Splined shaft  
W50x2x30x24x9g  
DIN 5480



## Unit Dimensions, Size 250

Prior to finalising your design, please obtain a certified drawing.

### Clockwise and anti-clockwise operation



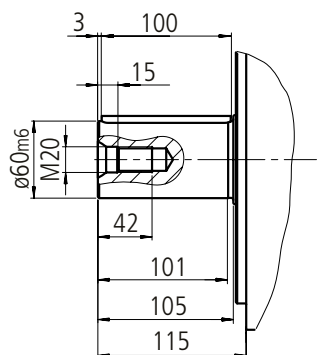
### Connections

B	Service line port	SAE 1 1/2" (high pressure series)
B <sub>1</sub>	2nd service line port (plugged with a flange)	SAE 1 1/2" (high pressure series)
S	Suction port	SAE 3" (standard series)
R (L)	Case drain port, oil filling	M42x2
T	Oil drain (plugged)	M42x2
M <sub>B</sub>	Gauge port operating pressure (plugged)	M14x1,5
M <sub>S</sub>	Gauge port suction pressure (plugged)	M14x1,5
U	Flushing port (bearing flushing) (plugged)	M14x1,5

### Shaft ends

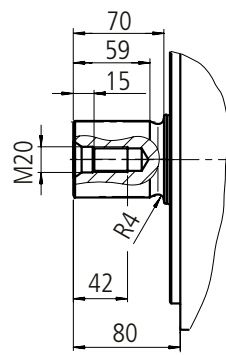
#### P

Parallel shaft with key  
AS 18x11x100  
DIN 6885



#### Z

Splined shaft  
W60x2x30x28x9g  
DIN 5480





### Through drive SAE A (K01)

Technical drawing of the 1632 DP valve, showing a top view and a side view.

**Top View Dimensions:**

- Central opening: M10; 15 deep
- Overall width: 106.4

**Side View Dimensions:**

- Overall height: 17.5
- Internal diameter:  $\phi 82.55 \pm 0.025$
- Flange thickness: 9
- Valve body height: 10
- Base height: 17
- Stem diameter:  $\phi 17.5$
- Stem length: 10
- Stem thread: (N $\frac{3}{8}$ -9T 16/32 DP)

- gear pump G2 (RE 10030)
- variable pump A10VSO10 (RE 92713)
- variable pump A10VSO18 (RE 92712)

Technical drawing of a splined hub SAE A (N5/g-9T 16/32). The drawing includes a front view (left) and a side view (right).

**Front View Dimensions:**

- Top hole: M10; 15 deep
- Overall width: 106.4
- Overall height: 106.4

**Side View Dimensions:**

- Overall width: 209
- Internal hole diameter:  $\phi 17.5$
- Internal hole tolerance:  $\pm 0.025$
- Internal hole length: 10
- Internal hole offset: 12
- Internal hole depth: 17
- Internal hole diameter:  $\phi 82.55 \pm 0.025$

- gear pump G2 (RE 10030)
- variable pump A10VSO10 (RE 92713)
- variable pump A10VSO18 (RE 92712)

Technical drawing of the SAE B flange for sizes 16, 22, and 28. The drawing includes a front view on the left and a side view on the right.

**Front View (Left):**

- Central bore: M12; 18 deep
- Mounting holes: 4 holes, each with a diameter of  $\phi 101.6^{+0.035}$
- Overall width: 146

**Side View (Right):**

- Overall height: 11
- Distance from base to mounting holes: 12
- Distance from base to center of mounting holes:  $\phi 101.6^{+0.035}$
- Mounting holes: 4 holes, each with a diameter of  $\phi 101.6^{+0.035}$
- Central bore: M12; 18 deep
- Label: splined hub SAE B (N7/8-13T 16/32 DP)

- fixed pump A4FO 16, 22, 28
- gear pump G3 (RE 10039)
- gear pump G4 (RE 10042)
- variable pump A10VG18 (RE 92750)
- variable pump A10VO28 (RE 92701/  
RE 92703)

**Size**  
**A1**

Through drive dimensions see RE 92050 (A4VS0)

Size	71	125	250	500
A1	194	231	293	335

## Permissible Input and Through Drive Rotation Torques

Size			16	22	28	40
Corner torque (at $\Delta p = 400$ bar) <sup>1)</sup>	$T_{\max}$	Nm	102	140	178	254
Max. perm. through drive torque <sup>2)</sup>	$T_{D \text{ perm.}}$	Nm	192	192	192	314
Max. perm. input torque <sup>3)</sup>	shaft end S (SAE J744)	$T_{E \text{ perm.}}$	Nm	192 (SAE B, W $7/8$ " )	192 (SAE B, W $7/8$ " )	192 (SAE B, W $7/8$ " )
	shaft end T (SAE J744)	$T_{E \text{ perm.}}$	Nm	—	—	—
Size			71	125	250	500
Corner torque (at $\Delta p = 350$ bar) <sup>1)</sup>	$T_{\max}$	Nm	395	696	1391	2783
Max. perm. through drive torque <sup>2)</sup>	$T_{D \text{ perm.}}$	Nm	395	696	1391	2783
Max. perm. input torque <sup>3)</sup>	shaft end Z (DIN 5480)	$T_{E \text{ perm.}}$	Nm	790 (W40)	1392 (W50)	2782 (W60)
	shaft end P (keyed shaft, DIN 6885)	$T_{E \text{ perm.}}$	Nm	700 (AS12x8x68)	1392 (AS14x9x80)	2300 (AS18x11x100)
						5566 (W80)
						5200 (AS22x14x125)

<sup>1)</sup> efficiency not taken into consideration

<sup>2)</sup> note: max. perm. input torque  $T_{E \text{ perm.}}$  may not be exceeded

<sup>3)</sup> drive shaft without side load

### Code explanations

$T_{D \text{ perm.}}$  = max. permissible through drive torque

$T_{E \text{ perm.}}$  = max. permissible input torque at the drive shaft

$T_1$  = take off torque at 1st pump  $= \frac{1,59 \cdot V_{g1} \cdot \Delta p_1}{100 \cdot \eta_{mh}}$  in Nm

$T_2$  = take off torque at 2nd pump  $= \frac{1,59 \cdot V_{g2} \cdot \Delta p_2}{100 \cdot \eta_{mh}}$  in Nm

$V_{g1}$  = pump displacement per rev. 1st pump in cm<sup>3</sup>

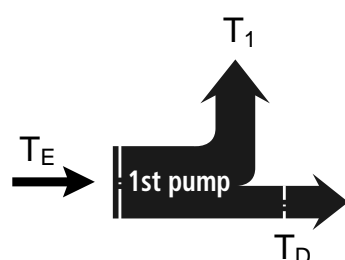
$V_{g2}$  = pump displacement per rev. 2nd pump in cm<sup>3</sup>

$\Delta p_1$  = differential pressure 1st pump in bar

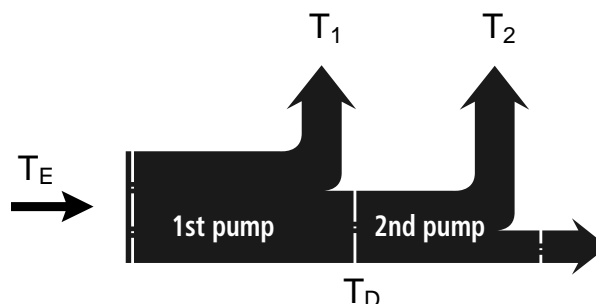
$\Delta p_2$  = differential pressure 2nd pump in bar

$\eta_{mh}$  = mechanical-hydraulic efficiency

### Single pump



### Combination pump



## Installation and Commissioning Guidelines, Sizes 16...40

### General

At start-up and during operation the pump housing has imperatively to be filled up with hydraulic fluid (filling of the case chamber). Start-up has to be carried out at low speed and without load till the system is completely bled.

At a longer standstill the case may discharge via operating line. At new start-up a sufficient filling of the housing has to be granted.

The min. suction pressure at port S should not fall below 0,8 bar absolute.

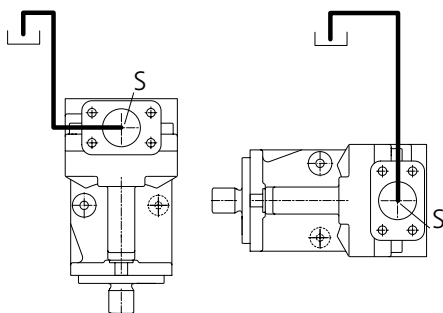
### Installation position

Shaft horizontally resp. to the bottom. When mounting on top of the tank the installation position "shaft horizontally, suction port to the bottom" is not admissible!

### Installation below tank level

Pumps below min. oil level in the tank (standard)

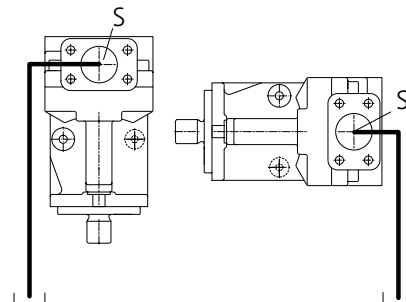
- ➔ Fill up axial piston pump before start-up via highest positioned case drain port
- ➔ Recommendation: Fill up suction lines
- ➔ Operate pump at low speed (ignition speed) till pump system is completely filled up
- ➔ Minimum immersion depth of the suction line or drain line in the tank: 200 mm (relative to the min. oil level in the tank).



### Installation on top of tank level

Pump on top of min. oil level in the tank

- ➔ Actions as installation below tank level
- ➔ Installation positions "shaft to the top" and "shaft horizontally, suction port at bottom" are not admissible (at standstill the pump case is bleeding via suction line).
- ➔ note: - max. perm. suction pipe length  $h_{\max} = 800$  mm  
- min. admissible pressure at port S (min. suction pressure)



## Installation and Commissioning Guidelines, Sizes 71...500

see RE 92050 (A4VSO)

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