Variable displacement axial piston pump type V30D
for open circuit

<table>
<thead>
<tr>
<th>Pressure $p_{\text{max}}$</th>
<th>420 bar (6000 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement $V_{\text{max}}$</td>
<td>260 cm$^3$/rev (16.16 cu in/rev)</td>
</tr>
</tbody>
</table>

1. General description

The axial piston variable displacement pumps of the type V30 of D offer extremely high function safety. Its remarkably low noise levels, the high pressure rating (peak = 420 bar / perm. = 350 bar), the low weight/performance ratio as well as the wide controller range make it possible to employ it for most industrial and mobile applications. The variable displacement pumps work according to the swash plate principal: 9 pistons operate in a rotating cylinder cavities where they fulfill one suction and one pressure stroke per rotation.

Opening and closing of the cylinder cavities is via openings in the control disc. The axial movement of the pistons is provided by an adjustable swash plate. The setting angle (0 - max) can be steplessly varied in proportion to the desired displacement/flow. The setting range can be mechanically limited by setting screws (with V and VH controller only fixed limitation is possible). The position of the swash plate can be controlled via a visual mechanical indicator.

The latest knowledge and experience with regard to noise reduction has been used in the development of this pump design. V30D is therefore rather quiet, even when taken to the limit. All components used in the V30D are manufactured from high grade materials and machined with close tolerances.

The wide range of modular controllers along with a thru-shaft (option for mounting auxiliary pumps or a second V30D) open up a wide range of application possibilities.

Therefore type V30D features a pump design, which ideally suits the special requirements of modern industrial and mobile hydraulic drive systems.

Outstanding design features:

- Low specific weight
- Very fast response times due to low mass moment of inertia of the setting unit
- Special swash plate bearing helps reduce noise
- New design of the hydrostatically balanced steel slipper shoes running on a bronze plate improves the life of typical wearing parts
- Valve plate made from steel provides high wear resistance. Carefully designed dampening slots result in exceptionally low noise level
- Large shaft bearings provide long life

The most important advantages:

- Low noise level, whereby secondary measures to reduce noise often are not necessary
- Controller assemblies have been designed on a modular basis and can be installed without dismantling the basic pump
- Thru-shaft allows tandem pump combinations and mounting of auxiliary pumps of all kinds (see sect. 5)
- Swash plate dial indicator provides visual indication of displacement and can also be used to provide feedback information in control systems
2. Available versions, main data (see also drawings page 4)

**Calculation:**

Unit conversion, see page 12 below

<table>
<thead>
<tr>
<th>Flow rate</th>
<th>Torque</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q = \frac{V_g \cdot n \cdot \eta_v}{1000}$</td>
<td>$M = 1.59 \cdot V_g \cdot \Delta p \cdot 100 \cdot \eta_{tn}$</td>
<td>$P = \frac{2\pi \cdot M \cdot n}{60000} \cdot \frac{M \cdot n}{9549} \cdot \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$</td>
</tr>
</tbody>
</table>

- $V_g =$ Displacement [cm$^3$/rev]  
- $\Delta p =$ Diff. pressure [bar]  
- $n =$ Speed [rpm]  
- $\eta_v =$ Volumetric efficiency  
- $\eta_{tn} =$ Mechanical efficiency  
- $\eta_t =$ Total efficiency ($\eta_t = \eta_v \cdot \eta_{tn}$)

**Order example:**

| Basic type | V30D - 095 R KN - 1 - 1 - XX/LN - 2 - 120 - 200 |

**Table 1: Designation**

<table>
<thead>
<tr>
<th>Coding</th>
<th>045</th>
<th>075</th>
<th>095</th>
<th>115</th>
<th>140</th>
<th>160</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement cm$^3$/rev. (cu. in./rev.)</td>
<td>45 (2.73)</td>
<td>75 (4.58)</td>
<td>96 (5.86)</td>
<td>115 (7.02)</td>
<td>142 (8.66)</td>
<td>164 (9.30)</td>
<td>260 (16.16)</td>
</tr>
<tr>
<td>Flow (theor.) at 1450rpm [lpm] (1800 rpm [gpm])</td>
<td>65 (21.4)</td>
<td>109 (35.7)</td>
<td>139 (45.7)</td>
<td>167 (54.7)</td>
<td>206 (67.6)</td>
<td>238 (77.3)</td>
<td>356 (99.9)</td>
</tr>
<tr>
<td>Max. continuous pressure bar (psi)</td>
<td>350 (5000)</td>
<td>350 (5000)</td>
<td>350 (5000)</td>
<td>250 (3600)</td>
<td>350 (5000)</td>
<td>250 (3600)</td>
<td>350 (5000)</td>
</tr>
<tr>
<td>Max. peak pressure bar (psi)</td>
<td>420 (6000)</td>
<td>420 (6000)</td>
<td>420 (6000)</td>
<td>300 (4300)</td>
<td>420 (6000)</td>
<td>300 (4300)</td>
<td>420 (6000)</td>
</tr>
<tr>
<td>Max. case pressure bar (psi)</td>
<td>1.0 (15)</td>
<td>1.0 (15)</td>
<td>1.0 (15)</td>
<td>1.0 (15)</td>
<td>1.0 (15)</td>
<td>1.0 (15)</td>
<td>1.0 (15)</td>
</tr>
</tbody>
</table>

**Direction of rotation:**

- L = Left hand (facing the drive shaft)
- R = Right hand

**Table 2: Controller**

<table>
<thead>
<tr>
<th>Coding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>The V30D pump with power controller is used in applications with highly varying pressure demands and it is important to protect the electric motor (engine) from overload. The controller limits the hydraulic power (at constant shaft speed) according to the ideal curve “pressure x flow = constant”. The product of pressure and flow cannot exceed the pre-set power value. If, for example, the pressure doubles (at max power) the flow is automatically reduced by 50%.</td>
</tr>
<tr>
<td>LF1</td>
<td>Means that there is a hydraulic displacement limiter included. The displacement can be reduced by a pilot pressure from an outside source.</td>
</tr>
</tbody>
</table>
| LS | Load-Sensing-Controller  
Like coding LS, but with additional pressure limitation |
| LSN | Like coding LS, but with additional pressure limitation |
| N | Pressure controller, adjustable directly at the pump.  
Pressure controller automatically maintains a constant system pressure independent of the required flow. Therefore it is suited for constant pressure systems, where differing flow is required or as efficient pressure limitation of the hydraulic system. |
| P | Remotely adjustable pressure setting; the pressure is set with a pilot relief valve. The pilot relief can be positioned up to 20 m (60 ft) from the pump. |
| Pb | Like coding N, recommended only for systems with tendency to oscillations (accumulator systems). External lines are necessary. |
| Q | The flow compensator maintains a constant flow, with small power losses, in spite of variations in shaft speed and pressure. The flow is determined by the size of the flow restrictor (see the schematic on the right). |
| Qb | This is a special version of the Q compensator above. It has been developed to meet the accuracy and response requirements of hydrostatic transmission for generator drives and similar applications. The flow restrictor should be installed close to the pump in the main high pressure line. Pressure is sensed before and after the flow restrictor and connected to the compensator with two external lines. This provides increased control accuracy. |
| V | The controller V is used to control flow or speed in electronic or computer controlled systems. The V controller consists of a proportional solenoid acting on a servo valve that determines the position of the pump setting piston. The displacement of the pump is proportional to the current through the 24 VDC solenoid (about 250 - 750 mA). In order to minimize valve hysteresis, a pulse width modulated control signal of approx. 80-100 Hz frequency is recommended. |
| VH | The VH is a flow controller. It is similar to the V controller but the control signal is hydraulic. The required signal range is 7...32 bar (215...725 psi). The pump displacement is determined by the control signal (refer to the diagram). Pilot pressure can be supplied either from the system through a pressure reducing valve, or from an auxiliary pump. The pump should provide a pulsating flow of about 100 Hz; gear pump with 7 teeth and 750 rpm is recommended. If the system pressure is below 40...60 bar (580...870 psi) (depending on size) a small auxiliary pump is required to secure proper functioning of the controller. |
**Table 3: Flow pattern**

Variable displacement axial piston pump with controller

<table>
<thead>
<tr>
<th>Coding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L</strong></td>
<td>Orifice U (see also sect. 4.2)</td>
</tr>
<tr>
<td><strong>Lf1</strong></td>
<td>Pilot valve</td>
</tr>
<tr>
<td><strong>LS, LSN</strong></td>
<td>Metering orifice</td>
</tr>
</tbody>
</table>

**Coding N**

<table>
<thead>
<tr>
<th>Coding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P</strong></td>
<td>Pilot valve</td>
</tr>
<tr>
<td><strong>Q</strong></td>
<td>Metering orifice</td>
</tr>
<tr>
<td><strong>Qb</strong></td>
<td>40 ... 60 bar</td>
</tr>
</tbody>
</table>

**Coding Pb**

<table>
<thead>
<tr>
<th>Coding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V</strong></td>
<td>40 ... 60 bar</td>
</tr>
</tbody>
</table>

1) The pressure limiting valve "N" is not available with type LS (version without pressure cut-off)
Illustration controller range
Type V30D - 045 (075; 140; 160)
(For position of controller for pumps type V30D-095 (115), see page 11!)
3. Additional versions

3.1 General

Working principle: Variable displacement axial piston pump acc. to swash plate principle
Installation: Flange or bracket mounting
Direction of rotation: Right hand or left hand
Mounting position: Optional
Pressure fluid: Hydraulic fluid (DIN 51524 table 2 and 3); ISO VG 10 to 68 (DIN 51519)
Viscosity range: min. 10; max. 1000 mm²/s,
optimal operation range: 10...35 mm²/s
Also suitable are biodegradable pressure fluids of the type HEES (synth. Ester) at operation temperatures up to +70°C.

Temperature
Ambient: -40 ... +60°C
Fluid: -25...+80°C, pay attention to the viscosity range!
Start temperature down to -40°C are allowable (Pay attention to the viscosity range during start!), as long as the operation temperature during consequent running is at least 20K (Kelvin) higher.

Filtration
Should conform to ISO standard 4406 coding 18/13.

Start-up
All hydraulic lines should be flushed with appropriate hydraulic fluid before start-up. The pump case should then be tilted through the uppermost drain port. The drain line must be positioned so that the case is always filled during operation. At start-up and during the first few minutes of the operation the pressure relief valve should be adjusted to 50 bar (700 psi) or less.

Designation | 045 | 075 | 095 | 115 | 140 | 160 | 250
---|---|---|---|---|---|---|---
Max. swash plate angle [°] | 17 | 17.5 | 17 | 20 | 17.5 | 20 | 17.5
Min. inlet pressure (absolute), bar | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85
open circuit (psi) | 12 | 12 | 12 | 12 | 12 | 12 | 12
Self-priming speed at max rpm | 2600 | 2400 | 2200 | 2000 | 2200 | 1900 | 1800
swash plate angle and 1 bar (15 psi) absolute inlet pressure
Max. speed rpm (requires increased inlet pressure) | 3600 | 3200 | 2900 | 2800 | 2600 | 2500 | 2000
Min. continuous speed rpm | 500 | 500 | 500 | 500 | 500 | 500 | 500
Torque (theor.) at 1000 psi (lbf ft) | 71 | 119 | 153 | 185 | 226 | 261 | 414
Input power at 250 bar and 1450 rpm (hp) | 30 | 50 | 64 | 77 | 95 | 109 | 174
at 3000 psi and 1800 rpm (hp) | 41 | 68 | 87 | 105 | 129 | 148 | 237
Weight (approx. kg) without controller (approx. lbs) | 40 | 60 | 70 | 70 | 85 | 85 | 130
Weight (approx. kg) with controller (approx. lbs) | 101 | 145 | 168 | 168 | 201 | 201 | 300
Moment of inertia kg m² (ft. lbs. sec²) | 0.0056 | 0.0124 | 0.0216 | 0.0216 | 0.03 | 0.03 | 0.0825
0.0041 | 0.0092 | 0.016 | 0.016 | 0.022 | 0.022 | 0.061
L10 bearing life at 250bar (1450 rpm) (h) or 3600 psi (1800 rpm) and max. displacement | 31000 | 20000 | 17000 | 10000 | 17000 | 10000 | 23000
Max. dynamic torque | | | | | | | |
Spline shaft (D) input Nm (lbf ft) | 550 | 910 | 1200 | 1200 | 1700 | 1700 | 1700 | 3100
| 405 | 670 | 885 | 885 | 1250 | 2285
Spline shaft (D) output Nm (lbf ft) | 275 | 455 | 600 | 600 | 850 | 850 | 1550
| 205 | 333 | 445 | 445 | 625 | 1145
Key shaft (K) input Nm (lbf ft) | 280 | 460 | 650 | 650 | 850 | 850 | 1550
| 205 | 340 | 480 | 480 | 630 | 630 | 1145
Spline shaft (S) input Nm (lbf ft) | 500 | 500 | 1200 | 1200 | 1200 | 1200 | 1200
| 370 | 370 | 885 | 885 | 885 | 885 | 885
Spline shaft (S) output Nm (lbf ft) | 275 | 455 | 600 | 600 | 850 | 850 | 1000
| 205 | 335 | 445 | 445 | 625 | 625 | 740
Noise level at 250 bar and (1450 rpm), or 3600 psi and max. (1800 rpm) displacement (measured in a semi-anechoic room according to ISO 4412 measuring distance 1m) | 72 | 74 | 75 | 75 | 76 | 76 | 77
| 75 | 78 | 79 | 79 | 80 | 80 | 82
1) (theoretical) Drive torque must not be exceeded
2) The max. geometric displacement of 260 cm³/rev can only be achieved up to a self sucking speed of 1600 rpm
3.2 Curves

3.2.1 Flow and Power (basic pump)

The following diagrams show max. delivered flow vs. pressure (without controller).
Required input power at max. swash angle and required input power when the pump is operating at “idling”. Shaft speed: 1450 rpm

Inlet pressure
To avoid cavitation, it is essential to ensure that the pump inlet pressure always exceeds the min pressure shown in the diagram above. The diagram is valid for viscosities up to 75 mm²/s at max. swash plate angle.
3.2.2 Controller-curves

<table>
<thead>
<tr>
<th>Coding</th>
<th>Curves, notes</th>
</tr>
</thead>
</table>

Lowest recommended torque setting:
Valid only for version with power controller without additional combination

<table>
<thead>
<tr>
<th>Coding</th>
<th>Nm (lbf ft)</th>
<th>Power kW/rpm (hp/rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>045</td>
<td>40 (29.5)</td>
<td>6 /1500 (10/1800)</td>
</tr>
<tr>
<td>075</td>
<td>70 (51.6)</td>
<td>11/1500 (18/1800)</td>
</tr>
<tr>
<td>095/115</td>
<td>99 (73.0)</td>
<td>15/1500 (25/1800)</td>
</tr>
<tr>
<td>140/160</td>
<td>146 (107.7)</td>
<td>22/1500 (37/1800)</td>
</tr>
<tr>
<td>250</td>
<td>271 (199.8)</td>
<td>41/1500 (69/1800)</td>
</tr>
</tbody>
</table>

Flow Q (%)

Calculation of flow Q:

\[ Q = \frac{C \cdot A \sqrt{\Delta p}}{60} \text{ (lpm)} \]

- \( A \) = Size of orifice (mm²)
- \( \Delta p \) = Pressure drop = 10 bar (LS = 30 bar)
- \( C = 0.6 \)

Characteristics:
Accuracy with max. flow:

a) Speed “n” constant, pressure varying between 30 and 350 bar, (430 and 3600 psi): (< 3%)
b) Pressure “p” constant, speed varying (< 1%)

Response time

Solenoid current /displacement

Signal pressure/displacement

Solenoid current (mA)

\[ \Delta T = \text{Delay} \]
\[ T_1 = \text{Response time min to max} \]
\[ T_2 = \text{Response time max to min} \]
4. Unit dimensions  All dimensions in mm, (inch) and subject to change without notice!

4.1 Basic pump

**Type V30D - 045** (Drawings shows clockwise rotation, ports A and B are located different with anti clockwise rotation, see foot note 1))

Measuring port
G 1/4

Drain port (D1, D2) Auxiliary pump
G 1/2 conn. G 1/4

Breather G 1/4

Coding K:
Key shaft 10x8x56 DIN 6885

1) Clockwise rotation:
A = Suction SAE 1 1/2" (3000 psi)
B = Pressure SAE 3/4" (6000 psi)

Anti clockwise rotation:
A = Pressure SAE 3/4" (6000 psi)
B = Suction SAE 1 1/2" (3000 psi)

**Type V30D - 075** (Drawings shows clockwise rotation, ports A and B are located different with anti clockwise rotation, see foot note 1))

Measuring port
G 1/4

Drain port (D1, D2) G 3/4

Breather G 1/4

Coding K:
Key shaft 12x8x70 DIN 6885

1) With right-hand rotation:
A = Suction SAE 2" (3000 psi)
B = Pressure SAE 1" (6000 psi)

Anti clockwise rotation:
A = Pressure SAE 1" (6000 psi)
B = Suction SAE 2" (3000 psi)
Type V30D - 095 (115)  (Drawings shows clockwise rotation, ports A and B are located different with anti clockwise rotation, see foot note 1)

- Measuring port G 1/4
- Drain port (D1, D2) G 3/4
- Auxiliary pump conn. G 1/4
- All dimensions in mm, (inch) and subject to change without notice! (G = BSPP)

View X:

View U:

Coding K:
Key shaft 12x8x80
DIN 6885

For support screw M12, min. 19 (0.7) deep

- 1) Clockwise rotation:
  A = Suction SAE 2" (3000 psi)
  B = Pressure SAE 1 1/4" (6000 psi)

- Anti clockwise rotation:
  A = Pressure SAE 1 1/4" (6000 psi)
  B = Suction SAE 2" (3000 psi)

Type V30D - 140 (160)  (Drawings shows clockwise rotation, ports A and B are located different with anti clockwise rotation, see foot note 1))

- Measuring port or auxiliary pump conn. G 1/4
- Drain port (D1, D2) G 3/4
- All dimensions in mm, (inch) and subject to change without notice! (G = BSPP)

View X:

View U:

Coding K:
Key shaft 14x9x80
DIN 6885

For support screw M12, min. 19 (0.7) deep

- 1) Clockwise rotation:
  A = Suction SAE 2 1/2" (3000 psi)
  B = Pressure SAE 1 1/4" (6000 psi)

- Anti clockwise rotation:
  A = Pressure SAE 1 1/4" (6000 psi)
  B = Suction SAE 2 1/2" (3000 psi)
Type V30D - 250

(Drawings shows clockwise rotation, ports A and B are located different with anti clockwise rotation, see foot note 1)

All dimensions in mm, (inch) and subject to change without notice!

(G = BSPP)

4.2 Controller

For missing dimensions, see basic pump sect. 4.1!
Coding N, P, Pb, Q, Qb, LS and LSN

Type V30D - 045
V30D - 075
V30D - 140/160

(G = BSPP)

Basic type | A (mm) | H (mm) | B (mm)
---|---|---|---
045 | 208.19 | 6.19 | 117.46
075 | 224.82 | 6.82 | 117.46
095/115 | 307.12 | 7.28 | 120.48
140/160 | 240.94 | 7.52 | 118.46
250 | 365.14 | 14.4 | 209.82

Orifice U (M6) below controller 1)

Location of orifice U (M6) 1) at type V30D-095/115
(in the pump housing)
at type V30D-250
(in the blanking plate)

1) at version without power controller

Coding V

Coding VH

Basic type | A (mm) | H (mm) | B (mm)
---|---|---|---
045 | 338.13 | 13.31 | 157.61
075 | 371.14 | 14.65 | 171.63
095/115 | 381.15 | 15.00 | 185.72
140/160 | 390.15 | 15.35 | 191.75
250 | 438.17 | 17.24 | 209.82

For missing dimensions, see basic pump sect. 4.1!
5. Tandem pumps

Two variable displacement axial piston pumps can be linked via an intermediate flange. Available are shaft design “D” and “S”.

Same controller range as for individual pumps.

Order example:
V30D - 140 RKN-2-1-XX/LLSN -2/120 - 200 - V30D - 140 RKN-1-1-XX/LLSN -2/120 - 200
(1. pump) (2. pump)
(For type coding key, see sect. 2)

There are additionally several other combination possibilities via the SAE-flange. This enables direct connection of an auxiliary pump (e.g. gear pump).

Order example:
V30D - 140 RSN -2-1-XX/LN - 2 /120 - 200 - SAE-C/4

Combination possibilities and dimensions (dimension b acc. to above illustration)

<table>
<thead>
<tr>
<th>SAE-A</th>
<th>SAE-B/2</th>
<th>SAE-B/4</th>
<th>SAE-C/2</th>
<th>SAE-C/4</th>
<th>SAE-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>V30D - 045</td>
<td>36</td>
<td>62</td>
<td>62</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>V30D - 075</td>
<td>31,5</td>
<td>52</td>
<td>52</td>
<td>83,5</td>
<td>63</td>
</tr>
<tr>
<td>V30D - 095 (115)</td>
<td>24</td>
<td>52</td>
<td>52</td>
<td>83,5</td>
<td>63</td>
</tr>
<tr>
<td>V30D - 140 (160)</td>
<td>30,5</td>
<td>52</td>
<td>52</td>
<td>83,5</td>
<td>63</td>
</tr>
<tr>
<td>V30D - 250</td>
<td>38</td>
<td>52</td>
<td>52</td>
<td>81,5</td>
<td>66</td>
</tr>
</tbody>
</table>

Dimension m 106,4 146 89,8 181 114,5 161,9

n 2xM10 2xM12 4xM12 2xM16 4xM16 4xM16

Flange
SAE-A
SAE-B/2
SAE-C/2

Flange
SAE-B/4
SAE-C/4
SAE-D

Metric conversions:
1 psi = 0.0689 bar
1 cu in = 16.387 cm³
1 lbf ft = 1.3562 Nm
1 US gal = 3.7854 l
1 lb = 0.454 kg
1 in = 25.4 mm
1 ft lns² = 1.3558 kg m²

1) Notes to version with shaft end coding S
The SAE-flanges on the drive side feature thru-holes instead of threads n