HPR-02

REGULATING PUMPS
for open loop
We move the world.

Hydraulic Components + Electronic Components from Linde this means total Vehicle Management through the complete Linde System.

Linde – the pioneer in mobile hydraulics – perfected hydrostatics as the ideal drive system for mobile machinery. Since 1959, Linde has equipped more than two million vehicles in the fields of:

- Construction Equipment
- Agricultural Machinery
- Forestry Equipment
- Municipal Vehicles
- Material Handling

with hydrostatic drives and working systems. The use of these systems in our own fork lift trucks has made Linde the world market leader! Electronics also play an important role in those applications.

Linde products have been leaders in the field of mobile hydraulics for many years. Our customers can rely on our systems expertise and our know-how. Linde engineers are masters of their field – whether it involves better power utilization, the best possible interaction among the total-system components, ease of operation or safety.

Components and systems from Linde are also widely used in industrial applications. Many different uses and applications can be served: woodworking machines, mixers, agitators and centrifuges in process engineering, presses, drilling machines, cable winches, plastic-processing machines, theater engineering, ships’ helms and other marine applications, rotary drums for the cement and sugar industries, material handling systems, amusement park rides, and many others.

Whether it’s closed or open loop systems,

Linde hydraulics is always the right choice.
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1. PUMP DESIGN

Pressure areas

Regulator mechanism

Linear force compensation 100 % hydrostatic
Advanced design of piston/slipper assembly

Response Times

Swashing from maximum displacement \( V_{\text{max}} \) to minimum displacement \( V_{\text{min}} \).
Response times are for swashing from high pressure (HD) to stand-by-pressure.

<table>
<thead>
<tr>
<th></th>
<th>Speed</th>
<th>HD 100 bar</th>
<th>HD 200 bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPR 75-02</td>
<td>2000 rpm</td>
<td>120</td>
<td>70</td>
</tr>
<tr>
<td>HPR 105-02</td>
<td>1500 rpm</td>
<td>120</td>
<td>70</td>
</tr>
<tr>
<td>HPR 135-02</td>
<td>1500 rpm</td>
<td>130</td>
<td>70</td>
</tr>
<tr>
<td>HPR 210-02</td>
<td>1500 rpm</td>
<td>200</td>
<td>70</td>
</tr>
</tbody>
</table>

Swashing from minimum displacement \( V_{\text{min}} \) to maximum displacement \( V_{\text{max}} \).
Response times are for swashing from stand-by-pressure to high pressure (HD).

<table>
<thead>
<tr>
<th></th>
<th>Speed</th>
<th>HD 100 bar</th>
<th>HD 200 bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPR 75-02</td>
<td>2000 rpm</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>HPR 105-02</td>
<td>1500 rpm</td>
<td>450</td>
<td>350</td>
</tr>
<tr>
<td>HPR 135-02</td>
<td>1500 rpm</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>HPR 210-02</td>
<td>1500 rpm</td>
<td>160</td>
<td>130</td>
</tr>
</tbody>
</table>

Response times are in milliseconds (ms), measured at an oil temperature of 60 °C.
The indicated HD-values refer to the respective operating pressure at max. displacement.
2. CHARACTERISTICS, FEATURES, SIZES

Characteristics

- Axial piston, swash-plate pump for open loop circuit application, designed as a regulated capacity pump with variable volume displacement.
- Load-sensing control (flow on demand) for energy-saving operation of the entire system.
- Self-priming up to rated speed, with excellent suction capacity. Speed can be increased by tank pressurisation or reducing the swash angle.
- Optimum interaction with Linde-LSC directional control valves (Closed-Centre, Load-Sensing, directional control valves) and LINTRONIC electronic control unit with associated peripherals, developed by Linde.
- Noise optimisation: significant reduction of structure-borne and fluid noise by means of a silencer (SPU) which considerably diminishes pressure peaks and pulsation levels, the major causes of system noise.
- Compact design, high power density.
- Superior quality due to appropriate design and construction and the latest production methods.
- Optimised for high reliability, long service life, high efficiency.
- Fast response times.
- HPR-02 Pumps can be used in both mobile and stationary applications.

Design Features

- Maximum 21° swash angle
- Clockwise or anti-clockwise rotation possible
- Various load sensing control methods
- Service life increased by supporting the cradle in plain bearings and a new, stable piston/slipper connection. The plain bearings contribute significantly to noise reduction and improved control response of the pump.
- High safety factors and conservative ratings
- Rugged precision regulating mechanisms (mechanical, hydraulic, electrical)
- External venting of decompression fluid for suction side stability
- Single piece housing eliminates leakage and improves rigidity
- Hydrostatic compensation of axial forces generated during operation
- Installation: see Chapter 10, Main Dimensions
- Through Drive (PTO) for fitting further hydraulic pumps
- SAE high-pressure connections (6000 psi)

Sizes

- 55, 75, 105, 135, 210, 2 x 105 cm³/rev Tandem Pumps and Multiple Pump configurations optional
3. TECHNICAL DATA

<table>
<thead>
<tr>
<th>Nominal displacement / Size</th>
<th>55</th>
<th>75</th>
<th>105</th>
<th>135</th>
<th>210</th>
<th>105 D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual displacement</td>
<td>cm³/rev</td>
<td>54,8</td>
<td>75,9</td>
<td>105</td>
<td>135,6</td>
<td>210</td>
</tr>
<tr>
<td>Rated speed, continuous</td>
<td>min⁻¹</td>
<td>2700</td>
<td>2600</td>
<td>2300</td>
<td>2300</td>
<td>2000</td>
</tr>
<tr>
<td>w/o supercharging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with supercharging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. oil flow</td>
<td>l/min</td>
<td>147,9</td>
<td>197,3</td>
<td>241,5</td>
<td>311,9</td>
<td>420</td>
</tr>
<tr>
<td>Max. operating pressure</td>
<td>bar</td>
<td>420</td>
<td>420</td>
<td>420</td>
<td>420</td>
<td>420</td>
</tr>
<tr>
<td>Max. intermittent pressure</td>
<td>bar</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Permissible casing pressure (abs.)</td>
<td>bar</td>
<td>2,5</td>
<td>2,5</td>
<td>2,5</td>
<td>2,5</td>
<td>2,5</td>
</tr>
<tr>
<td>Max. input torque*)</td>
<td>Nm</td>
<td>368</td>
<td>508</td>
<td>702</td>
<td>907</td>
<td>1404</td>
</tr>
<tr>
<td>Shaft load, radial</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Permissible casing temperature</td>
<td>°C</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>39</td>
<td>39</td>
<td>50</td>
<td>65</td>
<td>116</td>
</tr>
<tr>
<td>Max. moment of inertia</td>
<td>kgm²x10⁻²</td>
<td>0,79</td>
<td>0,79</td>
<td>1,44</td>
<td>2,15</td>
<td>4,68</td>
</tr>
<tr>
<td>Main dimensions (see Chapter 10)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*) at max. operating pressure and max. displacement \( V_{\text{max}} \), all values are theoretical

The data on which this brochure is based correspond to the current state of development. We reserve the right to make changes in case of technical progress. The dimensions and technical data of the individual installation drawings are prevailing.
4. LOAD SENSING (LS) TECHNOLOGY

4.1 Basics

The main feature of Load Sensing control is:
Continuous detection of the load pressure in the hydraulic system, with constant adjustment of the pump delivery volume according to the requirements of the moment. This control method is also referred to as "flow on demand control".

This is accomplished as follows:

The load signal (pressure) is measured between an adjustable orifice and the consumer (hydraulic motor or cylinder) (see figure / circuit diagram). The signal activates the LS controller of the pump, which adjusts the pump flow such that the pressure differential ($\Delta p$) across the orifice remains constant at all times. Pump flow $Q$ obeys the equation $Q \sim A \sqrt{\Delta p}$. With a constant $\Delta p$ pressure differential, the pump flow $Q$ is therefore solely dependent on the open cross-sectional area $A$ of the valve: $Q \sim A$. This system relieves the operator of the need to adjust when the load changes since the system compensates automatically to maintain a constant flow regardless of load. For this example, the orifice might be a proportional valve or a fully hydraulic controller with an LS signal connection.

The most striking advantage of a Load Sensing System is the significant energy saving, compared to conventional hydraulic systems.

- Longer pump service life due to lower overall working load
- Fast, accurate control of the pump flow, irrespective of load at any given time
- Less heat generated, so a smaller oil cooler is sufficient
- Overall system noise reduction thanks to lower working pressures

Load Sensing pumps and systems are used very successfully in large numbers of working hydraulic circuits (open loop) e.g.: construction and agricultural machinery, transport vehicles, materials handling, industrial and marine equipment.

Common to all LS applications are the significant energy saving and better utilisation of the prime mover (diesel engine, electric motor) compared to conventional systems.

In addition to reduced environmental impact, in some applications this means that a prime mover (diesel engine, electric motor) of the next rating class down can be used.

The advantages for both equipment manufacturer and operator are obvious.

Further advantages of an LS system:
4.2 LS Pump Performance

This is the most effective pump design in terms of energy utilization. Compared to the power-regulated variable displacement pump, this model represents a further substantial improvement. The additional improvement in energy consumption produced by flow on demand control applies not just to the pump but to the entire system (reduced power consumption, lower heat generation, lower noise level).

Unlike a power-regulated variable displacement pump, a hydraulic pump with an LS regulator can operate at any point below the power hyperbola, i.e. the pump is not “bound” to the power hyperbola. It delivers exactly the flow demanded by the system without producing any excess flow which then has to be dissipated by means of high pressure valves resulting in wasteful heat generation. To ensure this economic operation the LS pump controller constantly measures the load pressure at the LS valves.

The only “loss” arises from maintaining a pressure differential \( \Delta p \) of about 20 bar. This relatively small excess pressure over system pressure makes the pump highly responsive.

An additional power saving is achieved because the pump swashes back towards zero on low stand-by pressure when there is no flow requirement.

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Energy Consumption within a Hydraulic System
5. REGULATOR VERSIONS

5.1 Load Sensing with Electrical Override Control (E1L)

The LS regulator is designed so that external LS pressure signals arriving from the consumer are conducted to a spring chamber, where they act against the pump pressure. The LS regulator spring is preloaded to circa 20 bar (standard setting) and therefore the pressure generated by the pump is above the system pressure by this amount.

The basic design of the HPR-02 hydraulic pump makes it eminently suitable to supplement this regulator concept by adding an electrical override to the LS regulating signal.

A pressure-reducing valve operated by a control solenoid produces a proportional pressure, which acts against the 20 bar spring and thereby reduces its effect. The pump thus receives a modulated Δp LS value and as a result, reduces its flow output.

The control solenoid and the pressure-reducing valve it actuates are integrated in the pump regulator, so that the transmitted signal is direct and instantaneous. The regulator design caters for solenoid voltages of 12 or 24 V from the vehicle electrical systems (in the case of mobile applications) or from an external supply (mostly stationary applications).

The regulator concept described here is an ingenious solution for
- power limit regulation (reduction control) and
- mode switching (mode selection)

The power limit regulator detects speed reductions in the prime mover (e.g. diesel engine), caused by overload. As a result, the pump delivery volume (and consequently the power demanded by the pump) is reduced, and the prime mover then “recovers” so that it is available with full power (speed) for other consumers.

Power limit regulation is made possible by system components from the Linde transmission technology range: the CEB/CED electronic control units and the CEH speed sensor. These components are thoroughly proven and operate in an optimum combination with the HPR-02 hydraulic pump.

Mode switching (mode selection) allows for specific external action to be taken to influence LS regulator behaviour, thus overriding the LS signal. This can be effected proportionately or in steps. By actuating the control solenoid (e.g. from a potentiometer in the cabin), the instantaneous effective Δp LS value can be modulated to a smaller value by the pressure-reduction valve described above so that the pump reduces its delivery volume. In this way, the control range can be “fine-tuned” for precision sensitive work. Signals are processed by the tried and tested Linde CEB/CED electronic controllers.
The relationship between the proportional current (I) to the solenoid and Δp LS is shown in the graph below (Δp LS = f (I)).

The LS regulator spring provides a basic setting range for Linde HPR-02 pumps (test rig setting) of between Δp LS = 16 bar and 30 bar. The standard Linde factory setting is Δp LS = 20 bar.

In principle, the Δp LS acting on the LS pilot can be decreased to a value of 0 bar if required, although in this case it should be noted that at low values of Δp LS, pump system response times can be slower.
5.2 Load Sensing with Power Limiter (TL)

For applications where the input power for a hydraulic system is limited but where optimum use must nevertheless be made of the available power, the power limiter can be used as a regulating device. It limits the mathematical product of flow volume $Q$ (working velocity) and pressure $p$ (force) according to an approximated characteristic curve. When the set value of the adjusted power limiter is reached it reduces the flow volume (i.e., the displacement of the HPR pump), such that product $p \times Q$ corresponds to the set value. The approximated exponential regulator characteristic is implemented by a spring system incorporated in the controller.

If the power consumption of the system remains below the set value of the power limiter the LS regulator alone controls the pump. This enables the pump/valve system to operate at any point below the power characteristic. The overall working range is only limited upwards by reaching the set power, as the power limiter overrides the LS regulator and thereby prevents the prime mover from being overloaded.
5.3 Load Sensing with Pressure Cut-off (LP)

One advantage of hydraulic systems is their simple protection against overloads. Nonetheless, relying on the response of high pressure-relief valves during overload is inefficient because the fluid power dissipated is uncontrolled and generates excessive heat. The fast response of the pressure cut-off valve in an HPR pump means that there are no power losses due to the slow response by pressure relief valves. The pump displacement is limited by the maximum pressure regulator whilst, at the same time, maintaining the operating pressure.

The pump displacement can be reduced to near zero during this operating period, only delivering sufficient flow to make up system leakage in order to maintain the system pressure. The pump can stay at this operating point for considerable periods thus demanding minimal power, which is highly advantageous for the overall energy consumption of the system.

Similar to the situation described under Section 5.2, in this mode the pump is also controlled solely by the LS regulator characteristic. Here as well the pump/valve system can operate at any point below the power hyperbola. The LS regulator is not overridden until the pressure set on the maximum pressure regulator is reached, when the pump is reduced to near zero displacement.
The noise characteristics of a hydraulic pump have become a major quality feature, not least because of increased environmental awareness. Linde have taken account of this and developed an appropriate technical solution.

In principle, every hydraulic system will inevitably develop noise, regardless of which components are coupled together (pumps, motors, valves, orifices, restrictors, piping). These noises are ultimately transmitted to the human ear as airborne noise. This airborne noise is the result mainly of structure-borne noise (caused by the inevitable pressure changes), that in turn is largely fed by fluid noise (caused by the equally inevitable pressure pulsation due to the number of working pistons, the compressibility of the pressure fluid and valve operation). Every hydraulic circuit is inescapably associated with this unwanted noise sequence.

The task of the designer is to minimise noise where it occurs and to check or prevent its propagation as much as possible. Linde designers, together with an experienced research team, have come up with an optimal solution to this problem for the HPR-02 open loop pump.

Noise is now reduced as soon as it occurs. The measures taken are primary measures, which are always more effective than measures introduced subsequently into an existing system (secondary measures). Secondary measures are always time-consuming and costly.

Pressure pulsating is disadvantageous, not only in terms of noise development but also because of the mechanical load on all the components and parts of
the overall hydraulic circuit. The main cause of pressure pulsation is the finite number of working pistons in conjunction with the high pressure produced by the pump, and the pump speed.

The volume flow and pressure pulsations are both significantly reduced by a self-compensating silencer. This results in a major reduction in the fluid and structure-borne noise emitted from the pump and consequently in a considerable reduction of the overall system noise.

The fact that the technical solution realised keeps pulsation at a low level over the entire operating range (pressure, speed, temperature), is highly advantageous and in turn leads to a balanced noise characteristic of the system over the whole operating cycle. However, it should not be forgotten that by far the largest noise component is generated, not by the pump, but by vibration of the mechanical elements of the whole system (sheet metal parts, floors, walls, girders, mountings, etc.).

The solution found to produce a substantial reduction in noise emissions is the Linde SPU Silencer which consists of an optimised arrangement of an additional chamber (silencer chamber) immediately adjacent to the valve (timing) plate and therefore to the prime source.

This new concept of a silencer chamber enables major practical requirements to be met and these are:

- a reduction in volume fluctuations over a wide operating range
- a reduction in pressure pulsation over a wide operating range
- no decrease in efficiency
- simple, maintenance-free design
- acceptable weight and volume increases
- self-compensating, so no adjustment necessary

Figure (page 14) shows a comparison of the pressure pulsation as a function of high pressure and speed in a standard unit and in a unit optimised with a silencer. The reduction in pressure pulsating, resulting directly in a marked reduction in noise is clear.

Figure (page 15) shows a comparison of the noise level of a standard unit and of a unit optimised with a silencer as a function of the prime mover (e.g. diesel engine) speed. The significantly reduced noise level of the SPU variable capacity pump is striking. Not only does the noise reduction apply over the entire speed range both inside and outside the cabin, but also the peaks are smoother than those occurring with the standard unit.

Benefit for Operator

<table>
<thead>
<tr>
<th></th>
<th>cabin noise</th>
<th>outside noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>noise level in 2 dB(A) steps</td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
</tr>
<tr>
<td>conventional</td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
</tr>
<tr>
<td>with SPU</td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
</tr>
<tr>
<td>diesel speed (typical operation range)</td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
<td><img src="image" alt="Graph of noise level comparison" /></td>
</tr>
</tbody>
</table>
7. DOUBLE AND MULTIPLE PUMPS

Double and multiple pumps consist of single units arranged in series.

The swash plate design is highly advantageous for this.

Multiple Pump: HPR regulated pump coupled to an HPV variable displacement pump
Double Pump: 2 equal-sized pump bodies arranged back-to-back, 1 common suction manifold, 2 pressure manifolds
Option: 1-circuit pump or 2-circuit pump

Multiple Pump with SAE3 bell housing
HPR 135-02 LP + HPV 105-02 E1 + MPR 45 LP + double gear pump
Multiple pumps may consist of only open circuit pumps or only closed circuit pumps but it is also possible to combine both types and the order of their assembly (i.e. 1st pump/2nd pump + further pumps) is, in essence, completely free. Similarly, their orientation to each other (e.g. respective positions of controls, regulators and/or pressure and suction ports) is flexible and determined only by installation limitations. The critical factor ruling the order of the individual units is primarily the admissible shaft torque that can be transmitted from one to the other. The timing of their respective work cycles is predominant when considering this.

Knowledge of each pump’s load cycle is, therefore, the key to the unit assembly order and thus ensuring reliable and trouble-free operation.

The Tandem Pump is, by definition, a special multiple pump usually comprising two equal size units of the same type and orientation of controls/regulators and porting.

Otherwise, the individual units in a Multiple Pump assembly may be of differing sizes, types and orientations.

Possible Combinations

<table>
<thead>
<tr>
<th>Rated size of the rear pump</th>
<th>55</th>
<th>75</th>
<th>105</th>
<th>135</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>105</td>
<td></td>
<td></td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>135</td>
<td></td>
<td></td>
<td></td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>210</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>yes</td>
</tr>
</tbody>
</table>

Transmittable Shaft Torques

<table>
<thead>
<tr>
<th>Max. transmittable torque</th>
<th>Nominal size of the front pump</th>
<th>55</th>
<th>75</th>
<th>105</th>
<th>135</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>at A</td>
<td>[Nm]</td>
<td>570</td>
<td>790</td>
<td>1090</td>
<td>1410</td>
<td>2174</td>
</tr>
<tr>
<td>at B</td>
<td>with rear pump nominal size 55 [Nm]</td>
<td>350</td>
<td>485</td>
<td>570</td>
<td>570</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>with rear pump nominal size 75 [Nm]</td>
<td></td>
<td>485</td>
<td>670</td>
<td>790</td>
<td>485</td>
</tr>
<tr>
<td></td>
<td>with rear pump nominal size 105 [Nm]</td>
<td></td>
<td></td>
<td>670</td>
<td>870</td>
<td>670</td>
</tr>
<tr>
<td></td>
<td>with rear pump nominal size 135 [Nm]</td>
<td></td>
<td></td>
<td></td>
<td>870</td>
<td>870</td>
</tr>
<tr>
<td></td>
<td>with rear pump nominal size 210 [Nm]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1338</td>
</tr>
</tbody>
</table>
| at C                      | (at the PTO) [Nm]               |     |     |     |     |     | see the Table in Chapter 8
8. POWER TAKE-OFF (PTO)

Technical description

Ancillary drives, e.g. for further working pumps, drive pumps, cooling pumps, power steering pumps or servo pumps, can be connected via the spline on the end of the pump through-drive shaft.

The Power Take-Off (PTO) can be fitted with an SAE A-, B-, B-B- or C- flange, as required. The SAE A connection has no intermediate flange and the coupling sleeve is lining up with the HPR shaft end. SAE B, B-B and C connections use an intermediate flange together with a coupling sleeve.

Transfer Torque at the HPR through-shaft end

<table>
<thead>
<tr>
<th>Nominal size</th>
<th>55</th>
<th>75</th>
<th>105</th>
<th>135</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>220</td>
<td>305</td>
<td>420</td>
<td>540</td>
<td>836</td>
</tr>
<tr>
<td>Max.</td>
<td>350</td>
<td>485</td>
<td>670</td>
<td>870</td>
<td>1338</td>
</tr>
</tbody>
</table>

For exact dimensions, please, refer to respective Installation Drawing (EBZ)
9. PRESSURE FLUIDS AND FILTRATION

Permitted Pressure Fluids

- Mineral oil HLP to DIN 51524
- Biodegradeable fluids upon request
- Other pressure fluids upon request

Technical Data

<table>
<thead>
<tr>
<th>Working Viscosity Range</th>
<th>[mm²/s] = [cSt]</th>
<th>10 to 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum Working Viscosity</td>
<td>[mm²/s] = [cSt]</td>
<td>15 to 30</td>
</tr>
<tr>
<td>Max. Viscosity (short time start up)</td>
<td>[mm²/s] = [cSt]</td>
<td>1000</td>
</tr>
</tbody>
</table>

The hydraulic components and parts are designed for a temperature range of -20 °C to max. +90 °C.

Viscosity Recommendations

<table>
<thead>
<tr>
<th>Working temperature [°C]</th>
<th>Viscosity class [mm²/s] = [cSt] at 40 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>ca. 30 to 40</td>
<td>22</td>
</tr>
<tr>
<td>ca. 60 to 80</td>
<td>46 or 68</td>
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</table>

Linde recommend using only pressure fluids which are confirmed by the producer as suitable for use in high pressure hydraulic installations. For the correct choice of suitable pressure fluid it is necessary to know the working temperature in the hydraulic circuit. The pressure fluid chosen must allow the working viscosity to be within the optimum viscosity range (refer to above table).

Attention!
Due to pressure and speed influences the leakage fluid temperature is always higher than the circuit temperature. The temperature must not exceed 90 °C in any part of the system. Under special circumstances, if the stated conditions cannot be observed then please consult Linde.

Filtration

In order to guarantee proper functions and efficiency of the hydraulic pumps the purity of the pressure fluid over the entire operating period, must comply to at least class 18/13 according to ISO 4406. With modern filtration technology, however, much better values can be achieved which contributes significantly to extending the life and durability of the hydraulic pumps and complete system.
# 10. MAIN DIMENSIONS

<table>
<thead>
<tr>
<th>Size</th>
<th>55</th>
<th>75</th>
<th>105</th>
<th>135</th>
<th>210</th>
<th>2x105</th>
<th>2x105</th>
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<tbody>
<tr>
<td>Mounting Flange F</td>
<td>SAE C</td>
<td>SAE D</td>
<td>SAE E</td>
<td>plug-in</td>
<td>SAE 3</td>
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<tr>
<td>Fixing</td>
<td>2-hole</td>
<td>4-hole*</td>
<td>-</td>
<td>bell</td>
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<tr>
<td>Shaft Profile W</td>
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<td>ANSI B92.1</td>
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<tr>
<td>Spline pitch</td>
<td>12/24</td>
<td>16/32</td>
<td>8/16</td>
<td>16/32</td>
<td>16/32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teeth</td>
<td>14</td>
<td>23</td>
<td>27</td>
<td>15</td>
<td>23</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>D1 [mm]</td>
<td>127</td>
<td>152,4</td>
<td>165,1</td>
<td>216</td>
<td>409,6</td>
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<td></td>
</tr>
<tr>
<td>D2 [mm]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>428,6</td>
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<td></td>
</tr>
<tr>
<td>D3 [mm]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>456</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1 [mm]</td>
<td>181</td>
<td>229</td>
<td>225 □</td>
<td>124</td>
<td>124</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2 [mm]</td>
<td>208</td>
<td>256</td>
<td>269 □</td>
<td>120</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3 [mm]</td>
<td>176</td>
<td>173</td>
<td>174</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4 [mm] (SPU)</td>
<td>215</td>
<td>222</td>
<td>236</td>
<td>262</td>
<td>222</td>
<td>222</td>
<td></td>
</tr>
<tr>
<td>B5 [mm] (T)</td>
<td>21</td>
<td>25</td>
<td>40</td>
<td>57</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>B6 [mm] (P)</td>
<td>91</td>
<td>100</td>
<td>107</td>
<td>145</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>H1 [mm]</td>
<td>94</td>
<td>104</td>
<td>120</td>
<td>145</td>
<td>141</td>
<td>141</td>
<td>141</td>
</tr>
<tr>
<td>H2 [mm]</td>
<td>93</td>
<td>106</td>
<td>100</td>
<td>135</td>
<td>141</td>
<td>141</td>
<td>141</td>
</tr>
<tr>
<td>H3 [mm]</td>
<td>145</td>
<td>148</td>
<td>155</td>
<td>178</td>
<td>144</td>
<td>144</td>
<td>144</td>
</tr>
<tr>
<td>H4 [mm] (SPU)</td>
<td>147</td>
<td>137</td>
<td>146</td>
<td>145</td>
<td>137</td>
<td>137</td>
<td></td>
</tr>
<tr>
<td>H5 [mm] (P)</td>
<td>24</td>
<td>26</td>
<td>30</td>
<td>27</td>
<td>75</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>H6 [mm]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>38</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>H7 [mm]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>196</td>
<td>196</td>
<td></td>
</tr>
<tr>
<td>L1 [mm]</td>
<td>232</td>
<td>262</td>
<td>285</td>
<td>346</td>
<td>358</td>
<td>450</td>
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</tr>
<tr>
<td>L2 [mm]</td>
<td>250</td>
<td>280</td>
<td>303</td>
<td>370</td>
<td>376</td>
<td>468</td>
<td></td>
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<tr>
<td>L3 [mm]</td>
<td>55</td>
<td>75</td>
<td>171</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>L4 [mm] (SPU)</td>
<td>192</td>
<td>215</td>
<td>236</td>
<td>278</td>
<td>116</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>L5 [mm] (P)</td>
<td>194</td>
<td>218</td>
<td>244</td>
<td>293</td>
<td>116</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>L6 [mm] (T)</td>
<td>201</td>
<td>227</td>
<td>250</td>
<td>296</td>
<td>116</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>P (SAE) pressure port</td>
<td>3/4&quot;</td>
<td>1&quot;</td>
<td>1 1/4&quot;</td>
<td>1 1/2&quot;</td>
<td>2 x 1&quot;</td>
<td>2 x 1&quot;</td>
<td></td>
</tr>
<tr>
<td>T (SAE) suction port</td>
<td>1 1/2&quot;</td>
<td>2&quot;</td>
<td>2&quot;</td>
<td>3</td>
<td>1 x 3&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*HPR 210-02 with square 4-hole-mounting-flange (not shown in schematics of page 21)
Single Pump HPR-02 E1L, SPU

Double Pump HPR-105 D-02 E1L, SPU
plug-in version (without bell housing)

Double Pump HPR-105 D-02 E1L, SPU
with SAE 3 bell housing
MODEL CODE FOR HPR -02 SERIES OPEN LOOP PUMPS

**FRAME SIZE**

<table>
<thead>
<tr>
<th>FRAME SIZE</th>
<th>25</th>
<th>75</th>
<th>105</th>
<th>105E</th>
<th>120</th>
<th>210</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **1** **DISPLACEMENT**
  - 055 - 54.8 cc/r (3.35 cir)
  - 075 - 75.9 cc/r (4.63 cir)
  - 105 - 105 cc/r (6.41 cir)
  - 105D - 105(x2) cc/r (12.81 cir)
  - 135 - 135.6 cc/r (8.27 cir)
  - 210 - 210 cc/r (12.81 cir)

- **2** **SPU**
  - S - SPU
  - X - Without

- **3** **ROTATION**
  - R - Right (CW)
  - L - Left (CCW)

- **4** **PORTING**
  - D - Straight metric thread. DIN 3852
  - I - Metric straight thread w/o-ring boss, ISO 6149 (standard)
  - U - SAE, UNF thread w/o-ring boss, SAE J514/J1926

All ports, excluding "P" (Discharge) and "S" (Studport). "P" port is SAE code 62. "S" port is SAE code 61. Both w/metric threads (ISO 6162)

- **5** **CONTROL TYPE**
  - LP - Load Sense w/P Pressure Compensation
  - E1L - Load Sense w/P Power Mode Valve (Must specify pos. 6 and 7)
  - TL - Load Sense w/P Power Limiter (Specify HP and Speed setting in pos. 16)
  - LO - Load Sense Only (Pressure compensator canceled)
  - PO - Pressure Compensation Only (Load Sense canceled)
  - X - Special (Specify in pos. 16)

Must specify voltage w/E1L control

- **6** **VOLTAGE**
  - 1 - 12Vdc (E1L control only.)
  - 2 - 24Vdc (E1L control only.)
  - 3 - No Solenoid. (Blanked off for remote control. E1L control only.)
  - X - Not Applicable

Must specify connector w/E1L control

- **7** **CONNECTOR TYPE**
  - A - AMP Junior-Timer (Only for E1L control)
  - H - Hirschmann (Only for E1L control)
  - X - Not Applicable

- **8** **MOUNTING**
  - C - SAE C, 2-Bolt
  - D - SAE D, 2-Bolt
  - E - SAE D, 4-Bolt
  - P - Plug-In
  - 2 - SAE #2 Engine Mount
  - 3 - SAE #3 Engine Mount
  - 4 - SAE #4 Engine Mount

**Legend**

- = Standard
- = Option
- = Special, Consult Factory
- = Not Available
* = With Restriction(s)
**MODEL CODE FOR HPR -02 SERIES OPEN LOOP PUMPS**

### 16 SPECIALS
- **X - None**
- **S -** Call out requirement in clear text or use specified code from factory.

### 15 SERIES
- **2 - Assigned at Factory**

### 14 PTO COUPLING
- **X - No Coupling**
- **A - SAE A, 9T, 16/32dP**
- **B - SAE B, 13T, 16/32dP**
- **J - SAE B, 15T, 16/32dP**
- **C - SAE C, 14T, 12/24dP**
- **D - SAE D, 13T, 8/16dP**
- **F - SAE F, 15T, 8/16dP**
- **S - Special (Specify in pos. 16)**

### 13 PTO MOUNT
- **A - SAE A, 2-Bolt Mount**
- **B - SAE B, 2-Bolt Mount**
- **C - SAE C, 2-Bolt Mount**
- **D - SAE D, 2-Bolt**
- **E - SAE E, 4-Bolt**

### 12 MIN DISPLACEMENT
- **X - Zero minimum displacement.**
- **- - - - Specify setting in cc/rev.**

### 11 MAX DISPLACEMENT
- **X - Standard unit setting.**
- **- - - - Specify setting in cc/rev.**

### 10 COMPENSATOR (PCO)
Specify spring range and setting in BAR.
- **K - - - 82 to <125 bar**
- **L - - - 125 to <230 bar**
- **M - - - 230 to <350 bar**
- **N - - - 350 to 420 bar**
- **X - Not using pressure compensated control.**

### 9 SHAFT
- **C - SAE C, 14T, 12/24dP**
- **G - SAE C-C, 17T, 12/24dP**
- **D - SAE D, 13T, 8/16dP**
- **F - SAE F, 15T, 8/16dP**
- **H - ANSI 21T, 16/32dP**
- **23T, 16/32dP**
- **27T, 16/32dP**
Here is how to reach us

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Direct route to Linde Hydraulics and Electronics
You can reach us by:

• Telephone  330-533-6801 (switchboard)

• Fax  330-533-8383

• E-mail  info@lindeamerica.com

• Internet  http://www.lindeamerica.com

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