

Oil recommendations

Product documentation



Hydraulic fluids, viscosity classes and application



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1 Selection of the hydraulic fluid

The performance of a hydraulic system depends to a large extent on the quality of the hydraulic fluid used.

The hydraulic fluid should essentially be selected according to the operating conditions, such as

- Temperature (see viscosity classes)
- Nomenclature (possible ban on certain hydraulic fluids due to undesired reactions with metals, seals, etc.)
- Usage type (e.g. environmentally compatible hydraulic fluids)
- Surroundings (use of existing hydraulic fluids)

Overview of temperature and viscosity

Temperature range:	Surrounding area: -40 to +80°C Exception: air-powered pumps type LP (+5 to +80°C) Hydraulic fluid: -25...+80°C Please observe viscosity range and any additional restrictions.
Start temperature:	Down to -40°C permissible Observe start viscosities as long as the steady-state temperature is at least 20K higher for subsequent operation! Biologically degradable or fire inhibiting pressure fluids generally not over max. +60...+70°C.
Viscosity range:	Min. approx. 4 mm ² /s, Max. approx. 1500 mm ² /s Optimal operating range approx. 10...500 mm ² /s

2 Mineral oils

Mineral oils

Hydraulic fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> Hydraulic oils HLP (DIN 51524-2) 	Mineral oil with additives improving corrosion, oxidation and wear protection	Common hydraulic fluid
<ul style="list-style-type: none"> Hydraulic oils HL (DIN 51524-1) 	Mineral oil without wear protecting additives	<p>Not suitable for any types of gear pump due to the lack of wear protection additives.</p> <ul style="list-style-type: none"> No pumps and power packs with gear pumps type RZ, Z No compact hydraulic power packs HC, KA, MP, MPN, HK, HKL
<ul style="list-style-type: none"> Hydraulic oils HVLP (DIN 51524-3) 	Mineral oil with same additives as HLP, but with increased viscosity index for use in higher temperature ranges	<p>The viscosity index correctors have a negative effect on the shear strength (viscosity loss approx. 30% when loaded), demulsifying behaviour and air release characteristics, for example.</p> <p>Only use if required due to temperature range. Oil manufacturer must be consulted!</p>
<ul style="list-style-type: none"> Unalloyed oils H, e.g. <ul style="list-style-type: none"> - Lubricating oils (DIN 51524-1) - White oils (e.g. NSF H1) 	Mineral oil without additives	Due to lack of additives only suitable for systems in the standby mode (S2 or S3 mode) (low lubricity). White oils are mostly used in systems with possible contact with foodstuffs.
<ul style="list-style-type: none"> Hydraulic oils PAO (tested for compliance with DIN 51524-1 and DIN 51524-2) 	mineral oil-free synthetic oil with additives improving corrosion, oxidation and wear protection	See information on hydraulic oils HVLP
<ul style="list-style-type: none"> Special fluids in the aviation sector (MIL H-5606) in the marine sector (NATO H 540) 	Mineral oils are based as a rule on naphthenic oil with wide temperature range	Seals made of fluor rubber FPM might be required, depending on hydraulic fluid. Consult the oil manufacturer!
<ul style="list-style-type: none"> Other mineral oils <ul style="list-style-type: none"> Engine oils HD ATF automatic transmission fluid (AQ A, suffix A) Diesel Test oil for diesel injection pump test 	Mineral oils which basically were developed for other application purposes	<p>More or less suitable hydraulic fluids. Pay attention to the presence of oxidation and corrosion protection as well as material compatibility (above all in relation to the seals).</p> <p>Attention: increased leakage with directional spool valves. Oil manufacturer must be consulted!</p>

3 Environmentally compatible hydraulic fluids

Environmentally compatible hydraulic fluids ISO 15380

Hydraulic fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> Seed oil type HETG 	Fluids based on seed oils e.g. rape or sunflower with additives show only low temperature resistance (< 60...70°C)	Not suitable for compact power packs type HC, KA, MP, MPN, HK, HKL, all valves with wet armature solenoids as well as control systems utilizing many throttles. HETG fluid show a tendency to gum, ageing, and sticking at higher temperatures (> 60...70°C). Their use should be avoided!
<ul style="list-style-type: none"> Polyethyleneglycol HEPG PEG-Polyethylene (may be solved in water) PPG-Polypropylene (can't be solved in water) 	Fluids based on polyethylene glycol (PEG) Properties similar to mineral oil with regard to lifetime, lubricity and pressure resistance	<p>No restrictions with regard to the operation behavior, but it</p> <ul style="list-style-type: none"> Is harmful to standard enamel (does not apply to two-pot enamel) Will clog cellulose filters (use only glass fiber or metallic filters)! Shows bad lubrication characteristic with material pairings steel / light alloy or brass No pumps and power packs with gear pumps type RZ and Z Do not use compact hydraulic power packs type HC, KA, MP, MPN, HK, HKL No connection blocks with return line filter type A.F., AF, BF, EF, FF
<ul style="list-style-type: none"> Synthetical ester HEES (carbon acid ester, diester, polyester) 	Similar qualities i.e. lifetime, lubricating characteristics and pressure resistance, like mineral oil	No restrictions with regard to the operation behavior. Contact with PVC should be avoided.

4 Flame-resistant hydraulic fluids

Flame-resistant hydraulic fluids ISO 12922

Hydraulic fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> HFA (pressurized water, emulsions) 	Oil in water emulsion, (water content > 80%) max. temp. range approx. 60°C	<p>There is the danger of corrosion and cavitation due to the high water content, only use devices specially constructed for this purpose (radial piston pumps type R, directional seated valves type G) Max. pump pressure 50...60% (danger of cavitation) minimum content of mineral oil > 4%</p> <ul style="list-style-type: none"> Do not use compact hydraulic power packs HC, KA, MP, MPN, HK, HKL – risk of short circuit No paper filters – risk of blockage No connection blocks with return line filter type A.F., AF, BF, EF, FF
<ul style="list-style-type: none"> HFC 	Diluted (poly) glycol solution (water content > 35%) max. temp. range up to approx. 60°C	<p>No restrictions with regard to the operation behavior, but it</p> <ul style="list-style-type: none"> Incompatible with zinc No paper filters – risk of blockage No connection blocks with return line filter type A.F., AF, BF, EF, FF Will clog cellulose filters (use only glass fiber or metallic filters)! Shows bad lubrication characteristic with material pairings steel/light alloy or brass No compact hydraulic power packs HC, KA, MP, MPN, HK, HKL
<ul style="list-style-type: none"> HFD HFDR phosphoric ester HFDU polyolester 	Fluids without water content, properties similar to mineral oil	<p>Normal operation possible Restrictions:</p> <ul style="list-style-type: none"> Requires seals out of FPM (FKM) (see also section "Seals") Oil manufacturer must be consulted!

5 Special fluids

Special fluids

Hydraulic fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> AT-Brake fluid 	Brake fluid based on glycol (DOT 4)	<p>No restrictions with regard to the operation behaviour, but devices must be equipped with EPDM or SBR seals (see "Seals" section) No compact hydraulic power packs type HC, KA, MP, MPN, HK, HKL</p>

6 Viscosity class

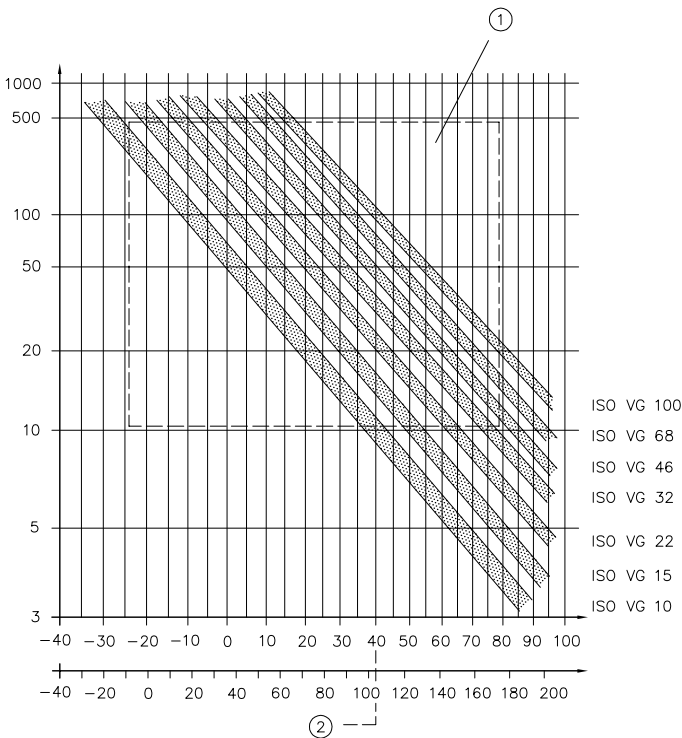
Viscosity grade selection

From the 18 viscosity classes (ISO VG) listed in the standard "ISO viscosity classification for liquid lubricants" (DIN ISO 3448), the ranges ISO VG10 to ISO VG68 are relevant for hydraulic systems. The number after "ISO VG" corresponds to the nominal viscosity at a reference temperature of 40°C. The temperature behaviour displayed in the diagram corresponds to that of mineral hydraulic oils. The characteristic curve increase of HVLP and the environmentally compatible hydraulic fluids is flatter, indicating that the temperature effect is lower.

Due to manufacturer-related differences, the following benchmark figures are to be clarified and compared with the permissible viscosity ranges:

- Viscosity at 40°C
- Viscosity at the lowest (estimated or demanded) temperature
- Viscosity at the highest (presumed, required) temperature
(to guarantee a good seal life $\leq 80^\circ\text{C}$!)

Temperature / viscosity curve



- 1 Optimum range
- 2 Reference temperature
DIN ISO 3448

Guide lines for selection

- VG10, VG15
Systems intended for short time operation or use in the open or for clamping devices.
Systems intended for continuous operation
(for use in the open, operation in winter only)
- VG22, VG32
General use
(when used outside, only summer operation)
- VG46, VG68
Systems in closed rooms at
ambient temperatures up to 40°C or tropical conditions

7 Purity and filtering of the hydraulic fluid

Purity of the hydraulic fluid and correct filtering

Fine contamination (e.g. debris and dust) or contamination in the macro range (e.g. wear debris, rubber particles from hoses and seals) may significantly impair the function of a hydraulic system.

Maintain the following hydraulic fluid purities (assuming a thorough flushing has taken place prior to the date of commissioning):

Recommended purity of the hydraulic fluid	Recommended filter fineness	Devices	Note
ISO 4406			
21/18/15...19/17/13	$\beta_{16...25} \geq 75$	Radial piston and gear pumps, valves, cylinders (use in general mechanical engineering)	The purity degree of the hydraulic fluid is especially important for the repeatability accuracy with proportional valves.
20/17/14...18/15/12	$\beta_{6...16} \geq 75$	Prop. pressure and flow control valves	It should be noted that new hydraulic fluid "from the barrel" does not necessarily fulfil the highest cleanliness requirements.
19/17/14	$\beta_{6...16} \geq 75$	Variable displacement axial piston pumps	

Lower limits must be applied for pressure above 250 bar

8 Service life

Service life of the hydraulic fluid

The aging of hydraulic fluids is caused by shearing processes, cracking induced by high temperatures (gumming), mixing with (condensed) water or reaction with other materials (e.g. metal) in the system (sludging). A major factor for the service life of the fluid is beside the anti-shear additives of the fluid the lay-out of the system e.g. tank size, operation temperature, number and design of throttling sections.

Besides the properties of the hydraulic fluid itself (e.g. due to additives for high shear stability), the design of the hydraulic control system (e.g. tank size, steady-state temperature, number and type of throttling points) has a major influence on this.

The following points are to be noted:

- Service temperature in the tank < 80°C (mineral oils, hydraulic fluids with low water content) Avoid higher temperatures – Service life reduction – (+10K corresponds to half service life)

- Rotational conditions of hydraulic fluid $\frac{Q_{pump}[lpm]}{V_{system}[l]}$ (Reference values)

- Approx. 0.2...0.4/min for conventional hydraulic power packs
- Approx. ...1/min in mobile hydraulics
- Approx. ...4/min for compact hydraulic power packs in standby or load/no load operation
- Control of the hydraulic fluid on a regular base (fluid level, contamination, coloring index, neutralization value etc.)
- Change of the hydraulic fluid on a regular base (depending on fluid type and application conditions)

Guideline:

- approx. 4000 ... 8000 h (mineral oil)
- approx. 2000 h (other hydraulic fluids)
- or at least annually

Take into account notes of the fluid manufacturer!

9 Changing the hydraulic fluid

Changing the hydraulic fluid

Do not mix different types of hydraulic fluids! This may lead to undesirable chemical reactions causing sludge, resinification etc.

The relevant manufacturers should be consulted when switching between different hydraulic fluids. In all cases, the whole hydraulic system should be thoroughly flushed.

10 Seals

Interaction with seals

Any question about the compatibility with seal material should be settled with the fluid manufacturer always before using a certain hydraulic fluid (except mineral oil and synthetic esters). A rough overview is given in the table at the start of this section. HAWE utilizes seals made of the following materials as standard:

- NBR (acrylonitrile rubber, e.g. Bunan, Perbunan) or HNBR (hydrated NBR).

Some devices are available on request with seals made of:

- FPM (also FKM, fluor rubber) e.g. for fluids type HFD
 - The coding ...-PYD should be added to the coding for HAWE devices, e.g. WN1H-G24-PYD
- EPDM (ethylen propylen rubber) or SBR (styrene-butadiene rubber)
 - The coding ...-AT should be added to the coding for HAWE devices, e.g. WN1H-G24-AT (for brake fluid)

Note

- For the seal specification coding -PYD and -AT, the maximum operating pressure is limited to 250 bar.
- This limitation conditionally applies to other values specified in the relevant product documentation.

11 Storing hydraulic fluids and hydraulic components

Storing hydraulic fluids and hydraulic components

Storage conditions for hydraulic components depend primarily on the following factors:

- seals utilised, moistening with oil during the factory functional test

The storability of rubber materials is generally influenced by the following factors:

- Warmth, light, humidity, oxygen, ozone

As far as possible, components should be de-energised and without deformation when stored. A storage temperature range of 15 to 20°C is optimum. Relative humidity approx. 65% (+-10%). Exposure to direct sunlight or a light source with strong UV rays should be avoided.

Ozone-producing equipment (electric motors, high-voltage equipment) among other things must not be present in the storage room.

If seals are packaged in plastic bags, these should not contain any plasticisers and, if necessary, should be impermeable to UV light.

Details on storage of elastomers are also available in the following standards:

DIN 7716, MIL-HDBK-695, SAE ARP5316D, SAE AS 1933, DIN 9088.

Hydraulic fluids can be stored for an unlimited period in sealed containers supplied by the manufacturer, as no chemical reactions take place. The presence of atmospheric oxygen, dust and moisture can lead to more or less rapid oxidation and resinification, depending on the type of oil and its additives.

A dark room with virtually constant temperature and humidity is recommended for storage of hydraulic components. The parts should be kept in a plastic bag to protect them from dust and continuous air exchange.

A functional test (manual override, dry switching) should be carried out at least once a year to ensure operation.

Safety-related components: A six-monthly functional test on site and a regular factory inspection including seal replacement every 2 years.

When the hydraulic components are stored as described above, the risk of corrosion is low. Most external parts of HAWE components are coated with a protective layer (galvanised, nitrided) and moistened with oil.

12 Manufacturers' addresses (selection)

Company	Address	
Agip Schmiertechnik GmbH Deutschland	Paradiesstrasse 14 D-97080 Würzburg	Telephone +49 / (0) 931 / 90098-0 Fax +49 / (0) 931 / 98442
Aral AG Geschäftsbereich Schmierstoffe	Überseeallee 1 D-20457 Hamburg	Telephone +49 / (0) 40 / 3594-01 E-mail inboundaral@bp.com
BP Europa SE Castrol Industrial	Erekelenzer Straße 20 D-41179 Mönchengladbach	Telephone +49 / (0) 2261 / 909-30
Esso AG	Kapstadtring 2 D-22297 Hamburg	Telephone +49 / (0) 40 / 63930 Fax +49 / (0) 40 / 63933368
Fragol Industrieschmierstoffe GmbH	Reichspräsidentenstr. 21-25 D-45470 Mülheim	Telephone +49 / (0) 208 / 300020 Fax +49 / (0) 208 / 3000246
Fuchs Mineraloelwerke GmbH	Friesenheimer Straße 15 D-68169 Mannheim	Telephone +49 / (0) 621 / 3701-0 Fax +49 / (0) 621 / 3701-570
Liqui Moly GmbH	Jerg-Wieland-Str. 4 D-89081 Ulm	Telephone +49 / (0) 731 / 1420-0 Fax +49 / (0) 731 / 1420-71
Mobil Oil AG	Kapstadtring 2 D-22297 Hamburg	Telephone +49 / (0) 40 / 63930 Fax +49 / (0) 40 / 63933368
Shell Deutschland Schmierstoffe GmbH	Suhrenkamp 71-77 D-22284 Hamburg	Telephone +49 / (0) 01805 6324 00 Fax +49 / (0) 0800 6324 000 E-mail Schmierstoffe-DE@shell.de
Panolin AG	Bläsimühle CH-8322 Madetswil	Telephone +41 / (0) 44 / 95665-65 Fax +41 / (0) 44 / 95665-75
Klüber Lubrication Deutschland KG	Geisenhausenerstrasse 7 D-81379 München	Telephone +49 / (0) 89 / 7876-403 Fax +49 / (0) 89 / 7876-333

Further information

HAWE Hydraulik SE is a responsible development partner with application expertise and experience in more than 70 areas of mechanical engineering and plant engineering. The product range includes hydraulic power packs, constant and variable pumps, valves, sensors and accessories. The modular system is complemented by electronic components which are perfectly coordinated with the hydraulic components and simplify control, signal evaluation and fault detection.

The intelligent system solutions reduce energy consumption and operating costs. Compact drives save space and permit innovative machine design.

Approximately 2000 employees in 16 countries and more than 30 sales partners around the globe provide customers with local, professional and personal support.

The company is certified in accordance with ISO 9001:2015-09, ISO 14001, ISO 50001, OHSAS 18001.



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