

Pressure fluids - notes for selection

1. General information

The operation behavior of a hydraulic application mainly depends on the quality of the utilized pressure fluid. The selection of the pressure fluid is determined by the operating conditions of the system such as:

- Temperature (see viscosity classification)
- Nomenclature (some pressure fluids may be unacceptable because of undesired reactions with metals, seals etc.)
- Kind of application (e.g. ecologically compatible pressure fluids)
- Associated field (Use of already available pressure fluids)

2. Pressure fluids

2.1 Mineral oils

Pressure fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> • Pressure fluids HLP (DIN 51524 part 2) 	Mineral oil with additives improving corrosion, oxidation and wear protection	Common hydraulic oil
<ul style="list-style-type: none"> • Pressure fluids HL (DIN 51524 part 1) 	Mineral oil without wear protecting additives	No wear protection additives therefore not suitable for gear pumps. HAWE-pumps type: Z, RZ, MP..-Z, HK..Z Observe manufacturer's specifications for other devices!
<ul style="list-style-type: none"> • Pressure fluids HVL (DIN 51524 part 3) 	Mineral oil with same additives as HLP, but with increased viscosity index for use in higher temperature ranges	Additives improving the viscosity index show drawbacks concerning e.g. shear strength (viscosity drop during load by 30%), fall out of water and air. Use only, if temperature range requires this. Observe fluid manufacturer's specification!
<ul style="list-style-type: none"> • Undoped oil H e.g. - Lubricating oils (DIN 51517 Part 1) - white oil (e.g. USDA H1) 	Mineral oil without additives	Only for systems for intermittent service (S2 or S3 operation), due to the missing additives (low lubricating characteristic). White oil is mainly used in systems for food processing.
<ul style="list-style-type: none"> • Special fluids for aviation (MIL H-5606) for off-shore applications (NATO H 540) 	Mineral oils are based as a rule on naphthenic based oil with wide temperature range	Seals made of fluor rubber FPM might be required, dep. on the pressure fluid. Observe fluid manufacturer's specification!
<ul style="list-style-type: none"> • Other mineral oils • Engine oils type HD (e.g. DIN 51511) Automatic transmission fluid type ATF (AQ A Suffix A) Oils for manual transmissions of vehicles (e.g. DIN 51512) Test oil for diesel injection pumps 	Mineral oils which actually were developed for other application purposes	More or less well suited pressure fluids. Observe whether it contains additives preventing corrosion and oxidation as well as material compatibility (especially with seals). Observe fluid manufacturer's specification!

2.2 Environmentally friendly pressure fluids VDMA 24568 and 24569

Pressure fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> • Seed oil HETG 	Seed oil type HETG Fluids based on seed oils e.g. rape or sunflower with additives show only low temperature strength (< 60...70°C)	Not suited for oil immersed hydraulic power packs type HC, MP, FP, HK, all valves with wet armature solenoids as well as control systems utilizing many throttles. Fluids type HETG show a tendency to gum, aging, and sticking at higher temperature (> 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 Polyethyleneglycol (PAG) Similar qualities i.e. service life, lubricating characteristics and pressure resistance, like mineral oil	No restrictions with regard to the operation behavior, but it <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 • is not suitable for pumps type HC, MP, FP, HK, RZ, Z and connection blocks with 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. service life, lubricating characteristics and pressure resistance, like mineral oil	No restrictions with regard to the operation behavior, but contact with PVC should be avoided.

2.3 Fire inhibiting pressure fluids conforming DIN 51502

Pressure fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> • HFA (pressurized water, emulsions) 	Emulsion, oil solved in water (water content > 80%) max. temp. range approx. 60°C	There is the danger of corrosion and cavitation due to the high water content, therefore only devices intended for it, should be used (some pump versions of type R, directional seated valves acc. to D 7300). Max. oper. pressure of the pump 50...60% - danger of cavitation - Min. oil content > 4% <ul style="list-style-type: none"> • No use of oil immersed hydraulic power packs - danger of short-cuts - applies to pumps type HC, MP, FP, HK • No cellulose filters - danger of clogging -
<ul style="list-style-type: none"> • HFC 	Glycol / water solution (water content < 35%) max. temp. range approx. 60°C	No restrictions with regard to the operation behavior, but it <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 • is not suitable for pumps type HC, MP, FP, HK, RZ, Z and connection blocks with filter type A.F., AF, BF, EF, FF
<ul style="list-style-type: none"> • HFD HFDR phosphoric ester HFDS chlorinated hydrocarbon HFDT blend of HFDR and HFDS HFDU other composition 	Fluids without water content, similar qualities like mineral oil	No restrictions with regard to the operation behavior, but it <ul style="list-style-type: none"> • requires seals out of FPM (FKM) (see also section "Seals")

2.4 Special fluids

Pressure fluid	Characteristics	Unusual features / restrictions
<ul style="list-style-type: none"> • AT-Brake fluid 	Brake fluid based on glycol (DOT 4)	No restrictions with regard to the operation behavior, but devices must be equipped with EPDM or SBR-seals when operated with brake fluid. (see also section "Seals") No use of oil immersed hydraulic power packs, applies to pumps type HC, MP, FP, HK

3. Viscosity classification

Selection of the viscosity

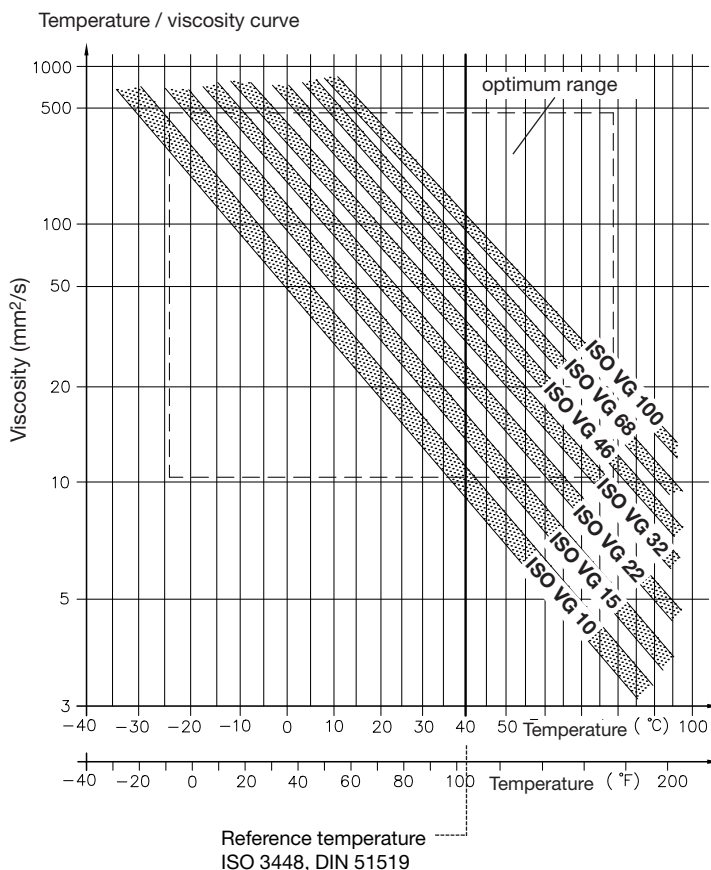
The industrial standard "ISO Viscosity classification for liquid lubricants" (ISO 3448, DIN 51519) lists 18 viscosities, but only the viscosity classes ISO VG10 to ISO VG 68 are of common interest for hydraulic systems. The index No. behind ISO VG informs about the nom. viscosity at 40°C. The temperature behavior illustrated in the curve applies to mineral oil only. The behavior of HVLP and environmentally friendly fluids is less temperature dependent i.e. the curve is less steep.

The following points should be checked in the manufacturer's specification before selecting a fluid.:

- Viscosity at 40°C
- Viscosity at the lowest (estimated or demanded) temperature
- Viscosity at the highest (estimated or demanded) temperature (to ensure sufficient service life of the seals not above 80°C!)

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)
- VG22, VG32
General application (for use in the open, operation in summer only)
- VG46, VG68
Systems in tropical conditions at ambient temperatures up to 40°C or closed rooms (Note start-viscosity!)



4. Filtration

Major malfunctions of a hydraulic system can be caused by contamination like fine wear particles and dust or bigger particles e.g. swarf, rubber from tubing or seals. Therefore the following filtration is recommended (after a thorough initial flushing):

Permissible contamination of the pressure fluid			Recommended filter separation	Devices
ISO 4406	NAS 1638	SAE T 490		
21/18/15...19/17/13	12 ... 8	≥ 6	$\beta_{16...25} \geq 75$	Radial piston and gear pumps, valves, cylinders (use in general mechanical engineering)
20/17/14...18/15/12	11 ... 6	5 ... 3	$\beta_{6...16} \geq 75$	Prop. pressure and flow control valves

The purity degree of the pressure fluid is especially important for the repeatability accuracy with proportional valves. It is important to be aware that fresh fluid from the barrel does not always fulfill the highest standards of clean-liness.

5. Service life of pressure fluids

The aging of pressure 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.

The following points should be observed:

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

- Circulation ratio of the pressure fluid $\frac{Q_{\text{pump}} [l/min]}{V_{\text{system}} [l]}$ (guideline)

- approx. 0.2 ... 0.4/min for conventional hydraulic power packs
- approx. ...1/min for mobile hydraulics
- approx. ...4/min for hydraulic power packs operated on/off or

- Control of the pressure fluid on a regular base (fluid level, contamination, coloring index, neutralization value etc.)

- Change of the pressure fluid on a regular base (depending on fluid type and application conditions)

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

Take into account notes of the fluid manufacturer!

6. Change of the pressure fluid

Mixing different kinds of pressure fluid sometimes can cause unintended chemical reactions such as sludging, gumming etc. The respective manufacturers should therefore always be consulted when changing from one to another pressure fluid. The complete hydraulic system should be thoroughly flushed anyway.

7. Seals

Any question about the compatibility with seal material should be settled with the fluid manufacturer always before using a certain pressure 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) e.g. for SKYDROL or brake fluid or
SBR (styrene-butadiene rubber) e.g. for brake fluid (not suitable for SKYDROL!)
The coding ...-AT should be added to the coding for HAWE devices, e.g. WN1H-G24-AT

8. Manufacturers (selection only)

Company	Address in Germany			
Agip Schmiertechnik GmbH Deutschland	Paradiesstrasse 14 D-97080 Würzburg	Telefon Fax	+49 / (0) 931 / 90098-0 +49 / (0) 931 / 90098-76	
Aral Lubricants GmbH & Co.KG	Max-Born-Str. 2 D-22761 Hamburg	Telefon Fax	+49 / (0) 40 / 3594-05 +49 / (0) 40 / 639589685	
Deutsche BP Holding Aktien-Gesellschaft	Wittener Str. 45 D-44789 Bochum	Telefon Fax	+49 / (0) 234 / 315-0 +49 / (0) 234 / 315-2679	
DEA Mineraloel AG	Überseering 40 D-22297 Hamburg	Telefon Fax	+49 / (0) 40 / 6375-0 +49 / (0) 40 / 6375-3496	
Esso AG	Kapstadtring 2 D-22297 Hamburg	Telefon Fax	+49 / (0) 40 / 6393-0 +49 / (0) 40 / 6393-3368	
Fragol Industrieschmierstoffe GmbH	Reichspräsidentenstr. 21-25 D-45470 Mülheim	Telefon Fax	+49 / (0) 208 / 30002-22 +49 / (0) 208 / 30002-46	
Fuchs Mineraloelwerke GmbH	Friesenheimer Straße 15 D-68169 Mannheim	Telefon Fax	+49 / (0) 621 / 3701-0 +49 / (0) 621 / 3701-570	
Liqui Moly GmbH	Jerg-Wieland-Str. 4 D-89081 Ulm	Telefon Fax	+49 / (0) 731 / 1420-0 +49 / (0) 731 / 1420-71	
Mobil Oil AG	Kapstadtring 2 D-22297 Hamburg	Telefon Fax	+49 / (0) 40 / 6393-0 +49 / (0) 40 / 6393-3368	
Deutsche Shell AG	Suhrenkamp 71-77 D-22284 Hamburg	Telefon Fax	+49 / (0) 40 / 6324-0 +49 / (0) 40 / 6321 - 051	
Panolin AG	Bläsimühle CH-8322 Madetswil	Telefon Fax	+41 / (0) 44 / 95665-65 +41 / (0) 44 / 95665-75	
Klüber Lubrication Deutschland KG	Geisenhausenerstrasse 7 D-81379 München	Telefon Fax	+49 / (0) 89 / 7876-0 +49 / (0) 89 / 7876-333	