Rexroth
Bosch Group

RE 07 075/02.03

Replaces: 07.98

Mineral oil based pressure fluids for use with vane pumps, radial piston pumps and gear pumps as well as MCR, MR and MKM/MRM motors

(for axial piston maschines see RE 90 220)

The quality, cleanliness and operating viscosity of the hydraulic medium are decisive factors in the operating reliability, efficiency and service life of a system. The catalogue sheets for the various types of hydraulic components contain specifications regarding the viscosity range and suitable fluids. Furthermore, the ordering details contain details of special models for use with special fluids. The following points must be taken into account in addition to the specifications stated in the catalogue sheets.

1. Viscosity

The permissible viscosity range of an installation, including combination pumps, is always restricted to that of the component with the narrowest range. (For combination pumps V7/R4, for example, the viscosity range of the R4 is limited to that of the V7). The viscostiy range must be not be exceeded under all operating conditions.
The viscostiy of HV oils falls in operation due to shearing by up to 30%. This has to be taken into account during the design phase. The viscosity is dependent on the temperature. Due to this fact, when determing the viscosity classes, the minimum and maximum oil temperatures in the oil reservoir must be adhered to. As a rule heating or cooling or both is necessary. If in spite of this, difficulties are still experianced then an operating medium with a different viscosity class (ISO VG class) will probably have to be utilised. In case of doubt, please consult Bosch Rexroth.

1.1 Viscosity range of vane pumps

1.1.1 V7 pumps:
Max. 800 mm²/s at start-up when pumping
Max. 200 mm²/s at start-up at zero stroke
Min. 16 mm²/s at max. permissible operating temperature
Permissible operating viscosity range 16 to 160 mm²/s
(for permissible mediums, see points 2.1 and 2.2)

1.1.2 VV and VQ pumps:
Permissible viscosity range 13 to 860 mm²/s
(recommended 13 to 54 mm²/s)
(for permissible mediums, see point 2.2)

1.2 Viscosity range for R4 radial piston pumps:
Permissible viscosity range 10 to 200 mm²/s
(for permissible mediums, see point 2.2)

1.3 Viscosity range for external gear pumps and gear motors
G2, G3, G4 pumps or G2, G3 motors:
Permissible viscosity range 10 to 300 mm²/s
Permissible start-up viscosity 1000 mm²/s
(for permissible mediums, see points 2.1 and 2.2)

1.4 Viscosity range for internal gear pumps

1.4.1 PGF pumps:
Permissible operating viscosity range 10 to 300 mm²/s
Max. permissible start-up viscosity 2000 mm²/s
(for permissible mediums, see points 2.1 and 2.2)

1.4.2 PGH pumps:
Permissible operating viscosity range 10 to 300 mm²/s
Max. permissible start-up viscosity 2000 mm²/s
(for permissible mediums, see points 2.1 and 2.2)

1.5 MCR motor viscosity range:
Permissible operating viscosity is 10 to 2000 mm²/s
(for permissible mediums see points 2.1 and 2.2)

1.6 MR(E), MRD(E), MRT(E) motor viscosity range:
Permissible operating viscosity is 18 to 1000 mm²/s
The recommended operating viscosity is 30 to 50 mm²/s
(for permissible mediums see point 2.2)

1.7 MKM/MRM motor viscosity range:
Permissible operating viscosity is 20 to 150 mm²/s
Max. permissible start-up viscosity is 1000 mm²/s
The recommended operating viscosity is 30 to 50 mm²/s
(for permissible mediums see point 2.2)

2. Pressure fluids

The specification of the operating medium is always determined by the most sensitive component in the system.
All components of the system must be compatible with the fluid used.

2.1 HL oils to DIN 51 524 part 1:
These mediums do not contain any additives for anti-wear protection for mixed friction and can only be used with the following pumps and motors:
PGH, PGF, G2, G3, and V7[1], (NS 10, 16, 25 and 40) as well as MCR motors.
Aircraft mediums to MIL-H-5606 (e.g. Aero Shell Fluid 4) relate to the wear protection of HL oils and can be used, within the permissible viscosity range, with the above mentioned pumps and motors. Hydraulic mediums which attack lead or bearing materials which contain lead must not be used, even though they comply with the specifications HL to DIN 51 524 part 1. These are mainly multi-purpose oils (e.g. bedway oils), that contain fatty acids or fatty acid esters. Oils simular to HL oils are also specified as HL oils within CETOP RP 75 H and ISO 11 158.

2.2 Oils with HLP characteristics

2.2.1 HLP oils to DIN 51 524 part 2:
(Oils with corrosion, oxidisation and wear additives)
These fluids are those most commonly used in hydraulics. As long as the viscosity specifications are adhered to, they may be used with all components.
In the viscosity classes VG10, VG15 and VG22, DIN 51 524 part 2 does not place adequate requirements on resistance to wear. Oils of these visocity classes are, therefore, only permitted if they reach the minimum resistance class of 10 on the FZG (gear wear) test to DIN 51 354 part 2.
Hydraulic fluids, which attack lead, or bearings containing lead, must not be used, even when they comply with the HLP specification to DIN 51 524 part 2. They are mainly multi-purpose oils (e.g. bedway oils) and sometimes HLP-D oils. Type CG multi-purpose oils to DIN 51 502 or HG oils to ISO 11 158 may only be used if written authorisation has been obtained from Bosch Rexroth.
We permit the use of all HLP oils, which comply with DIN 51 524 part 2, with the exception of those indicated abvove, but would point out here, that this standard merely lays down the minimum requirements.
As may be seen from the table, there are oils available, with regard to aging, wear protection, non-ferrous metal compatibility, thermic loadability and filterability, that far exceed these minimum requirements.
The resistance to aging has an obvious effect on the usable life of the fluid. A low sediment content leads to lower deposits in the system. Good filterability prevents breakdowns. If in doubt please contact the oil manufacturer.
We would also recommend to users, that when selecting an oil supplier, to take into account that some suppliers offer the possibility of checking the oil condition for contamination, aging and additive reserves. This knowledge can then be used to forcast the further useful life of the fluid.

2.2.2 HVLP oils to DIN 51 524 part 3:
(Oils with an increased viscosity index for the use in systems exposed to a wide temperature range.)
Here the same guidelines and limitations apply that have been stated within point 2.2.1 for HLP oils. When selecting a HV oil the loss in viscosity, due to the effect of shearing, of up to 30% has to be taken into consideration. This means, e.g. when using a V7 pump with HV oils the minimum permissible viscosity of 25 mm^2/s has to be increased to 36 mm^2/s, so that when shearing losses occur during operation the minimum permissible viscosity is not exceeded. VI improvers can also have a detrimental effect on the demulsifing relationship and the air seperation qualities of the oil, therefore, HV oils should only be used when the temperature conditions demand that they are used.
The result of the test for viscosity drop to DIN 51 382 is in practise of no consequence. For evaluations the results of the test to E-DIN 51 350 part 6 over 20 h can be used.
(Aircraft oils to MIL-H-5606, see point 2.1 HL oils)

2.2.3 The application of HLP-D oils:
(HLP oils with detersive and dispersing additives)
These oils can absorb a considerable quantity of water. Especially if this water is present in the form of large drops, it can detract from the wear protection given by the oil. They should, therefore, not be used where water may enter the system. Where synthetic cooling and cutting fluids are used, installations will only operate correctly if HLP-D oils are used. Other oils lead to the components sticking. In the mobile area, these oils have been of particular advantage. We recommend the use of HLP-D oils only in the above mentioned cases.
The film strength of these oils is very much dependent on the manufacturer.. The statement, that these oils are particularly good in preventing stick/slip at low cylinder speeds, cannot, therefore, be accepted as universally true.
In indivudual cases, where heavy contamination from water is to be expected, (i.e. in steel works or in damp surroundings), HLP-D oils may not be used, as the emusified water is not deposited in the tank, but is turned into steam at highly loaded parts of the system.
In these cases the use of HLP hydraulic oils which have particularly good demulsification characteristics is recommended. The water which collects at the bottom of the reservoir has to be drained at regular intervals. The filterability of zinc-free oils is generally better particularly when finest filtration stations are used. When selecting an oil, particular attention has to be taken to ensure that the filterability of the medium with the ingress of water is not excessivbly worsened. When using HLP-D oils contamination is not deposited, it is held in suspence and has to be filtered out. Due to this a larger filtration area is required, (filter laid out for a Δp = 0.2 bar). The filter rating should also be lowered by one step.
The water content must lie below 0.1%, as water accelerates the aging of the oil, detracts from the lubricity, leads to corrosion

[1] up to max. 80 bar;

and cavitation, shortens the life of seals and reduces the filterability. Various HLP-D oils contain fatty acids or fatty acid esters. These fluids must not be used, as they attack lead. If in doudt, contact the manufacturer of the oil. In general, with the exception of the demulsification characteristics, the same is valid as under point 2.2 for HLP-D oils.

3. Filtration

Generally a minimum cleanliness class of 20/18/15 to ISO 4406 should be maintained. We recommend a filter with a minimum retention rate of $\beta_{10} \geq 100$.

Please take into account also the details stated within the associated catalogue sheets for the hydraulic components. If there are any more sensitive components (e.g. servo valves) installed within the system, then the filter rating has to be matched to suit the most sensitive component. New oil, as delivered, often does not meet these cleanliness requirements. Careful filtering is therefore necessary when filling. The cleanliness class of the oil, as delivered, can be obtained from the oil supplier.

The oil used must, not only in their new condition but also during these operational life, have good filteration characteristics. There are large differences in relation to the additives used.

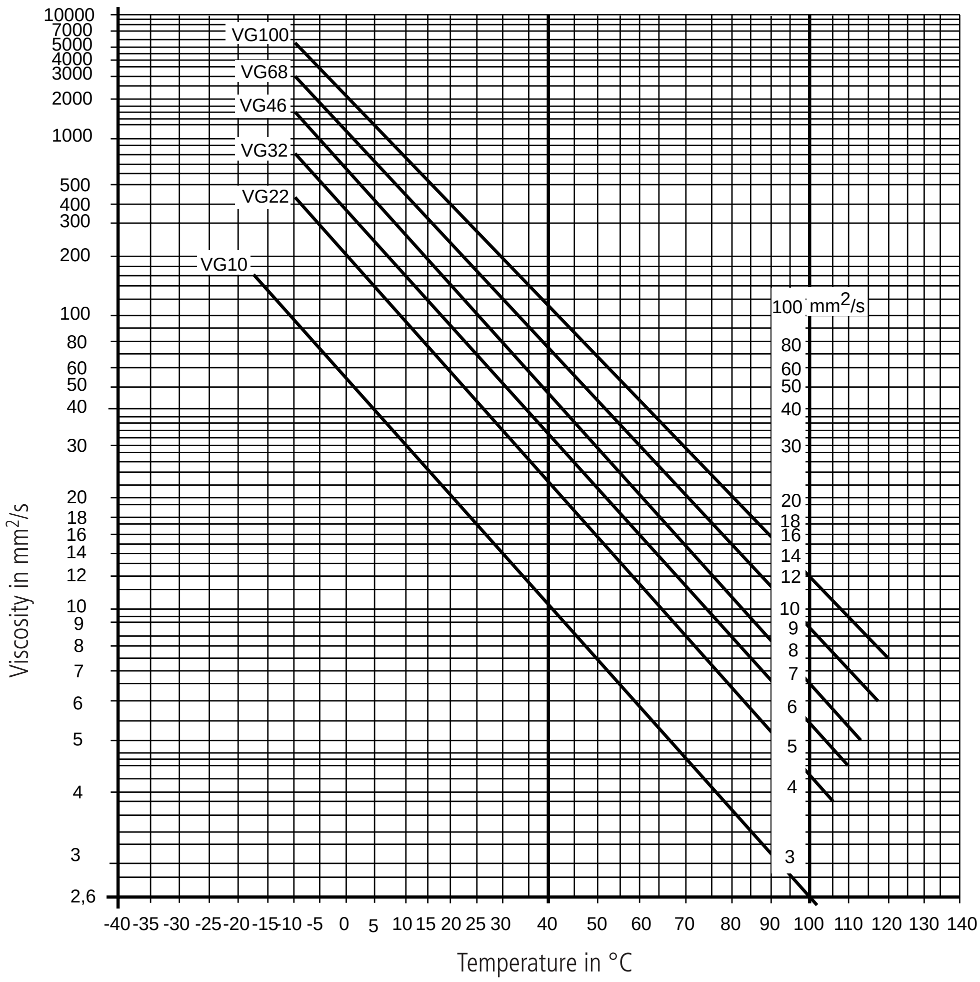
Electrical safety devises must be provided so that it is not possible to operated the system with a clogged filter.

So that the required cleanliness class can be maintained, careful air breather filtration is also required. With damp ambient conditions silica gell absorbers are required.

4. Mixing differing hydraulic oils

If oils from differing manufactureres or different types of oil from the same manufacturer are mixed, then sticking, sedimentation and siltration can occur. These can cause faults or lead to damage to the hydraulic system. Due to these reasons we cannot accept any guarantees when mixed oils are used. It must also be taken into account that oils to the same standard are not always compatible. The appropriation of blame in cases of damage due to the mixing of oils from different manufacturers or the addition of additives can generally not be appropriated. The oil supplier can, however, check the mixability (compatibility) of different oils and provide the operator with a guarantee.

Viscosity-temperature diagram



Physical formulas

a) Velocity of sound in mineral oil $c = 1320$ m/s

b) Compressibility factor β (compression module)

$$\beta = \frac{\Delta V}{V \bullet \Delta p} = 3 \text{ to } 8 \bullet 10^{-5} \left[\frac{1}{\text{bar}}\right]$$

c) Viscostiy-temperature function

Gradient $n = \dfrac{U_1 - U_2}{2{,}303\,(\lg T_2 - \lg T_1)}$ where $U = \text{arsinh}\ ln\ \nu$

Viscosity index *VI* (calculated to DIN/ISO 2909)

d) Viscosity-pressure relationship (dynamic viscosity η)

$\eta_p = \eta_0 \bullet e^{\alpha \bullet p}$ (p in bar) [mPa•s]

$\alpha_{20\,°C} = 0{,}00240\ \text{bar}^{-1}$

$\alpha_{50\,°C} = 0{,}00205\ \text{bar}^{-1}$

$\alpha_{100\,°C} = 0{,}00247\ \text{bar}^{-1}$

(from: "Pressure fluids"
by Dipl. Eng. Horst Dietterle, Co. Shell)

e) Specific heat capacity

$c = 1{,}84 \bullet \frac{\text{kJ}}{\text{kg} \bullet \text{K}}$

f) Thermal expansion

$\Delta v = v \bullet 0{,}0007 \bullet \Delta T$ [cm³] (T in K)

g) Bunsen co-efficient for air in mineral oil = 0,09

$$V_L \approx 0{,}09 \bullet V_{oil} \bullet \frac{p_2}{p_1}$$

V_L = air dissolved in oil in cm^3

V_{oil} = oil volume in cm^3

p_1 = start pressure in bar

p_2 = final pressure in bar

h) Co-efficient of circulation (no. of circulations)

$$i = \frac{q_v}{V_{system}}\ \text{min}^{-1}$$

this is the reciprocal of the dwell time

q_v in L/min (pump flow)

V in L (oil content of the installation)

Measuring techniques and standards

1 Kinematic viscosity in mm^2/s
Measurement e.g. with a Ubbelohde viscometer
to DIN 51 562

2 Density at 15 °C in g/cm^3 with an areometer
to DIN 51 757

3 Viscosity index (*VI*)
to DIN/ISO 2909

4 For HL fluids DIN 51 524 part 1
For HLP fluids DIN 51 524 part 2
For HV fluids DIN 51 524 part 3

5 Viscosity classification (to ISO)
to DIN 51 519

6 Pour point
(reaching the flow limit is 3° higher than the solidifing point)
to DIN/ISO 3016

7 Gear tooth test (FZG normal test) A/8, 3/90
(gear tooth load test in 12 stages
at 90 °C start temperature and 8.3 m/s
circumferential speed)
to DIN 51 354 part 2

8 Pressures – terms – pressure ratings
to DIN 24 312

9 Air separation characteristics
to DIN 51 381

10 Corrosion protection characteristics
compared to steel (process A) DIN 51 585
corrosive effect on copper DIN 51 759

11 Demulsification characteristics DIN 51 599
Water content DIN/ISO 3733

12 Effect on seal materials
to DIN 53 538 part 1
in connection with DIN 53 521 and DIN 53 505

13 Neutralisaion no. in $\frac{\text{mg KOH}}{\text{g}}$ DIN 51 558 part1

14 Determination of carbonised residue accoring to
Conradson to DIN 51 551

15 Mechanical testing of vane pumps
(wear in mg) to DIN 51 389 part 2

16 Aging characteristics
Increase in the neutralistion number (NZ)
after 1000 h (mg KOH/g) to DIN 51 587

Bosch Rexroth AG
Industrial Hydraulics
D-97813 Lohr am Main
Zum Eisengießer 1 • D-97816 Lohr am Main
Telefon 0 93 52 / 18-0
Telefax 0 93 52 / 18-23 58 • Telex 6 89 418-0
eMail documentation@boschrexroth.de
Internet www.boschrexroth.de

Bosch Rexroth Limited
Cromwell Road, St Neots,
Cambs, PE19 2ES
Tel: 0 14 80/22 32 56
Fax: 0 14 80/21 90 52
E-mail: info@boschrexroth.co.uk