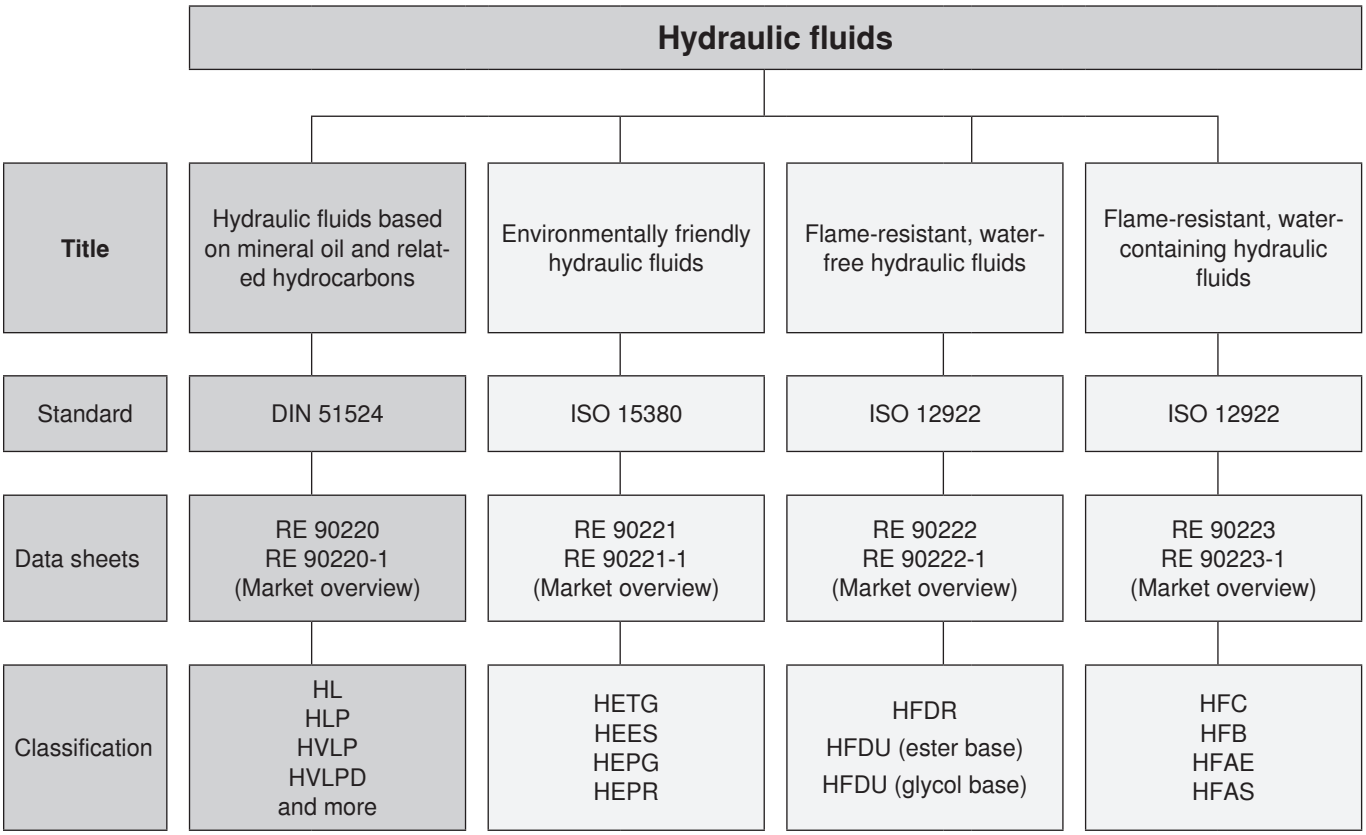
Rexroth
Bosch Group

Hydraulic fluids based on mineral oil and related hydrocarbons

RE 90220/10.08 1/16
Replacing: 05.03 and
RE 07075/10.05

For all Rexroth hydraulic components



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1 Basic information

1.1 General information

The hydraulic fluid is the connecting element in any hydraulic unit. It is important to select with care the hydraulic fluid for the hydrostatic circuit. Quality and cleanliness of the hydraulic fluid are decisive factors for the operational reliability, efficiency and life cycle of the system. Hydraulic fluids must conform with, and be selected and used in accordance with, the safety provisions as well as the generally acknowledged rules of technology. Reference is made to the local standards and directives (in Germany: the directive of the Employer's Liability Insurance Association 137 BGR 137).

This data sheet includes recommendations and regulations concerning the selection, operation and disposal of hydraulic fluids from the perspective of Bosch Rexroth AG as the manufacturer of hydraulic components. The operator is solely responsible for the selection of the suitable hydraulic fluid. He is to ensure that the selected fluid meets the minimum requirements of the relevant fluid standard during the whole of the period of use.

The technical characteristics in the respective component data sheets are applicable only as long as the fluids comply with the respective product information data immediately after filling as well as in used condition.

Furthermore, further regulations and legal provisions may apply; the operator is solely responsibly for complying with these.

We recommend that you maintain a long-term contact with fluid suppliers to support you in the selection, maintenance, care and analyses.

When disposing of used hydraulic fluids, apply the same care as during use.

1.2 Scope of application

This data sheet is to be applied when using fluids based on mineral oil and related hydrocarbons, such as fluids based on hydrocrack (HC) or poly-alpha-olefins (PAO) in Rexroth hydraulic components.
Please note that the specifications of this data sheet may be detailed further by the data sheets of the individual components. Furthermore this data sheet is concerned solely with the technical suitability of the various fluids for use with our hydraulic components.
The use of the individual fluids in accordance with the intended purpose can be seen in the safety data sheets or other product description documents of the fluid manufacturers. In addition, each use is to be inspected individually.

Hydraulic fluids based on mineral oil and related hydrocarbons in accordance with DIN 51524 are automatically admitted for use with our components in accordance with the fluid category required in the data sheet of the relevant component. You can find information on other fluids in section 6.
You can find hydraulic fluids based on mineral oil and a defined minimum performance in our **market overview RE 90220-1**. The products listed there have full certification in accordance with the current fluid standard and meet further necessary characteristics to comply with our minimum requirements.

1.3 Safety notices

Hydraulic fluids can constitute a risk for persons and the environment. Safety notices and risks are described in the safety data sheets. The user is to ensure that a current safety data sheet for the hydraulic fluid used is available and meets the national regulations and that the measures stipulated therein are complied with.

2 Solid particle contamination and cleanliness classes

Solid particle contamination is the major reason for faults occurring in hydraulic systems. It may lead to a number of effects in the hydraulic system. Firstly, single large solid particles may lead directly to a system malfunction, and secondly small particles cause continuous elevated wear.

For hydraulic fluids, the cleanliness class is given as a three-digit numerical code in accordance with ISO 4406. The numerical code classifies the cleanliness with reference to the particle sizes > 4 µm, > 6 µm and >14 µm, see Table 1. Furthermore solid foreign material may not exceed a mass of 50 mg per kg hydraulic fluid.

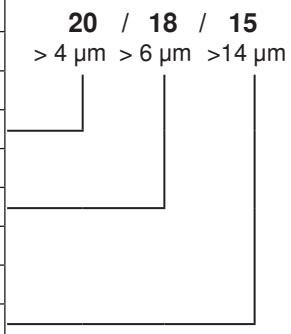
In general, compliance with a minimum cleanliness class of 20/18/15 in accordance with ISO 4406 or better is to be maintained in operation. Special servo valves require higher cleanliness classes of at least 18/16/13.

An ordinal number reduced by one means half the quantity of particles and therefore a better cleanliness class. One should always try to attain higher cleanliness classes as they enable a longer life cycle. The component with the highest cleanliness requirements determines the required cleanliness of the overall system. Please also note the data in Table 5: “Viscosity ranges and required cleanliness classes of hydraulic components” and in the respective data sheets of the various hydraulic components.

Fresh fluids frequently fail to meet these minimum cleanliness class requirements after delivery. Therefore careful filtration is required during filling. DIN 51524 defines a minimum cleanliness class of 21/19/16 for the filling condition into the bins. Your oil supplier will tell you the cleanliness class of the fluids as delivered. To maintain the required cleanliness class over the operating period, you must use a tank breather filter. If the environment is humid, take appropriate measures, such as a breather filter with air drying or permanent off-line water separation.

Table 1: Cleanliness classes according to ISO 4406

Particles per 100 ml		Ordinal number
More than	Until and including	
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64000	130,000	17
32000	64000	16
16000	32000	15
8000	16000	14
4000	8000	13
2000	4000	12
1000	2000	11
500	1000	10
250	500	9
130	250	8
64	130	7
32	64	6



3 Selection of the hydraulic fluid

3.1 General

The use of hydraulic fluids in Rexroth hydraulic components is based on compliance with the technical requirements of the latest DIN 51524.

3.2 Selection criteria for the hydraulic fluid

The prescribed limit values of each part of the hydraulic system need to be complied with while observing the specified operating conditions with the fluid used.

The suitability of the fluid depends, among others, on the factors of viscosity (see 3.3) and viscosity-temperature behavior (see 3.4).

3.3 Viscosity

Viscosity is a basic property of hydraulic fluids. The permitted viscosity range of complete systems needs to be determined taking account of the permitted viscosity of all components and it is to be observed for each individual component.

The viscosity data always refer to kinematic viscosity.

The viscosity at operating temperature determines the response characteristics of closed control loops, stability and damping of systems, the efficiency factor and the degree of wear.

We recommend that the optimum operating viscosity range of each component be kept within the permitted temperature range. You can find an overview in Table 5: “Viscosity ranges and required cleanliness classes of hydraulic components”; please also note the information in the individual component data sheets.

If the viscosity of a hydraulic fluid used is above the permitted operating viscosity, this will result in increased hydraulic-mechanical losses. In return, there will be lower internal leakage losses. If the pressure level is lower, lubrication gaps are not filled up, which can lead to an increased level of wear. For hydraulic pumps, the permitted suction pressure may not be reached, which may lead to cavitation damage.

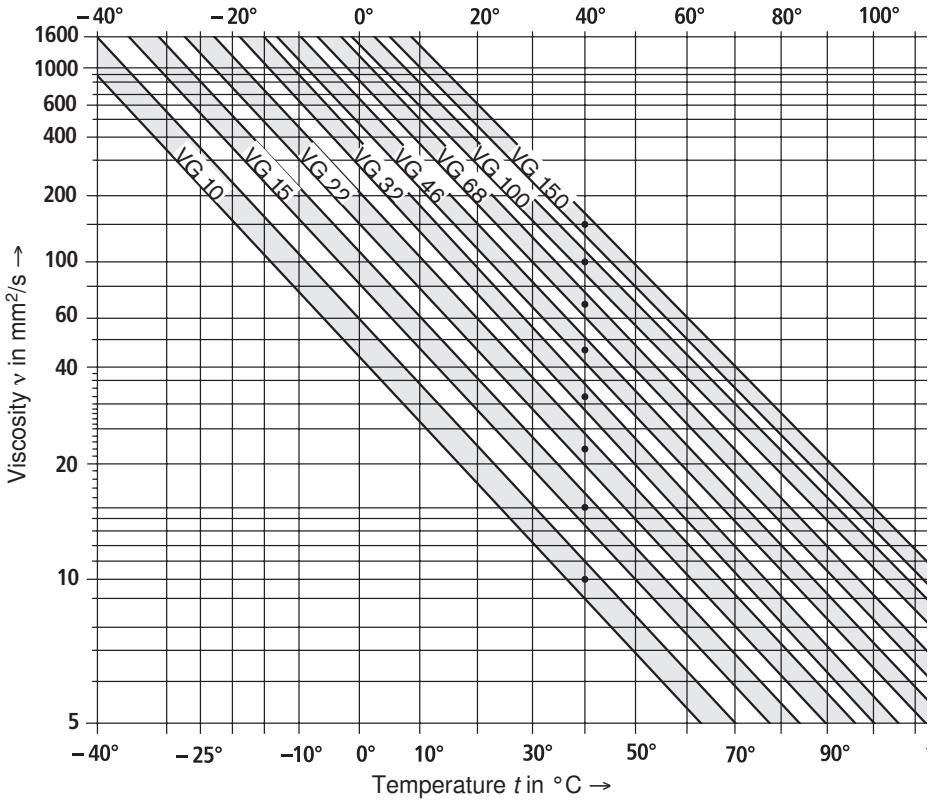
If the viscosity of a hydraulic fluid is below the permitted operating viscosity, this leads to an excessive amount of leakage, a higher level of wear, higher susceptibility to contamination and a reduced life cycle for the components.

For this reason, it is paramount that the maximum and minimum oil temperatures of the components as determined with the selection of the viscosity classes be observed for every location within the circuit. This usually requires either cooling or heating, or both.

3.4 Viscosity-temperature behavior

For hydraulic fluids, the viscosity-temperature behavior (VT behavior) is of particular importance. The viscosity drops significantly when the temperature is increased and rises when the temperature drops; see Fig. 1 “Viscosity-temperature chart for HL, HLP, HLPD (VI 100)”. The interrelation between viscosity and temperature is described by the viscosity index.

Fig. 1: Viscosity-temperature chart for HL, HLP, HLPD (VI 100)



3.5 Wear protection capability

Wear protection capability describes the property of hydraulic fluids to prevent or minimize wear within the components. The wear protection capability is described in DIN 51524 parts 2 and 3 via the test procedures “FZG gear test rig” (FZG DIN 51354-2) and “Mechanical test in the vane pump” (DIN 51389-2).

3.6 Material compatibility

The hydraulic fluid may not react with the materials used in the components. Compatibility with coatings, seals, hoses, metals and plastics is to be observed in particular. The fluid categories given in the respective data sheet of the components have been tested by the manufacturer with regard to material compatibility.

Table 2: Material incompatibilities with hydraulic fluids based on mineral oil and related hydrocarbons

Classification	Incompatible with:
HLxx gen.	with EPDM seals
Zinc- and ash-free hydraulic fluids	with bronze-filled PTFE seals

3.7 Resistance to aging

The way a hydraulic fluid ages depends on the thermal, chemical and mechanical stress to which it is subjected. Resistance to aging can be influenced greatly by the composition of the fluids.

Tank temperatures of more than 80 °C lead to the service life being halved for every 10 °C of temperature increase and should therefore be avoided in general (reference value, Arrhenius equation).

Table 3: Practical reference values for temperature-dependent fluid aging

Tank temperature	Fluid life cycle
80 °C	**100 %**
90 °C	**50 %**
100 °C	**25 %**

3.8 Air separation ability (ASA)

The air separation ability (ASA) describes the property of a hydraulic fluid to separate undissolved air. Hydraulic fluids contain approx. 7 to 13 percent by volume of dissolved air (with atmospheric pressure and 50 °C). During operation, dissolved air may be transformed into undissolved air, leading to cavitation damages. Fluid selection, tank size and form need to match and are to be determined in consideration of the dwell period and ASA value of the hydraulic fluid. The ASA value depends on the viscosity, temperature, base oil and aging. It cannot be improved by additives.

DIN 51524, for instance, stipulates an ASA value of ≤ 10 min for HLP 46, with lower values having to be preferred. HLP 46 fluids have a typical ASA value of ≤ 6 min.

3.9 Demulsifying ability / Water separation capability (WSC)

Demulsifying ability refers to the property of hydraulic fluids to separate penetrated water. DIN ISO 6614 describes the procedure to determine the water separation capability of fluids.

For larger systems with permanent monitoring, a demulsifying fluid with good water separation capability (WSC) is recommended. The water can be drained from the bottom of the tank. In case of smaller systems (e.g. in mobile machines), whose filling is only loosely monitored and where water influx to the hydraulic fluid (for instance through air condensation) cannot be ruled out completely, disperging fluid is recommended.

The demulsifying ability up to ISO-VG 100 is given at 54 °C, and at 82 °C for fluids with higher viscosity.

Deterging and disperging hydraulic fluids have no, or a very poor, demulsifying ability.

3.10 Filterability

Filterability describes the property of a hydraulic fluid to separate from its contamination with the help of a filter. The fluids used require a good filterability, not just when new, but also during the whole of their service life. There are significant differences depending on the additive system used.

The filterability is tested with the pure hydraulic fluid and after the addition of 0.2% water. The underlying standard (ISO 13357 parts 1 and 2) stipulates that the filterability must have no negative effect on the filters or the fluid. The filterability is a basic prerequisite for cleanliness, servicing and filtration of hydraulic fluids. See Section 4, “Hydraulic fluids in operation”.

3.11 Corrosion protection

Hydraulic fluids should not just prevent rust formation on steel components; they must also be compatible with non-ferrous metals and alloys. The corrosion protection properties regarding steel and copper are described in DIN 51524. No hydraulic fluid corroding those materials may be used, even if it complies with DIN 51524.

3.12 Additivation

The properties described above can be modified with the help of suitable additives. A general distinction for ready-to-use fluid formulations is between zinc-free and zinc-containing additive systems. Both additive systems are incompatible with each other. Even mixing smaller quantities must therefore be avoided. See Section “Hydraulic fluids in operation”.

An increased additivation generally leads to a deteriorated air separation ability (ASA) and water separation capability (WSC) of the fluid. According to the present state of knowledge, all hydraulic fluids described in this document, independently of the actual additivation, can be filtered using all filter materials with all known filtration ratings ≥ 1 μm without filtering out effective additives at the same time.

Bosch Rexroth AG does not prescribe any specific additive system.

3.13 Hydraulic liquid classification

Table 4: Hydraulic liquid classification

Classification	Features	Typical field of application	Notes
HL fluids in accordance with DIN 51524, part 1 VI = 100	Fluids predominantly only with additives for oxidation and corrosion protection, but no specific additives for wear protection in case of mixed friction	HL fluids can be used in hydraulic systems that do not pose any requirements as to wear protection.	Hydraulic fluids that only comply with the requirements of classes HL and HR in accordance with ISO 11158 without proving that DIN 51524-1 is also met may be used only with written approval of Bosch Rexroth AG. HL fluids may be used only for components whose data sheet specifically allows HL fluids. Observe restrictions as to pressure, rotation speed etc.
HLP fluids in accordance with DIN 51524, part 2 VI = 100	Fluids with corrosion, oxidation and proven wear protection additives	HLP fluids are suitable for most fields of application and components provided the temperature and viscosity provisions are observed.	For the viscosity classes VG10, VG15 and VG22, DIN 51524 defines no requirements as to wear protection (DIN 51354 part 2 and DIN 51389 part 2). Beyond the requirements of DIN 51524 part 2, we require the same base oil type, identical refining procedure, identical additivation and identical additivation level across all viscosity classes.
HVLP fluids in accordance with DIN 51524, part 3 VI > 140	HLP fluids with additional improved viscosity temperature behavior	HVLP fluids are used in system operated over a wide temperature range.	The same notes and restrictions as defined for HLP fluids apply accordingly. When using HVLP fluids, the viscosity may change on account of the shear of the long-chain VI conditioners. The viscosity index, high at the start, decreases during operation. This needs to be taken into account when selecting the hydraulic fluid. The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part 6. Please note that there are practical applications that create a much higher shear load on such fluids than can be achieved by this test. Up to VI < 160, we recommend a maximum permitted viscosity drop of 15 %, referring to the viscosity at 100 °C. The viscosity limits given by Bosch Rexroth for its components are to be observed for all operating modes, even after the hydraulic fluids have sheared. HVLP fluids should be used only if required by the temperature ranges of the application.

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3.13 Hydraulic fluid classification

Table 4: Hydraulic fluid classification (continued from page 7)

Classification	Features	Typical field of application	Notes
HLPD fluids and HVLPD fluids	HLP and HVLP fluids with additional deterging and disperging additives	HLPD and HVLPD fluids are used in systems where deposits as well as solid or liquid contamination need to be kept temporarily suspended	Some of these fluids are able to absorb significant quantities of water (> 0.1%). This may have negative implications for the wear protection and the aging properties of the fluid. The wetting ability of these fluids varies largely depending on the product. Therefore it is not correct to say that they are generally all very well able to prevent stick-slip. In individual cases where stronger water influx is to be expected (such as in steelworks or under humid conditions), the use of HLPD fluids cannot be recommended as the emulsified water does not settle in the tank but is evaporated in heavily loaded positions. For such cases, we recommend using HLP hydraulic fluids with particularly good demulsifying ability. The water collected at the tank bottom is to be drained regularly. If HLPD fluids are used, contamination does not settle. It rather remains suspended and needs to be filtered out or removed by appropriate draining systems. For this reason, the filter area must be increased. HLPD fluids may contain additives that in the long run are incompatible with plastics, elastomers and non-ferrous metals. Furthermore, these additives may lead to the premature clogging of hydraulic filters. Therefore, test the filterability and the selection of the filter material in consultation with the filter manufacturer.

3.14 Viscosity ranges and cleanliness classes required by hydraulic components

Table 5: Viscosity ranges and required cleanliness classes

Components	Maximum permitted viscosity	Optimum viscosity range	Minimum permitted viscosity	Cleanliness class according to ISO 4406
Pumps and motors				
Vane pumps PV7	max. 800 mm^2/s with start-up in pumping operation max. 200 mm^2/s with start-up in no-load operation	16…160 mm^2/s	16 mm^2/s	20/18/15
Vane pumps PVV and PVQ	860 mm^2/s	16…54 mm^2/s	13 mm^2/s	20/18/15
Radial piston pumps PR4	200 mm^2/s	16…100 mm^2/s	10 mm^2/s	20/18/15
External gear pumps and motors, AZP and AZM	800 mm^2/s (permitted start viscosity 2000 mm^2/s)	20…100 mm^2/s	12 mm^2/s	20/18/15
Internal gear pumps PGF and PGH	2,000 mm^2/s	10…300 mm^2/s	10 mm^2/s	20/18/15
Axial piston units	max. 1,000…1,600 mm^2/s (see corresponding product data sheet)	16…36 mm^2/s (see corresponding product data sheet)	5...10 mm^2/s (see corresponding product data sheet)	20/18/15 Temperature > 90 °C 19/17/14
Radial piston motors MCR	2,000 mm^2/s	10…200 mm^2/s	10 mm^2/s	20/18/15
Radial piston motors MR(E)	1,000 mm^2/s	30…50 mm^2/s	18 mm^2/s	20/18/15
Radial piston motors MKM and MRM	1,000 mm^2/s	30…50 mm^2/s	20 mm^2/s	20/18/15
Cartridge valves				
MHDB, MHDBB, MHDBD, MHSV, MH2DAD, MHDBE, MHDBH, MHDBL, MHDBM, MHDBN, MHDBV, MHSV		10…380 mm^2/s		20/18/15
MHDR, MHDRE		5…400 mm^2/s		20/18/15
2FRM, DA, DB, DR, KAV, KBD, KRD, KTV, DBD		10…800 mm^2/s		20/18/15
KBPS, KBVS		15…380 mm^2/s		20/18/15
3 WE 4 Atex, 4 WE 4 Atex		3…380 mm^2/s		20/18/15
KED, KGD, M-SR		3…500 mm^2/s		20/18/15
KKDS	380 mm^2/s	30…46 mm^2/s	20 mm^2/s	20/18/15
KKDE, KSDE		4…500 mm^2/s		20/18/15
FTDRE, FTWE		5…400 mm^2/s		20/18/15

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3.14 Viscosity ranges and required cleanliness classes of hydraulic components

Table 5: Viscosity ranges and required cleanliness classes (continued from page 9)

Components	Maximum permitted viscosity	Optimum viscosity range	Minimum permitted viscosity	Cleanliness class according to ISO 4406
Valves				
Pressure valves On/off valves (include pressure relief, pressure reducing, pressure sequencing, pressure shut-off valves)	380 mm^2/s (for safety valves 230 mm^2/s)	n.s.	15 mm^2/s	20/18/15
Pressure valves Servo, proportional, high-response valves (include pressure relief valves and pressure reducing valves)	380 mm^2/s (for (Z)DRS 280 mm^2/s)	20…100 mm^2/s (for DBETE and 3DREP(E) 30…46 mm^2/s)	20 mm^2/s	18/16/13 (for 3DREP(E) 17/15/12
Flow-control valves / On/off valves	380 mm^2/s	n.s.	10 mm^2/s	20/18/15
Flow-control valves / Servo, proportional, high-response valves	380 mm^2/s	30…45 mm^2/s	20 mm^2/s	17/15/12
Logic directional valves [LF(A)(S)(T) / LC(S)(T)]	500 mm^2/s	n.s.	3 mm^2/s	20/18/15
Logic directional valves [LFR (Bosch) / LR (Bosch)]	800 mm^2/s [with position switch 500 mm^2/s]	20…100 mm^2/s	10 mm^2/s	20/18/15
Logic pressure valves [LC(DR)/LC(DB)/LC(DZ)]	380 mm^2/s	n.s.	3 mm^2/s	20/18/15
Check valves [S / M-SR / Z1S(RA) / SV / SL / Z2SRK / Z2S]	500 mm^2/s	n.s.	3 mm^2/s	20/18/15
Rectifier sandwich plate [Z4S]	800 mm^2/s	n.s.	10 mm^2/s	20/18/15
Pre-fill valves [SFA / ZSF(W) /SF(S) / SFE]	800 mm^2/s	n.s.	10 mm^2/s	20/18/15
On/off directional valves direct operated, seat valves	500 mm^2/s	3…500 mm^2/s	3 mm^2/s	20/18/15
On/off directional valves, pilot operated	800 mm^2/s	3…500 mm^2/s	3 mm^2/s	20/18/15
Proportional directional valves	380 mm^2/s	30…46 mm^2/s	20 mm^2/s	20/18/15
High-response directional valves	800 mm^2/s	20…100 mm^2/s	10 mm^2/s	18/16/13
Servo valves	380 mm^2/s	30…45 mm^2/s	15 mm^2/s	18/16/13
Servo cylinders	68 mm^2/s	32…46 mm^2/s	32 mm^2/s	18/16/13
Cylinders	380 mm^2/s	20…100 mm^2/s	12 mm^2/s	20/18/15

The temperature and viscosity limits required by Bosch Rexroth AG are to be observed during operation!

4 Hydraulic fluids in operation

4.1 General

The properties of hydraulic fluids may change during storage and operation.

Please note that the fluid standard DIN 51524 merely describes minimum requirements for hydraulic fluids in new condition at the time of filling into the bins. The user of the hydraulic system is to ensure that the fluid meets the minimum requirements of this standard over the whole of its service life.

Deviations from the characteristic values in new condition are to be clarified with the fluid supplier, the test labs or Bosch Rexroth AG.

Please note the following aspects in operation:

4.2 Storage and handling

Hydraulic fluids are to be stored correctly in accordance with the instructions of the fluid supplier. The bins must be stored in such a way as to exclude the influx of foreign fluids (such as water) and solid particle contamination inside the bin. The bins must be closed correctly immediately after extraction.

4.3 Filling of new systems

The cleanliness classes of the fluids as delivered usually do not meet the requirements of our components. Fluids must be filtered using an appropriate filter system to minimize solid particle contamination and water in the system.

As early as during test operation, new systems should be filled with the selected fluid so as to preclude non-permitted mixing (see Section 4.7 “Mixing and compatibility of different hydraulic fluids”). Changing the hydraulic medium at a later point represents significant additional costs (see Section 4.4 “Changeover of fluid”).

4.4 Changeover of fluid

Changeovers, in particular between fluids with zinc-free and fluids with zinc-containing additives, frequently lead to malfunctions. See Section 3.12 “Additivation”.

In case of changeovers of fluid in hydraulic systems, it is important to ensure compatibility of the new hydraulic fluid with the remainders of the previous fluid. We recommend obtaining a written performance guarantee from the supplier of the new fluid. The remainder quantities of the old fluid need to be minimized. Mixing of fluids must be prevented; see Section 4.5 “Mixing and compatibility of different hydraulic fluids”.

You can find information on the changeover of fluids based on mineral oil to convert to environmentally friendly or flame-resistant fluids in the changeover instructions of the fluid suppliers and the data sheets on environmentally friendly and flame-resistant fluids of Bosch Rexroth AG.

Bosch Rexroth AG does not assume liability for damages resulting from unworkmanlike changeovers!

4.5 Mixing and compatibility of different hydraulic fluids

If hydraulic fluids from different manufacturers or different types from the same manufacturer are mixed, this may lead to additive reactions (see Section 3.12 “Additivation”), such as agglutination, silting, deposits or foam. The air separation ability may be affected. These reactions may lead to malfunctions or damages in the hydraulic system.

One usually speaks of a mix if it contains at least 2% of foreign fluid. Exceptions apply for water. (See Section 4.10 “Water” in this regard.)

No mixing of any kind with other fluids is permitted. This also includes fluids with the same classification and fluids from the market overview RE 90220-1. If individual fluid suppliers advertise the miscibility and/or compatibility, this is entirely the responsibility of the supplier.

Caution! With connectable accessory units and mobile filtering systems, there is a considerable risk of non-permitted mixing of the hydraulic fluids!

Bosch Rexroth AG does not assume liability for damages resulting from fluid mixes!

4.6 Later additivation

Additives added at a later point in time such as colors, wear reducers, VI conditioners or anti-foam additives, may affect the usage properties of the hydraulic fluid and the compatibility with our components.

Bosch Rexroth AG does not assume liability for damages resulting from later additivation.

4.7 Foaming behavior

Foam is created by rising air bubbles at the surface of hydraulic fluids in the tank. Foam that occurred should decompose independently as quickly as possible.

Usual hydraulic fluids in accordance with DIN 51524 are sufficiently secured against foam formation in new condition. On account of aging and accretion to surfaces, the defoamer concentration may decrease over time, leading to a stable foam.

Defoamers may be redosed only after consultation with the fluid supplier and with his written approval.

Defoamers may affect the air separation ability.

4.8 Corrosion

The hydraulic fluid is to guarantee sufficient corrosion protection of components under all operating conditions, even in the event of a possible water influx.

During storage and operating periods, fluids with mineral oil base ensure the protection of components from water and “acidic” oil decomposition products.

4.9 Air

The hydraulic medium under atmospheric conditions contains dissolved air. In the negative pressure range, for instance in the suction tube of the pump or downstream of control edges, this dissolved air may transform into undissolved air. The undissolved air content represents a risk of cavitation and of the diesel effect. This results in material erosion at components and increased fluid aging.

With constructive measures, such as suction tube and tank design, and an appropriate hydraulic fluid - ASA < 10 min, it is possible to influence air intake and separation significantly.

See also Section 3.8 “Air separation ability (ASA)”.

4.10 Water

Water contamination in hydraulic fluids can result from direct influx or indirectly through the condensation of water from the air due to temperature variations. Undissolved water may lead to wear or a direct malfunction of the hydraulic components.

Furthermore, a high water content in the fluid affects the aging as well as filterability of the fluid and increases the susceptibility to cavitation.

Undissolved water can be drained from the bottom of the tank. Dissolved water can be removed only by force, using appropriate measures. If the hydraulic system is used in humid conditions, preventive measures need to be taken, such as an air dehumidifier at the tank vent. The water content in the fluid, determined according to the “Karl Fischer method” must constantly be kept below 0.1 % (1000 ppm). To ensure a long service life for the fluids and the components, we recommend that constant values below 0.05 % (500 ppm) be kept. Deterging hydraulic fluids (HLPD / HVLPD) are able to absorb (and keep suspended) more water. Before using these fluids, please contact your fluid supplier.

4.11 Fluid servicing, fluid analysis and filtration

Air, water, temperature effects and solid particle contamination change the usage properties of hydraulic fluids, contributing to their aging.

To preserve the usage properties and ensure a long service life for fluid and components, the monitoring of the fluid condition and a filtration adapted to the application requirements (draining and degassing if required) are indispensable.

The effort is higher in case of unfavorable usage conditions, increased stress for the hydraulic system or high expectations as to availability and service life. See Section 2 “Solid particle contamination and cleanliness classes”.

When commissioning a system, please note that the required minimum cleanliness class can frequently be attained only by flushing the system. Due to severe start-up contamination, it may be possible that an oil and/or filter replacement becomes necessary after a short operating period (< 50 operating hours).

The operating medium needs to be replaced in regular intervals and tested by the fluid supplier or recognized, accredited test labs. We recommend a reference analysis after commissioning. The minimum data to be tested for analyses are:

- Viscosity at 40 °C and 100 °C (in acc. with ISO 3105)
- Acid number (AN, ISO 6618 / neutralization number DIN 51558)
- Reserve alkalinity or base number (BN, ISO 3771)
- Water content (Karl-Fischer method, ISO 12937)
- Particle measurement (ISO 4406) or mass of the filter membrane (EN 12662)
- Element analysis (RFA, ICP, specify test method)
- Comparison with new product or available trend analyses
- Assessment / evaluation for further use

For guarantee, liability or warranty claims, we require that servicing certificates and / or the results of fluid analyses be provided for us.

5 Disposal and environmental protection

Hydraulic fluids based on mineral oil and related hydrocarbons are hazardous for the environment.

The individual manufacturers of hydraulic fluids provide specifications on environmentally compatible handling and storage. Please ensure that spilt or sputtered fluids are absorbed with appropriate binding agents or by technical means and cannot reach waterbodies, the ground or sewerage.

Comply with the national legal provisions concerning the disposal of the corresponding hydraulic fluid.

6 Other fluids based on mineral oil and related hydrocarbons

Table 6: Other fluids based on mineral oil and related hydrocarbons

Hydraulic fluids	Features / Typical field of application / Notes
Fluids with classifications HL, HM, HV in acc. with ISO 11158	– Can be used without confirmation provided they comply with DIN 51524. This is to be cited in the technical data sheet of the corresponding fluid. For classification see Table 4: “Hydraulic fluid classification”. – Fluids **only** classified in accordance with ISO 11158 may be used only with prior written approval of Bosch Rexroth AG.
Fluids with classifications HH, HR, HS, HG in acc. with ISO 11158	– May not be used.
Fluids with classifications HL, HLP, HLPD, HVLP, HVLPD in accordance with DIN 51502	– DIN 51502 merely describes how fluids are classified / short-handed on a national level. – It contains no information on minimum requirements for hydraulic fluids. – Hydraulic fluids complying with DIN 51502 can be used without confirmation provided they comply with DIN 51524 at the same time. This is to be cited in the technical data sheet of the corresponding fluid. For classification see Table 4: “Hydraulic liquid classification”.
Fluids with classifications HH, HL, HM, HR, HV, HS, HG in acc. with ISO 6743-4	– ISO 6743-4 merely describes how fluids are classified / short-handed on an international level. It contains no information on minimum requirements for hydraulic fluids. – Hydraulic fluids complying with ISO 6743-4 can be used without confirmation provided they comply with DIN 51524 at the same time. This must be cited in the technical data sheet of the corresponding fluid. For classification see Table 4: “Hydraulic fluid classification”.
Lubricants and regulator fluids for turbines in acc. with DIN 51515	– Turbine oils can be used after confirmation and with limited performance data. – They usually offer a lower wear protection than mineral oil HLP, comparable to that of mineral oil HL fluids. – Particular attention must be paid to material compatibility!
Lube oils C, CL, CLP in accordance with DIN 51517	– Lube oils in acc. with DIN 51517 can be used after confirmation and with limited performance data. They are mostly higher-viscosity fluids with low wear protection. Classification: CL similar to HL fluids and CLP similar to HLP fluids. – Particular attention must be paid to material compatibility, specifically with non-ferrous metals!
Fluids to be used in pharmaceutical and foodstuff industries, in acc. with FDA / USDA / NSF H1	– There are medical white oils and synthetic hydrocarbons (PAO). – These fluids can be used without confirmation provided they comply with DIN 51524 at the same time. This must be cited in the technical data sheet of the corresponding fluid. For classification see Table 4: “Hydraulic fluid classification” – May be used only with FKM seals. – Other fluids used in pharmaceutical and foodstuff industries may be used only after confirmation. – Attention is to be paid to material compatibility in accordance with the applicable food law. **Caution!** Fluids used in pharmaceutical and foodstuff industries should not be confused with environmentally friendly fluids!
Automatic Transmission Fluids (ATF)	– ATF are operating fluids for automatic gearboxes in vehicles and machines. In special cases, ATFs are also used for certain synchronous gearboxes and hydraulic systems comprising gearboxes. – To be used only after confirmation! – Some of these fluids poor feature air separation abilities and modified wear behavior. – Check material compatibility and filterability!

6 Other fluids based on mineral oil and related hydrocarbons

Table 6: Other fluids based on mineral oil base and related hydrocarbons (continued from page 13)

Hydraulic fluids	**Features / Typical field of application / Notes**
Multi-purpose oil (MFO) - Industry	– Multi-purpose oils (industry) combine at least two requirements for a fluid, for instance metal machining and hydraulics. – To be used only after confirmation! – Please pay particular attention to air separation ability, modified wear behavior and the reduced material life cycle. – Check material compatibility and filterability!
Multi-purpose oil (MFO) – mobile UTTO, STOU	– Multi-purpose oils mobile combine requirements for wet brakes, gearboxes and hydraulics. Fluids of the types: UTTO (= universal tractor transmission oil) and STOU (= super tractor universal oil) – To be used only after confirmation! – Please pay particular attention to shear stability, air separation ability and modified wear behavior. – Check material compatibility and filterability!
Single-grade engine oils 10W, 20W, 30W	– Single-grade engine oils can be used without confirmation provided they comply with DIN 51524. This must be cited in the technical data sheet of the corresponding fluid. For classification see Table 4: “Hydraulic fluid classification”. – Please pay particular attention to the air separation ability and filtering ability.
Multi-grade engine oils 0Wx-30Wx	– To be used only after confirmation! – Please pay particular attention to the air separation ability, the viscosity changes during operation, material compatibility, water separation capability and filterability. **Caution!** Multi-grade engine oils have been adapted to specific requirements in combustion engines and are suitable for use in hydraulic systems only to a limited extent.
Hydraulic fluids for military applications in accordance with MIL 13919 or H 540, MIL 46170 or H 544, MIL 5606 or H 515, MIL 83282 or H 537, MIL 87257	– To be used only after confirmation! – Please pay particular attention to air separation ability, changes in wear protection capability, viscosity changes during operation, material compatibility, water separation capability and filterability. **Caution!** Hydraulic fluids for military applications do not meet the current requirements for high-quality hydraulic fluids and are suitable for use only to a limited degree.
Motor vehicle transmission oils	– Motor vehicle transmission oil can be used after confirmation and with limited performance data. – Pay particular attention to wear protection, material compatibilities, specifically with non-ferrous metals, as well as viscosity!
Diesel, test diesel in acc. with DIN 4113	– Diesel / test diesel has poorer wear protection capabilities and a very low viscosity (< 3 cSt). – May be used only with FKM seals – Please note their low flash point! – To be used only after confirmation and with limited performance data!

6 Other fluids based on mineral oil and related hydrocarbons

Table 6: Other fluids based on mineral oil and related hydrocarbons (continued from page 14)

Hydraulic fluids	Features / Typical field of application / Notes
Rolling oils	– Rolling oils have lower wear protection capabilities than mineral oil HLP and a lower viscosity – Please note their low flash point! – Rolling oils can be used only after confirmation and with limited performance data.
Fluids for power steering, hydropneumatic suspension, active chassis	– Can be used without confirmation provided they comply with DIN 51524 at the same time. This is to be cited in the technical data sheet of the corresponding fluid. For classification see Table 4: “Hydraulic fluid classification”. – Please note the low viscosity! – In most cases they have poor water separation capability – Check the material compatibility!

7 Glossary

Additivation:

Additives of chemical substances, added to base oils in low quantities, to achieve or improve specific properties.

Aging:

Fluids always age by oxidation (see 3.7 “Resistance to aging”). Liquid and solid contamination acts as a catalyzer for aging, which is why it needs to be minimized as far as possible by way of careful filtration.

Arrhenius equation, ICP, RFA:

The quantitative relation between reaction rate and temperature is described by an exponential function, the Arrhenius equation. This function is usually visualized within the typical temperature range of the hydraulic system. For a practical example, see Section 3.7 Resistance to aging

Demulsifying:

Ability of a fluid to separate water influx quickly; achieved with careful selection of base oil and additives.

Deterging:

Ability of certain agents to emulsify part of the water influx in the oil or to hold it suspended until it has evaporated with increasing temperature. Larger water quantities, in contrast (above approx. 2%), are separated immediately.

Disperging:

Ability of specific agents to keep insoluble liquid and solid contamination suspended in the fluid.

Diesel effect:

If mineral oil that contains air bubbles is compressed quickly, the bubbles are heated to such a degree that a self-ignition of the air-gas mix may occur. The temperature increase resulting from this may lead to damage in seals and increased aging of the fluid.

Fluids with hydrocrack base (HC):

Produced from crude oil through thermal or catalytic splitting under hydrogen atmosphere. The double bonds of the crude oil are cracked and sulfur, nitrogen and oxygen compounds are largely removed through the attachment of hydrogen. These fluids are the basis for high-quality HVLP fluids. They offer a higher thermal stability, a high shear stability, and the evaporation losses are lower compared with other fluids with mineral oil base.

Fluids with poly-alpha-olefin base (PAO):

Poly-alpha-olefins (PAO) are synthetic hydrocarbons. Their molecule distribution is defined precisely. PAO contain no sulfur compounds and are free from aromatic hydrocarbons. Furthermore, they offer a very good viscosity-temperature behavior and are characterized by the highest shear stability as well as low evaporation losses in operation.
With regard to their properties, PAO fluids are most frequently allocated to the classification “HVLP”; therefore, they are to be used correspondingly in Rexroth components (see Table 4: “Hydraulic fluid classification”).

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7 Glossary

(Continued from page 15)

ICP (atomic emission spectroscopy):

The ICP procedure can be used to determine various wear metals, contamination types and additives. Nearly all elements from the periodic table can be detected with this method.

Karl Fischer method:

Method to determine the water content in fluids. Indirect coulometric determination procedure in accordance with DIN EN ISO 12937 in connection with DIN 51777 T2. Only this method combined delivers measured values with sufficient accuracy.

Cavitation:

Cavitation is the creation of cavities in fluids due to insufficient gas pressure and subsequent implosion when the pressure increases. When the cavities implode, extremely high acceleration, temperatures and pressure may occur temporarily, which may damage the component surfaces.

RFA (wavelength dispersive x-ray fluorescence analysis):

Is a procedure to determine nearly all elements in liquid and solid samples with nearly any composition. This analysis method is suitable for examining additives and contamination, delivering fast and simple results.

Stick-slip:

Interaction between a resilient mass system involving friction (such as cylinder + oil column + load) and the pressure increase at very low sliding speeds. The static friction of the system is a decisive value here. The lower it is, the lower the speed that can still be maintained without jolts. Depending on the tribologic system, the stick-slip effect may lead to vibrations generated and sometimes also to significant noise emission. In many cases, the effect can be attenuated by replacing the lubricant, sealing and guide system.

Viscosity:

Viscosity is the measure for the internal friction of a fluid when flowing. It is defined as the property of a substance to flow under tension. Viscosity is the most important characteristic for describing the load-bearing capacity of a hydraulic fluid.

Kinematic viscosity is the ratio of the dynamic viscosity and the density of the fluid; the unit is mm^2/s. Hydraulic fluids are categorized in ISO viscosity classes by kinematic viscosity. The reference temperature for this is 40 °C.

Viscosity index (VI):

Refers to the viscosity temperature behavior of a fluid. The lower the change of viscosity in relation the temperature, the higher the VI.

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