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الإصدار الأول

مشروع تصويت

(إعداد)

زيوت التزييت ـ الزيوت الهيدروليكية ـ المواصفات الخاصة بالفئات

HH, HL, HM, HV, HG, HMHP, HVHP

Lubricating oils — Hydraulic oils — Specifications for categories
HH, HL, HM, HV, HG, HMHP, HVHP

مؤسسة المواصفات والمقاييس

المملكة الأردنية الهاشمية

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These Jordanian Standard 2422, JS 2421, JS 2423 and JS 2424 cancels and replaces the Jordanian Standard 476 issued in 2003.

Foreword

Jordan Standards and Metrology Organization is the national standardization body in Jordan. The work of preparing Jordanian Standards is normally carried out by technical committees composed of the interested parties, which are involved in the scope of the standard. All the interested parties have the right to comment on the draft Jordanian Standard during the inquiry stage, taking into consideration the importance of harmonizing Jordanian Standards with the international, regional or national standards (as much as possible) for the purpose of eliminating technical barriers to trade and facilitating the international trade.

Jordanian Standards are drafted in accordance with the rules given in the Jordanian Directive 1-2:2005, part 2: Rules for the structure and drafting of Jordanian Standards related to standardization department*.

The permanent technical committee Lubricating oils 4 has studied the Jordanian Standard 476:2003 related to **"Mineral oils – Hydraulic oils"**, and the prepared project 2422:2025 related to **"Lubricating oils – Hydraulic oils – Specifications for categories HH, HL, HM, HV, HG, HMHP, HVHP"**, and has recommended to approve the amended project as a technical regulation 2422:2025, according to article (12) of Standards and Metrology Law No. (22) for the year 2000 and it's amendments.

* under amendment.

●- Introduction

Fluids for hydraulic systems are used in a wide variety of hydraulic pumps, motors and circuits.
Hydraulic fluids are selected depending upon the anti-wear requirements of the equipment and the operating temperature range (temperature at cold starting and running temperature in stabilized conditions) to ensure the optimum mechanical and volumetric yield of the circuit and to protect pumps and motors against wear.

Mineral hydraulic fluids are formulated with mineral base stocks, from either groups I, II or III and various additives to provide the necessary oxidation stability, wear, rust, corrosion and foaming protection properties. To improve the operating temperature range, viscosity modifier polymers are added.

Lubricating oils — Hydraulic oils — Specifications for categories HH, HL, HM, HV, HG, HMHP, HVHP

1- Scope

This Jordanian Standard specifies the minimum requirements for new mineral oil hydraulic fluids and is intended for hydraulic systems, particularly for hydrostatic hydraulic fluid power application and high-performance systems. The purpose of this Jordanian Standard is to guide suppliers and end users of mineral oil hydraulic fluids and to direct equipment manufacturers of hydraulic systems.
This Jordanian Standard is intended to be used in conjunction with JS 2421, which classifies fluids used in hydraulic applications. Among the categories covered by JS 2421, only seven types of mineral oil-based fluids are covered in this Jordanian Standard. These categories are HH, HL, HM, HV, HG, HMHP, HVHP.

2- Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Indexes for published standard can be found in JSMO's library.

- ISO 4259-2, Petroleum and related products — Precision of measurement methods and results, Part 2: Interpretation and application of precision data in relation to methods of test.
- ISO 4406, Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid particles.
- ISO 5598, Fluid power systems and components — Vocabulary.
- ISO 14635-1, Gears — FZG test procedures, Part 1: FZG test method A/8,3/90 for relative scuffing load carrying capacity of oils.
- ISO 20763, Petroleum and related products — Determination of antiwear properties of hydraulic fluids — Vane pump method.
- ISO 26422, Petroleum and related products — Determination of shear stability of lubricating oils containing polymers – Method using a tapered roller bearing.
- ASTM D92, Standard test method for flash and fire points by Cleveland open cup tester.
- ASTM D97, Standard test method for pour point of petroleum products.
- ASTM D130, Standard test method for corrosiveness to copper from petroleum products by copper strip test.
- ASTM D445, Standard test method for kinematic viscosity of transparent and opaque liquids (and calculation of dynamic viscosity).
- ASTM D471, Standard test method for rubber property effect of liquids.
- ASTM D664, Standard test method for acid number of petroleum products by Potentiometric Titration.
- ASTM D665, Standard test method for rust-preventing characteristics of inhibited mineral oil in the presence of water.
- ASTM D892, Standard test method for foaming characteristics of lubricating oils.
- ASTM D943, Standard test method for oxidation characteristics of inhibited mineral oils.
- ASTM D974, Standard test method for acid and base number by color-indicator titration.
- ASTM D1401, Standard test method for water separability of petroleum oils and synthetic fluids.
- ASTM D1500, Standard test method for ASTM color of petroleum products (ASTM color scale).
- ASTM D2070, Standard test method for Thermal Stability of Hydraulic Oils.
- ASTM D2270, Standard practice for calculating viscosity index from kinematic viscosity at 40 °C and 100 °C.

- ASTM D2619, Standard test method for Hydrolytic Stability of Hydraulic Fluids (Beverage Bottle Method).
- ASTM D2983, Standard test method for low-temperature viscosity of automatic transmission fluids, hydraulic fluids, and lubricants using a Rotational Viscometer.
- ASTM D3427, Standard test method for air release properties of hydrocarbon-based oils.
- ASTM D4052, Standard test method for density, relative density, and API gravity of liquids by digital density meter.
- ASTM D4057, Standard practice for manual sampling of petroleum and petroleum products.
- ASTM D4310, Standard test method for determination of sludging and corrosion tendencies of inhibited mineral oils.
- ASTM D5182, Standard test method for evaluating the scuffing load capacity of oils (FZG visual method).
- ASTM D5950, Standard test method for pour point of petroleum products (Automatic Tilt method).
- ASTM D6203, Standard test method for Thermal Stability of Way Lubricants.
- ASTM D6304, Standard test method for determination of water in petroleum products, lubricating oils, and additives by coulometric Karl Fischer titration.
- ASTM D6749, Standard test method for pour point of petroleum products (automatic air pressure method).
- ASTM D6973, Standard test method for Indicating Wear Characteristics of Petroleum Hydraulic Fluids in a High-Pressure Constant Volume Vane Pump.
- ASTM D7042, Standard test method for dynamic viscosity and density of liquids by stabinger viscometer (and the calculation of kinematic viscosity).
- ASTM D7346, Standard test method for no flow point and pour point of petroleum products and liquid fuels.
- ASTM D8277, Standard test method for wet filterability of lubricants and hydraulic fluids by mass flow technique.
- ASTM D8385, Standard test method for dry filterability of lubricants and hydraulic fluids by mass flow technique.
- JS 2421, Lubricating oils — Hydraulic oils — Classification.
- JS ISO 3448, Industrial liquid lubricants — ISO viscosity classification.

3- Terms and definitions

For the purposes of this Jordanian Standard, the terms and definitions given in ISO 5598 apply.
ISO and IEC maintain terminology databases for use in standardization at the following addresses:
- ISO Online browsing platform: available at https://www.iso.org/obp/ui.
- IEC Electropedia: available at https://www.electropedia.org/.

4- Sampling

Sampling of hydraulic oils for the purpose of this Jordanian Standard, unless otherwise specified, shall be carried out in accordance with the pertinent procedure described in ASTM D4057. The sample shall be evaluated on a representative portion. Any drum, barrel, tanker compartment or any type of container delivered to the end user may be sampled and analysed at the discretion of the purchaser.

5- Specifications

5-1 General

Most of the test methods used in the specifications in Tables 1 to 7 contain a precision statement. In cases of dispute, the procedure described in ISO 4259-2 shall apply.

5-2 Specifications for hydraulic oils, categories HH, HL, HM, HV, HG, HMHP, HVHP

5-2-1 General

For the purpose of this Jordanian Standard, oils shall be refined petroleum oils. The classification of these hydraulic oils shall be in accordance with JS 2421.

Oils, when tested under prescribed methods, shall be in accordance with limiting values set out in Tables 1 to 7.

The appearance of the delivered oils shall be clear and bright and free of any visible particulate matter, under normal visible light at ambient temperature.

5-2-2 Specifications of HH hydraulic oils

These oils are based upon mineral base oils of either groups I, II or III, or blends thereof. They do not normally contain any additive. These oils shall be in accordance with the detailed specifications given in Table 1.

5-2-3 Specifications of HL hydraulic oils

These oils are based upon mineral base oils of either groups I, II or III, or blends thereof. These base oils are supplemented with anti-corrosion, anti-rust, anti-oxidants, pour point depressants and foam inhibitors. These oils shall be in accordance with the detailed specifications given in Table 2.

5-2-4 Specifications of HM hydraulic oils

These oils are of HL type, with supplementary anti-wear/extreme pressure additives to provide the necessary wear protection properties for the hydraulic equipment. Numerous technologies of antiwear additives are available, e.g. zinc di-thiophosphate, combinations of phosphorus and sulfur-based additives. Additionally, filterability is required to protect the most sensitive hydraulic circuits. These oils shall be in accordance with the detailed specifications given in Table 3.

5-2-5 Specifications of HV hydraulic oils

These oils are of HM type, with supplementary viscosity modifiers to improve and enlarge their operating temperature range. These oils shall be in accordance with the detailed specifications given in Table 4.

5-2-6 Specifications of HG hydraulic and slide-ways oils

These oils are of HM type, with friction modifiers to enable smooth motion on the slide-ways and to eliminate the stick-slip phenomenon. These oils shall be in accordance with the detailed specifications given in Table 5.

5-2-7 Specifications of HMHP hydraulic oils

A refined mineral base oil or synthetic base stock with rust and oxidation inhibitors plus anti-wear characteristics meeting a higher performance level than an HM fluid to address higher demanding hydraulic systems (Class HMHP). These oils shall be in accordance with the detailed specifications given in Table 6.

5-2-8 Specifications of HVHP hydraulic oils

A refined mineral base oil with rust or synthetic base stock and oxidation inhibitors, anti-wear characteristics, and increased viscosity index higher than 140 meeting a higher performance level than an HV fluid to address higher demanding hydraulic systems (Class HVHP). These oils shall be in accordance with the detailed specifications given in Table 7.

6- Packaging

Hydraulic oils shall be packed in suitable containers that neither affect nor are affected by the oils.

7- Labeling

Each container shall bear the following information, clearly and indelibly marked, in Arabic for locally produced products and in Arabic and/or English for imported products:

7-1 Product name.

7-2 Classification of the hydraulic oil.

7-3 ISO-viscosity grade.
7-4 The word “Recycled” for oils refined after use.
7-5 Country of origin or the country of packaging.
7-6 The name and address of the manufacturer, the packer, and the trademark, if applicable.
7-7 Net volume in liters.
7-8 The date of production and /or batch number.

Table 1 – Specifications for category HH mineral oils hydraulic fluids

Mineral oils of category HH: non-inhibited mineral oils											
Property	**limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Kinematic viscosity:	-	ASTM D445 [a]									
- at − 20 °C			mm^2/s	No requirement							
- at 0 °C			mm^2/s	No requirement							
- at 40 °C			mm^2/s	9,0 to 11,0	13,5 to 16,5	19,8 to 24,2	28,8 to 35,2	41,4 to 50,6	61,2 to 74,8	90,0 to 110,0	135,0 to 165,0
- at 100 °C			mm^2/s	No requirement							
Viscosity index	-	ASTM D2270	-	Report							
Colour [b]	-	ASTM D1500	-	Report							
Cleanliness [c]	-	ISO 4406	-	Report							
Appearance	-	Visual	-	Bright and clear					Bright		
Density at 15 °C	-	ASTM D4052	kg/m^3	Report							
Water content	max	ASTM D6304	mg/kg	250							
Pour point	max	ASTM D97 [d]	°C	−15	−12	−9	−6	−6	−6	−6	−6
Flash point	min	ASTM D92	°C	125	140	165	175	185	195	205	215
Acid number	max	ASTM D974/ASTM D664 [e]	mg KOH/g	0,1							
Corrosiveness to copper 3 h, at 100 °C	max	ASTM D130	Rating	2							

Table 1 – Specifications for category HH mineral oils hydraulic fluids (continued)

Mineral oils of category HH: non-inhibited mineral oils											
Property	**limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	–	JS ISO 3448	–	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Water separation Time to reach ≤ 3 ml emulsion at 54 °C Time to reach ≤ 3 ml emulsion at 82 °C	max max	ASTM D1401	min min	Report -						- Report	
Elastomer compatibility SRE-NBR-28/P/X, 100 °C, 168 h - Relative volume increase - Change in hardness		ASTM D471	% IRHD	Report Report							
Note 1: IRHD international rubber hardness degrees. Note 2: VG viscosity grade.											
[a] ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method. [b] For the purpose of identification, dye may be used by agreement between the supplier and the end user. [c] The requirements of the cleanliness of the hydraulic fluid is system dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end user. It should be noted that the fluid is exposed to various influences during transport and storage – the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling. [d] ASTM D6749 or ASTM D7346 may be used provided that ASTM D97 is the reference test method to resolve doubts or dispute. [e] ASTM D664 is the referee method.											

Table 2 ‒ Specifications for category HL mineral oils hydraulic fluids

Mineral oils of category HL: oils of HH type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Kinematic viscosity: at – 20 °C	max	ASTM D445 [a)]	mm^2/s	600	-	-	-	-	-	-	-
- at 0 °C	max		mm^2/s	90	150	300	420	780	1 400	2 500	4 500
- at 40 °C	–		mm^2/s	9,0 to 11,0	13,5 to 16,5	19,8 to 24,2	28,8 to 35,2	41,4 to 50,6	61,2 to 74,8	90,0 to 110,0	135,0 to 165,0
- at 100 °C	min		mm^2/s	2,50	3,20	4,10	5,00	6,10	7,80	9,90	14,0
Viscosity index	-	ASTM D2270	-	Report							
Colour [b)]	-	ASTM D1500	-	Report							
Cleanliness [c)]	-	ISO 4406	-	At delivery stage – Report							
Appearance	-	Visual	-	Bright and clear					Bright		
Density at 15 °C	-	ASTM D4052	kg/m^3	Report							
Water content [d)]	max	ASTM D6304	mg/kg	250							
Pour point	max	ASTM D97 [e)]	°C	−30	−27	−21	−18	−15	−12	−12	−12
Flash point (Open cup)	min	ASTM D92	°C	125	140	165	175	185	195	205	215
Acid number	max	ASTM D974/ ASTM D664 [f)]	mg KOH/g	Report							
Foaming Tendency/ stability Sequence I at 24 °C	max	ASTM D892	ml/ml	150/10							
Sequence II at 93 °C			ml/ml	80/10							
Sequence III at 24 °C after 93 °C			ml/ml	150/10							

Table 2 – Specifications for category HL mineral oils hydraulic fluids (continued)

Mineral oils of category HL: oils of HH type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	–	JS ISO 3448	–	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Air release - At 50 °C - At 75 °C	max	ASTM D3427	min min	5				10 -	13 -	- Report	
Corrosiveness to copper 3 h, 100 °C	max	ASTM D130	Rating	2							
Water separation [g)] - Time to reach ≤ 3 ml emulsion at 54 °C - Time to reach ≤ 3 ml emulsion at 82 °C	max max	ASTM D1401	min min	30 -						- 30	
Rust test (24 hours) - Procedure A - Procedure B	-	ASTM D665 [h)]		Pass Report			Pass Pass				
Oxidation stability - Acid number increase after 1 000 h - Insoluble sludge - Total copper content - Total iron content	max	ASTM D943	mg KOH/g mg mg/kg mg/kg	2,0 Report Report Report							
Thermal stability (168 h at 135 °C) - Sludge	-	ASTM D2070	mg/100 ml	Report							
Hydrolytic stability - Copper mass loss - Acidity of water layer	-	ASTM D2619	mg/cm^2 mg KOH	Report Report							
Elastomer compatibility SRE-NBR-28P/X, 100 °C, 168 h - Relative volume increase - Change in hardness	-	ASTM D471	% IRHD	0 to 18 0 to −10	0 to 15 0 to −8	0 to 15 0 to −8	0 to 12 0 to −7	0 to 12 0 to −7	0 to 10 0 to −6	0 to 10 0 to −6	0 to 10 0 to −6

Table 2 – Specifications for category HL mineral oils hydraulic fluids (continued)

Mineral oils of category HL: oils of HH type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	–	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Filterability – dry		ASTM D8385									
- Stage I	min		%				80				-
- Stage II	min		%				60				-
Filterability – wet		ASTM D8277									
- Stage I	min		%				70				-
- Stage II	min		%				50				-

Note 1: IRHD international rubber hardness degrees.
Note 2: VG viscosity grade.

[a] ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method.
[b] For the purpose of identification, dye may be used by agreement between the supplier and the end user.
[c] The requirements of the cleanliness of the hydraulic fluid is system dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end user. It should be noted that the fluid is exposed to various influences during transport and storage – the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.
[d] For detergent hydraulic oils, the limit is increased up to 500 mg/kg.
[e] ASTM D6749 or ASTM D7346 may be used provided that ASTM D97 is the reference test method to resolve doubts or dispute.
[f] ASTM D664 is the referee method.
[g] This property does not apply to fluid containing high detergent additive content (detergent hydraulic oil).
[h] ASTM D665, soak time is 24 h.

Table 3 — Specifications for category HM mineral oils hydraulic fluids

Mineral oils of category HM: oils of HL type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Kinematic viscosity:		ASTM D445 [a]									
- at −20 °C	max		mm^2/s	600	-	-	-	-	-	-	-
- at 0 °C	max		mm^2/s	90	150	300	420	780	1 400	2 500	4 500
- at 40 °C	-		mm^2/s	9,0 to 11,0	13,5 to 16,5	19,8 to 24,2	28,8 to 35,2	41,4 to 50,6	61,2 to 74,8	90,0 to 110,0	135,0 to 165,0
- at 100 °C	min		mm^2/s	2,50	3,20	4,10	5,00	6,10	7,80	9,90	14,0
Viscosity index	-	ASTM D2270	-	Report							
Colour [b]	-	ASTM D1500	-	Report							
Cleanliness [c]	-	ISO 4406	-	At delivery stage, report							
Appearance	-	Visual	-	Bright and clear					Bright		
Density at 15 °C	-	ASTM D4052	kg/m^3	Report							
Water content [d]	max	ASTM D6304	mg/kg	250							
Pour point	max	ASTM D97 [e]	°C	−30	−27	−21	−18	−15	−12	−12	−12
Flash point (open cup)	min	ASTM D92	°C	125	140	165	175	185	195	205	215
Acid number	max	ASTM D974/ D664 [f]	mg KOH/g	Report							
Foaming Tendency/stability	max	ASTM D892									
Sequence I at 24 °C			ml/ml	150/10							
Sequence II at 93 °C			ml/ml	80/10							
Sequence III at 24 °C after 93 °C			ml/ml	150/10							

Table 3 – Specifications for category HM mineral oils hydraulic fluids (continued)

Mineral oils of category HM: oils of HL type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Air release - At 50 °C - At 75 °C	max	ASTM D3427	min min	5 -				10 -	13 -	- Report	
Corrosiveness to copper 3 h, 100 °C	max	ASTM D130	Rating	2							
Water separation [g)] - Time to reach ≤ 3 ml emulsion at 54 °C - Time to reach ≤ 3 ml emulsion at 82 °C	max max	ASTM D1401	min min	30 -						- 30	
Rust test (24 hours) - Procedure A - Procedure B	-	ASTM D665 [h)]	-	Pass Report			Pass Pass				
Oxidation stability - Acid number increase after 1 000 h - Insoluble sludge - Total copper content - Total iron content	max	ASTM D943	mg KOH/g mg mg/kg mg/kg	2,0 Report Report Report							
Thermal stability (168 h at 135 °C) - Sludge	-	ASTM D2070	mg/100 ml	Report							
Hydrolytic stability - Copper mass loss - Acidity of water layer	-	ASTM D2619	mg/cm^2 mg KOH	Report Report							
Elastomer compatibility SRE-NBR-28P/X, 100 °C, 168 h - Relative volume increase - Change in hardness	-	ASTM D471	% IRHD	0 to 18 0 to −10	0 to 15 0 to −8	0 to 15 0 to −8	0 to 12 0 to −7	0 to 12 0 to −7	0 to 10 0 to −6	0 to 10 0 to −6	0 to 10 0 to −6

Table 3 – Specifications for category HM mineral oils hydraulic fluids (continued)

Property	Limit	Test method	Unit	Requirements							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Wear protection – gears FZG test A/8,3/90	-	ASTM D5182	-	-	-	-	Failure load stage ≥10				
Protection against wear - Vanes mass - Cam ring mass loss	max max	ISO 20763	mg mg	- -	- -	- -	30 120			- -	- -
Protection against wear - Vanes mass - Cam ring mass loss	max max	ASTM D6973	mg mg	- -	- -	- -	15 75	-			
Filterability – dry - Stage I - Stage II	min min	ASTM D8385	% %	80 60							-
Filterability – wet - Stage I - Stage II	min min	ASTM D8277	% %	70 50							-

Note 1: IRHD international rubber hardness degrees.
Note 2: VG viscosity grade.

[a] ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method.
[b] For the purpose of identification, dye may be used by agreement between the supplier and the end user.
[c] The requirements of the cleanliness of the hydraulic fluid is system dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end user. It should be noted that the fluid is exposed to various influences during transport and storage – the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.
[d] For detergent hydraulic oils, the limit is increased up to 500 mg/kg.
[e] ASTM D6749 or ASTM D7346 may be used provided that ASTM D97 is the reference test method to resolve doubts or dispute.
[f] ASTM D664 is the referee method.
[g] This property does not apply to fluid containing high detergent additive content (detergent hydraulic oil).
[h] ASTM D665, soak time is 24 h.

Table 4 – Specifications for category HV mineral oils hydraulic fluids

Mineral oils of category HV: oils of HM type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Kinematic viscosity:											
- at −20 °C	max	ASTM D445 [a)]	mm^2/s	Report							
- at 0 °C	max		mm^2/s	Report							
- at 40 °C	–		mm^2/s	9-11	13,5 - 16,5	19,8 - 24,2	28,8 - 35,2	41,4 - 50,6	61,2 - 74,8	90,0-110,0	135,0 - 165,0
- at 100 °C	min		mm^2/s	Report							
Viscosity index	min	ASTM D2270	-	140	140	140	140	140	140	140	120
Colour [b)]	-	ASTM D1500	-	Report							
Cleanliness [c)]	-	ISO 4406	-	At delivery stage, report							
Appearance	-	Visual	-	Bright and clear						Bright	
Density at 15 °C	-	ASTM D4052	kg/m^3	Report							
Water content [d)]	max	ASTM D6304	mg/kg	250							
Pour point	max	ASTM D97 [e)]	°C	−39	−39	−39	−30	−27	−24	−21	−18
Flash point	min	ASTM D92	°C	125	140	165	175	185	195	205	215
Acid number	max	ASTM D974/ ASTM D664 [f)]	mg KOH/g	Report							
Foaming Tendency/stability											
Sequence I at 24 °C	max	ASTM D892	ml/ml	150/10							
Sequence II at 93 °C			ml/ml	80/10							
Sequence III at 24 °C after 93 °C			ml/ml	150/10							

Table 4 – Specifications for category HV mineral oils hydraulic fluids (continued)

Mineral oils of category HV: oils of HM type with improved anti-rust and anti-oxidation properties											
Property	**Limit**	**Test method**	**Unit**	**Requirements**							
ISO-viscosity grade	-	JS ISO 3448	-	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Air release - At 50 °C - At 75 °C	max	ASTM D3427	min min	5 -				10 -	13 -	- Report	
Corrosiveness to copper 3 h, 100 °C	max	ASTM D130	Rating	2							
Water separation [g)] - Time to reach ≤ 3 ml emulsion at 54 °C - Time to reach ≤ 3 ml emulsion at 82 °C	max max	ASTM D1401	min min	30 -						- 30	
Rust test (24 hours) - Procedure A - Procedure B	-	ASTM D665 [h)]	-	Pass Report			Pass Pass				
Oxidation stability - Acid number increase after 1 000 h - Insoluble sludge - Total copper content - Total iron content	max	ASTM D943	mg KOH/g mg mg/kg mg/kg	2,0 Report Report Report							
Thermal stability (168 h at 135 °C) - Sludge	-	ASTM D2070	mg/100 ml	Report							
Hydrolytic stability - Copper mass loss - Acidity of water layer	-	ASTM D2619	mg/cm^2 mg KOH	Report Report							
Elastomer compatibility SRE-NBR-28P/X, 100 °C, 168 h - Relative volume increase - Change in hardness	-	ASTM D471	% IRHD	0 to 18 0 to −10	0 to 15 0 to −8	0 to 15 0 to −8	0 to 12 0 to −7	0 to 12 0 to −7	0 to 10 0 to −6	0 to 10 0 to −6	0 to 10 0 to −6

Table 4 – Specifications for category HV mineral oils hydraulic fluids (continued)

Property	Limit	Test method	Unit	Requirements							
ISO-viscosity grade	–	JS ISO 3448	–	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Wear protection – gears FZG test A/8,3/90	-	ASTM D5182		-	-	-	Failure load stage ≥10				
Protection against wear		ISO 20763									
- Vanes mass loss	max		mg	-	-	-	30			-	-
- Cam ring mass loss	max		mg	-	-	-	120			-	-
Protection against wear		ASTM D6973									
- Vanes mass loss	max		mg	-	-	-	15	-			
- Cam ring mass loss	max		mg	-	-	-	75	-			
Filterability – dry		ASTM D8385									
- Stage I	min		%	80							-
- Stage II	min		%	60							-
Filterability – wet		ASTM D8277									
- Stage I	min		%	70							-
- Stage II	min		%	50							-
Shear stability – tapered roller bearing (20 h at 60 °C)		ISO 26422									
- Loss in kinematic viscosity at 40 °C	max		%	Report							
- Loss in kinematic viscosity at 100 °C			%	20							

Note 1: IRHD international rubber hardness degrees.
Note 2: VG viscosity grade.

[a] ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method.
[b] For the purpose of identification, dye may be used by agreement between the supplier and the end user.
[c] The requirements of the cleanliness of the hydraulic fluid is system dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end user. It should be noted that the fluid is exposed to various influences during transport and storage – the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.
[d] For detergent hydraulic oils, the limit is increased up to 500 mg/kg.
[e] ASTM D6749 or ASTM D7346 may be used provided that ASTM D97 is the reference test method to resolve doubts or dispute.
[f] ASTM D664 is the referee method.
[g] This property does not apply to fluid containing high detergent additive content (detergent hydraulic oil).
[h] D665, soak time is 24 h.

Table 5 – Specifications for category HG mineral oils hydraulic fluids

Mineral oils of category HG: oils of HM type with improved friction properties					
Property	**Limit**	**Test method**	**Unit**	**Requirement**	
ISO-viscosity grade	-	JS ISO 3448	-	**VG 32**	**VG 68**
Kinematic viscosity: - at 0 °C - at 40 °C - at 100 °C	 max - min	ASTM D445 [a)]	 mm^2/s mm^2/s mm^2/s	 420 28,8 to 35,2 5,00	 1 400 61,2 to 74,6 7,80
Viscosity index	-	ASTM D2270	-	Report	
Colour [b)]	-	ASTM D1500	-	Report	
Cleanliness [c)]	-	ISO 4406	-	Report	
Appearance	-	Visual	-	Bright and clear	
Density at 15 °C	-	ASTM D4052	kg/m^3	Report	
Water content	max	ASTM D6304	mg/kg	250	
Pour point	max	ASTM D97 [e)]	°C	−18	−12
Flash point	min	ASTM D92	°C	175	195
Acid number	max	ASTM D974/ASTM D664 [f)]	mg KOH/g	Report	
Corrosiveness to copper	max	ASTM D130	-	2	
Foaming Tendency/stability Sequence I at 24 °C Sequence II at 93 °C Sequence III at 24 °C after 93 °C	max	ASTM D892	 ml/ml ml/ml ml/ml	 150/10 80/10 150/10	
Rust test (24 hours) - Procedure A - Procedure B	-	ASTM D665	-	 Pass Pass	

Table 5 – Specifications for category HG mineral oils hydraulic fluids (continued)

Property	**Limit**	**Test method**	**Unit**	**Requirement**	
ISO-viscosity grade	-	JS ISO 3448	-	**VG 32**	**VG 68**
Oxidation stability - Acid number increase after 1 000 h - Insoluble sludge	 max max	ASTM D943	 mg KOH/g mg	 2,0 Report	
Thermal stability (24 h to 24,5 h at 100 °C ± 2 °C) [g) h)] - Condition of the steel rod - Condition of the copper rod	-	ASTM D6203	-	 Report Report	
Elastomer compatibility SRE-NBR-28P/X, 100 °C, 168 h - Relative volume increase - Change in hardness	-	ASTM D471	 % IRHD	 0 to 12 0 to −7	 0 to 10 0 to −6
Wear protection – gears FZG test A/8,3/90	-	ISO 14635-1		Failure load stage ≥10	
Protection against wear - Vanes mass loss - Cam ring mass loss	 max max	ISO 20763	 mg mg	 30 120	
Protection against wear - Vanes mass loss - Cam ring mass loss	 max max	ASTM D6973	 mg mg	 15 75	 - -
Friction characteristics	-	-	-	Report	

Note 1: IRHD international rubber hardness degrees.
Note 2: VG viscosity grade.

a) ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method.
b) For the purpose of identification, dye may be used by agreement between the supplier and the end user.
c) The requirements of the cleanliness of the hydraulic fluid is system dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end user. It should be noted that the fluid is exposed to various influences during transport and storage – the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.
d) For detergent hydraulic oils, the limit is increased up to 500 mg/kg.
e) ASTM D6749 or ASTM D7346 may be used provided that ASTM D97 is the reference test method to resolve doubts or dispute.
f) ASTM D664 is the referee method.
g) Report the colours of the copper rod, and the presence of deposits on the steel rod and at the bottom of the beaker.
h) For lubricants for military or defence applications or end-uses, it is not necessary to measure or record the results according to ASTM D6203.

Table 6 – Specifications for category HMHP mineral oils hydraulic fluids

Mineral Oil or Synthetic Base Stock Hydraulic Fluids (Anti-wear/High Performance)									
Property	**Limit**	**Test method**	**Unit**	**Requirements**					
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG100**	**VG 150**
Kinematic viscosity at 40 °C	-	ASTM D445 a)	mm^2/s	19,8 to 24,2	28,8 to 35,2	41,4 to 50,6	61,2 to 74,8	90,0 to 110	135 to 165
Viscosity ≤ 750 mPa·s	-	D2983	temperature, °C	–15	–8	–2	4	10	16
Viscosity index	min	ASTM D2270	-	90					
Density at 15 °C	-	ASTM D4052	kg/m^3	Report					
Appearance	-	Visual	-	Bright and clear					
Pour point	max	ASTM D97 b)	°C	–21	–18	–15	–12	–12	–12
Flash point	min	ASTM D92	°C	165	175	185	195	205	215
Acid number	-	ASTM D974/ D664 c)	KOH, mg/g	Report					
Rust prevention	-	ASTM D665 d)	Visual, evaluation pass or fail	Pass					
Corrosiveness to copper 3 h, 100 °C	max	ASTM D130	Rating	2					
Hydrolytic Stability - copper corrosion D130 rating - copper mass loss - acidity of water layer	max	ASTM D2619	- mg/cm^2 KOH mg/g	2 0,4 4,0					
Water separation - Time to reach ≤ 3 ml emulsion at 54 °C - Time to reach ≤ 3 ml emulsion at 82 °C	max max	ASTM D1401	min min	30 -				- 30	- 30

Property	Limit	Test method	Unit	Requirements					
ISO-viscosity grade	**-**	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Elastomer compatibility 100 °C ± 1 °C / 288 h ± 2 h SRE-NBR-28P/X - Relative volume increase - Change in hardness	- - - -	ASTM D471	- - % IRHD	 0 to 15 0 to −8	 0 to 12 0 to −7	 0 to 12 0 to −7	 0 to 10 0 to −6	 0 to 10 0 to −6	 0 to 10 0 to −6
Foaming Tendency/ stability Sequence I at 24 °C Sequence II at 93 °C Sequence III at 24 °C after 93 °C	max	ASTM D892	ml/ml	75/0 50/0 75/0					
Air release - At 50 °C - At 75 °C	max	ASTM D3427	min	5 -	5 -	7 -	10 -	- Report	- Report
Oxidation stability, time for KOH acid number of 2 mg/kg, h	min	ASTM D943	mg KOH/g	2 500					
Sludge tendency - Acid number increase after 1 000 h - Total insoluble sludge - Copper oil/water/sludge	max	ASTM D4310	mg KOH/g mg mg	2 150 200					
Thermal stability (168 h at 135 °C)	-	ASTM D2070	copper appearance, visual	Report	5			Report	
Wear protection, mass loss vanes+ ring, mg, at 93 °C / 50 h	max	ASTM D6973	-	[e]	90	[e]			
Wear protection – gears FZG test A/8,3/90	-	ASTM D5182	Fail load stage	10	10	11			
Filterability – dry - Stage I - Stage II	min min	ASTM D8385	% %	80 60				Report Report	

Table 6 – Specifications for category HMHP mineral oils hydraulic fluids (continued)

Table 6 – Specifications for category HMHP mineral oils hydraulic fluids (continued)

Property	Limit	Test method	Unit	Requirements					
ISO-viscosity grade	**-**	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**
Filterability – wet - Stage I - Stage II	 min min	ASTM D8277	 % %	 70 50				 Report Report	

[a] ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method.
[b] Test Method D5950 can also be used.
[c] ASTM D664 is the referee method.
[d] ASTM D665, soak time is 24 h.
[e] These values can be read across from the ISO 32 testing report. ISO VG 22 best practices would be to run the pump test to verify results. Best practice is to run multiple cartridges to establish result.

Table 7 – Specifications for category HVHP mineral oils hydraulic fluids

Mineral Oil or Synthetic Base Stock Hydraulic Fluids (Multigrade Anti-wear/High Performance)									
Property	**Limit**	**Test method**	**Unit**	**Requirements**					
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG100**	**VG 150**
Kinematic viscosity at 40 °C (fresh oil)	-	ASTM D445 a)	mm^2/s	19,8 to 24,2	28,8 to 35,2	41,4 to 50,6	61,2 to 74,8	90,0 to 110	135 to 165
Viscosity ≤ 750 mPa·s	-	D2983	temperature, °C	–15	–8	–2	4	10	16
Viscosity index (fresh oil)	min	ASTM D2270	-	140					
Kinematic viscosity (after shear): - at 40 °C	-	ASTM D445 a)	mm^2/s	Report C)					
- at 100 °C	-			≥ 4,2 b)	≥ 5,2 b)	≥ 6,5 b)	≥ 8,3 b)	≥ 10,7 b)	≥14,1 b)
Viscosity index (after shear)	-	ASTM D2270	-	Report					
Density at 15 °C	-	ASTM D4052	kg/m^3	Report					
Appearance	-	Visual	-	Bright and clear					
Pour point	max	ASTM D97 c)	°C	–21	–18	–15	–12	–12	–12
Flash point	min	ASTM D92	°C	165	175	185	195	205	215
Acid number	-	ASTM D974/ D664 d)	mg KOH /g	Report					
Rust prevention	-	ASTM D665 e)	Visual, evaluation pass or fail	Pass					
Corrosiveness to copper 3 h, 100 °C	max	ASTM D130	Rating	2					
Hydrolytic Stability - copper corrosion D130 rating	max	ASTM D2619	-	2					
- copper mass loss			mg/cm^2	0,4					
- acidity of water layer			mg KOH /g	4,0					

Table 7 – Specifications for category HVHP mineral oils hydraulic fluids (continued)

Property	**Limit**	**Test method**	**Unit**	**Requirements**					
ISO-viscosity grade	**-**	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG100**	**VG 150**
Water separation Time to reach ≤ 3 ml emulsion at 54 °C	max	ASTM D1401	min	30				-	
Time to reach ≤ 3 ml emulsion at 82 °C	max		min	-				30	
Elastomer compatibility 100 °C ± 1 °C ⁄ 288 h ± 2 h SRE-NBR-28P/X - Relative volume increase - Change in hardness	- - - -	ASTM D471	- - % IRHD	0 to 15 0 to −8	0 to 12 0 to −7	0 to 12 0 to −7	0 to 10 0 to −6	0 to 10 0 to −6	0 to 10 0 to −6
Foaming Tendency/ stability Sequence I at 24 °C Sequence II at 93 °C Sequence III at 24 °C after 93 ˚C	max	ASTM D892	ml/ml ml/ml ml/ml	75/0 50/0 75/0					
Air release - At 50 °C - At 75 °C	max	ASTM D3427	min min	5 -	5 -	7 -	10 -	- Report	- Report
Oxidation stability, time for KOH acid number of 2 mg/kg, h	min	ASTM D943	mg KOH/g	2 500					
Sludge tendency - Acid number increase after 1 000 h - Total insoluble sludge - Copper oil/water/sludge	max	ASTM D4310	mg KOH/g mg mg	2 150 200					
Thermal stability (168 h at 135 °C) copper appearance, visual Steel appearance, visual sludge	max	ASTM D2070	- - mg/100 ml	Report Report Report	5 2 25	5 2 25	5 2 25	Report Report Report	Report Report Report

Table 7 — Specifications for category HVHP mineral oils hydraulic fluids (continued)

Property	**Limit**	**Test method**	**Unit**	**Requirements**					
ISO-viscosity grade	**-**	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG100**	**VG 150**
Wear protection, mass loss vanes+ C∕˚ring, mg, at 93 50 h	max	ASTM D6973	-	f)	90	f)	f)	f)	f)
Wear protection – gears FZG test A/8,3/90	-	ASTM D5182	-	10	10	11	11	11	11
Filterability – dry - Stage I - Stage II	 min min	ASTM D8385	 % %	 80 60	 80 60	 80 60	 80 60	 Report Report	 Report Report
Filterability – wet - Stage I - Stage II	 min min	ASTM D8277	 % %	 70 50	 70 50	 70 50	 70 50	 Report Report	 Report Report

a) ASTM D7042 may be used with bias correction for formulated oils. ASTM D445 is the referee method.
b) Results should target stay in grade performance but can be discussed with customer and new values agreed upon.
c) ASTM D6749 or ASTM D7346 may be used provided that ASTM D97 is the reference test method to resolve doubts or dispute.
d) ASTM D664 is the referee method.
e) ASTM D665, soak time is 24 h.
f) These values can be read across from the ISO 32 testing report. ISO VG 22 best practices would be to run the pump test to verify results. Best practice is to run multiple cartridges to establish result.

References

- ISO 11158:2023, Lubricants, industrial oils and related products (class L), Family H (Hydraulic systems) – Specifications for categories HH, HL, HM, HV and HG.
- ASTM D6158 :2023, Standard specification for mineral hydraulic oils.
- JS 119:2022, Label Industrial products label.