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زيوت التزييت ـ الزيوت الهيدروليكية ـ المواصفات الخاصة بالفئات HETG, HEPG, HEES, HEPR

Lubricating oils — Hydraulic oils — Specifications for categories HETG, HEPG, HEES, HEPR

مؤسسة المواصفات والمقاييس

المملكة الأردنية الهاشمية

Contents

Tables

These Jordanian Standard 2423, JS 2421, JS 2422 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 2423:2025 related to **"Lubricating oils – Hydraulic oils – Specifications for categories HETG, HEPG, HEES, HEPR"**, and has recommended to approve the amended project as a technical regulation 2423:2025, according to article (12) of Standards and Metrology Law No. (22) for the year 2000 and it's amendments.

* under amendment.

●- Introduction

The specifications for hydraulic fluids based upon mineral oils (H) are described in JS 2422 and the specifications for fire-resistant hydraulic fluids (HF) are given in JS 2424. This document gives specifications for environmentally acceptable hydraulic fluids (HE). These fluids are biodegradable and have a low eco-toxicity. They are designed to minimize the impact upon the environment in the event of a leak or spill.

Table A – 1 contains guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids.

Lubricating oils – Hydraulic oils – Specifications for categories HETG, HEPG, HEES, HEPR

1- Scope

This Jordanian Standard specifies the requirements for environmentally acceptable hydraulic fluids and is intended for hydraulic systems, particularly hydraulic fluid power systems. The purpose of this document is to provide guidance and requirements for suppliers and users of environmentally acceptable hydraulic fluids, and for the direction of original equipment manufacturers of hydraulic systems.

This Jordanian Standard stipulates the requirements for environmentally acceptable hydraulic fluids at the time of delivery.

Classification of fluids used in hydraulic application is defined in JS 2421. This document encompasses the four categories of environmentally acceptable fluids covered by JS 2421, namely HETG (triglycerides), HEPG (polyglycols), HEES (synthetic esters) and HEPR (polyalphaolefins and other synthetic hydrocarbons).

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 4259-1, Petroleum and related products – Precision of measurement methods and results, Part 1: Determination of precision data in relation to methods of test.

- 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 4259-3, Petroleum and related products – Precision of measurement methods and results, Part 3: Monitoring and verification of published precision data in relation to methods of test.

- ISO 4259-4, Petroleum and related products – Precision of measurement methods and results, Part 4: Use of statistical control charts to validate in-statistical-control' status for the execution of a standard test method in a single laboratory.

- ISO 4263-1, Petroleum and related products – Determination of the ageing behavior of inhibited oils and fluids – TOST test, Part 1: Procedure for mineral oils.

- ISO 4263-3, Petroleum and related products – Determination of the ageing behavior of inhibited oils and fluids using the TOST test, Part 3: Anhydrous procedure for synthetic hydraulic fluids.

- ISO 4406, Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid particles.

- ISO 6072, Rubber – Compatibility between hydraulic fluids and standard elastomeric materials.

- ISO 6341, Water quality – Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea) – Acute toxicity test.

- ISO 7346-2, Water quality – Determination of the acute lethal toxicity of substances to a freshwater fish [Brachydanio rerio Hamilton-Buchanan (Teleostei, Cyprinidae)], Part 2: Semi-static method.

- ISO 8192, Water quality – Test for inhibition of oxygen consumption by activated sludge for carbonaceous and ammonium oxidation.

- ISO 9439, Water quality – Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium – Carbon dioxide evolution test.

- ISO 13226, Rubber — Standard reference elastomers (SREs) for characterizing the effect of liquids on vulcanized rubbers.
- ISO 14593, Water quality — Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium — Method by analysis of inorganic carbon in sealed vessels (CO2 headspace test).
- 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 14669, Water quality — Determination of acute lethal toxicity to marine copepods (Copepoda, Crustacea).
- ISO 16221, Water quality — Guidance for determination of biodegradability in the marine environment.
- 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.
- EN 16807, Liquid petroleum products — Bio-lubricants — Criteria and requirements of bio-lubricants and bio-based lubricants.
- EN 17181, Lubricants — Determination of aerobic biological degradation of fully formulated lubricants in an aqueous solution — Test method based on CO2-production.
- 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 D482, Standard test method for ash from petroleum products.
- 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 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 D2270, Standard practice for calculating viscosity index from kinematic viscosity at 40 °C and 100 °C.
- ASTM D2272, Standard test method for oxidation stability of steam turbine oils by rotating pressure vessel.
- ASTM D2532, Standard test method for viscosity and viscosity change after standing at low temperature of aircraft turbine lubricants.
- ASTM D3427, Standard test method for air release properties of hydrocarbon-based oils.
- ASTM D4052, Standard practice 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 D6081, Standard Practice for Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation.
- 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 D6866, Standard Test Methods for Determining the Biobased Content of Solid, Liquid and Gaseous Samples Using Radiocarbon Analysis.
- 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

No terms and definitions are listed in this document.
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.
- IEC Electropedia: available at https://www.electropedia.org/.

4- Sampling

Sampling of hydraulic oils for the purpose of this document, 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- Requirements of environmentally acceptable hydraulic fluids

5-1 General

For the purpose of this document, hydraulic fluids shall be triglycerides, polyglycols, synthetic esters, polyalphaolefins and related hydrocarbon products. The classification of these hydraulic oils shall be in accordance with JS 2421 for categories HETG, HEPG, HEES and HEPR. The minimum category-defining base oil type content for each category shall be in accordance with the requirements of Table 1.

Table 1 — Minimum category-defining base fluid content for each category

Category	Mass fraction	Category defining base fluid [a] type content of the total fluid formulation	Total base fluid content of the fluid formulation
HETG	%	> 50	≥ 70
HEPG	%	> 50	≥ 70
HEES	%	> 50	≥ 70
HEPR	%	> 50	≥ 70

[a] Category defining base fluid is identified as the relevant triglycerides, polyglycols, synthetic esters, polyalphaolefins and related hydrocarbon products.

Environmentally acceptable hydraulic fluids shall comply with the requirements of EN 16807, as follows: HETG, HEPG, HEES and HEPR shall comply with the biodegradability and the toxicity

requirements. Additionally, HETG and HEES shall comply with the carbon of biological origin requirements (see Table 2).

The requirements published in EN 16807 are intended as baseline requirements for all bio-based lubricants, and represent minimum requirements compared to, for example, the European Ecolabel for Lubricants [3]. With the exception of content of carbon of biological origin, these requirements can also be minimum requirements for other types of environmental standards existing in the world.

In a product line of either of the categories, for all grades of a line that uses the same additive package and the same range of base stocks, toxicity requirements may be tested only on the lightest, medium and heaviest grade of the line.

The characteristics of the fluids shall comply with the limiting values set out in Table 2 and with the limiting values of the relevant fluid category set out in Tables 3 to 6. The test methods and standards listed in Tables 2 to 6 shall apply.

Table 2 – Environmental requirements for categories HETG, HEPG, HEES and HEPR

Characteristic of test	Unit	Requirement	Test method or applicable standard
Biodegradability resulting in mineralization of the organic material, 28 d, min.	%	60	ISO 14593 [c)] or ISO 9439 [c)] or ISO 16221 [c)] or EN 17181 [c)]
Toxicity [a)]			
Acute fish toxicity, 96 h, LC50	mg/l	> 100	ISO 7346-2 [c)]
Acute daphnia or copepods toxicity, 48 h, EC50	mg/l	> 100	ISO 6341 [c)] or ISO 14669 [c)]
Bacterial inhibition, 3 h, EC50	mg/l	> 100	ISO 8192 [c)]
Content of carbon of biological origin, min.[b)]	%	25	ASTM D6866

[a)] Water soluble fluids shall be tested in accordance with the test method cited. Fluids with low water solubility shall be tested using water-accommodated fractions, and shall be prepared in accordance with ASTM D6081.

[b)] Applies only to HETG and HEES type products.

[C)] The interpretation of the results of this test method is currently limited due to missing or inapplicable precision data. In case of dispute or doubt, a referee test should be performed in an independent laboratory.

The biodegradability and aquatic toxicity tests should be performed in a laboratory operating in accordance with ISO/IEC 17025 or according to good laboratory practice (GLP).

5-2 Biodegradability

In case of dispute, the referee method for compliance with the biodegradability requirement shall be the method specified in EN 17181. In order to check the procedure during the referee process, a reference compound of known biodegradability shall be tested in parallel. Aniline shall be used when testing water-soluble test compounds. For poorly water-soluble test substances, high oleic reference oil (HORO) shall be used.

5-3 Acute daphnia or copepods toxicity

In case of dispute, the referee method for compliance with the invertebrate requirement shall be the method specified in ISO 6341.

In order to check the procedure during the referee process, a reference compound of known toxicity shall be tested in parallel. Tetrapropylenebenzenesulfonic acid shall be used when testing water soluble test compounds. For poorly water-soluble test substances potassium 2,4,5-trichlorophenoxyacetate shall be used.

All other detailed specifications of each category mentioned in this document are provided in Tables 3 to 6, respectively, and as indicated below:

- Table 3: category HETG.
- Table 4: category HEPG.
- Table 5: category HEES.
- Table 6: category HEPR.

All of the categories listed above pertain to lubricants, industrial oils and related products of Group HE, i.e. environmentally acceptable hydraulic fluids, a typical application of which is in general hydraulic systems. The composition of each category is specified in the title of Tables 3 to 6. These elements are taken from JS 2421.

6- Precision

Most of the test methods specified in Table 3 to Table 6 contain a precision statement. In cases of dispute, the procedure described in ISO 4259-2 shall apply, only if the conditions specified in ISO 4259-1, ISO 4259-3 and ISO 4259-4 are met.

7- Packaging

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

8- 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:

8-1 Product name.
8-2 Classification of the hydraulic oil.
8-3 ISO-viscosity grade.
8-4 The word “Recycled” for oils refined after use.
8-5 Country of origin or the country of packaging.
8-6 The name and address of the manufacturer, the packer, and the trademark, if applicable.
8-7 Net volume in liters.
8-8 The date of production and /or batch number.

Table 3 – Specifications for type HETG hydraulic fluids, triglycerides

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Density at 15 °C	-	ASTM D4052	kg/m^3	Report	Report	Report	Report
Colour [a)]		ASTM D1500	-	Report	Report	Report	Report
Appearance at 25 °C	-	Visual	-	clear and bright	clear and bright	clear and bright	clear and bright
Ash content by mass		ASTM D482	%	b)	b)	b)	b)
Flash point	min	ASTM D92	°C	165	175	185	195
Kinematic viscosity		ASTM D445 [c)]					
at −20 °C	-		mm^2/s	b)	b)	b)	b)
at 0 °C	max		mm^2/s	300	420	780	1 400
at 40 °C	-		mm^2/s	19,8 to 24,2	28,8 to 35,2	41,4 to 50,6	61,2 to 74,8
at 100 °C	min		mm^2/s	4,1	5,0	6,1	7,8
Viscosity Index	-	ASTM D2270	-	Report	Report	Report	Report
Pour point	-	ASTM D97 [d)]	°C	b)	b)	b)	b)
Low temperature fluidity after 7 days	-	ASTM D2532	°C	b)	b)	b)	b)
Acid number	-	ASTM D974/ ASTM D664 [e)]	mg KOH/g	b)	b)	b)	b)
Water content	max	ASTM D6304	mg/kg	1 000	1 000	1 000	1 000
Cleanliness level	-	ISO 4406	b)	b)	b)	b)	b)
Copper corrosion, 100 °C 3 h	max	ASTM D130	rating	2	2	2	2
Rust prevention, 24 h:	-	ASTM D665	-	Pass	Pass	Pass	Pass
Procedure A				Pass	Pass	Pass	Pass
Procedure B							

Table 3 – Specifications for type HETG hydraulic fluids, triglycerides (continued)

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Foaming Tendency/ stability							
Sequence I at 24 °C	max	ASTM D892	ml/ml	150/0	150/0	150/0	150/0
Sequence II at 93 °C				80/0	80/0	80/0	80/0
Sequence III at 24 °C after 93 °C				150/0	150/0	150/0	150/0
Air release, 50 °C	max	ASTM D3427	min	5	5	10	13
Water separation							
Time to 3 ml emulsion at 54 °C	-	ASTM D1401	min	b)	b)	b)	b)
Elastomer compatibility after							
1 000 h at given temperature							
NBR 1 according to ISO 6072			°C	60	80	80	80
HNBR/1 according to ISO 13226			°C	60	80	80	80
FKM/2 according to ISO 13226			°C	60	80	80	80
Change in shore A hardness			grade	±10	±10	±10	±10
Change in volume			%	−3 to +10	−3 to +10	−3 to +10	−3 to +10
Change in elongation	max		%	30	30	30	30
Change in tensile strength	max		%	30	30	30	30
Oxidation stability:							
Dry TOST test, time to reach ΔTAN g) = 2 mg KOH/g	-	ISO 4263-3	h	Report b)	Report b)	Report b)	Report b)
RPVOT h)	-	ASTM D2272	min	Report	Report	Report	Report
Shear stability, tapered roller bearing, 20 h at 60 °C							
- Loss in kinematic viscosity at 40 °C	-	ISO 26422	%	Report	Report	Report	Report
- Loss in kinematic viscosity at 100 °C			%	Report	Report	Report	Report

Table 3 – Specifications for type HETG hydraulic fluids, triglycerides (continued)

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	**-**	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Load-carrying properties, FZG A/8,3/90, min.	-	ISO 14635-1	Fail load stage	-	10	10	10
Vane pump, Procedure A Ring Vane	 max max	ISO 20763	 mg mg	 - -	 120 30	 120 30	 120 30
Filterability, dry - Stage I filterability - Stage II filterability.	min	ASTM D8385	 % %	 80 60	 80 60	 80 60	 80 60
Filterability, wet - Stage I filterability - Stage II filterability	min	ASTM D8277	 % %	 Report Report	 Report Report	 Report Report	 Report Report

[a] For purposes of identification, dye may be used by agreement between supplier and end user.
[b] Criteria of performance or values of characteristics shall be negotiated between supplier and end user.
[c] Test Method ASTM D7042 may be used with bias correction for formulated oils. D445 is the referee method.
[d] Test Method 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.
[f] TAN = total acid number
[g] RPVOT = rotating pressure vessel oxidation test.

Table 4 – Specifications for type HEPG hydraulic fluids, polyglycols

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Density at 15 °C	-	ASTM D4052	kg/m^3	Report	Report	Report	Report
Colour [a)]	-	ASTM D1500	-	Report	Report	Report	Report
Appearance at 25 °C	-	Visual	-	clear and bright	clear and bright	clear and bright	clear and bright
Ash content by mass	-	ASTM D482	%	b)	b)	b)	b)
Flash point	min	ASTM D92	°C	165	175	185	195
Kinematic viscosity at −20 °C at 0 °C at 40 °C at 100 °C	 - max - min	ASTM D445 [c)]	 mm^2/s mm^2/s mm^2/s mm^2/s	 b) 300 19,8- 24,2 4,1	 b) 420 28,8-35,2 5,0	 b) 780 41,4- 50,6 6,1	 b) 1 400 61,2-74,8 7,8
Viscosity Index	-	ASTM D2270	-	Report	Report	Report	Report
Pour point	max	ASTM D97 [d)]	°C	-21	-18	-15	-12
Low temperature fluidity after 7 days	-	ASTM D2532	°C	b)	b)	b)	b)
Acid number	-	ASTM D974/ ASTM D664 [e)]	mg KOH/g	b)	b)	b)	b)
Water content	max	ASTM D6304	mg/kg	5 000	5 000	5 000	5 000
Cleanliness level	-	ISO 4406	b)	b)	b)	b)	b)
Copper corrosion, 100 °C 3 h	max	ASTM D130	rating	2	2	2	2
Rust prevention, 24 h: Procedure A Procedure B		ASTM D665	 - -	 Pass Pass	 Pass Pass	 Pass Pass	 Pass Pass

Table 4 – Specifications for type HEPG hydraulic fluids, polyglycols (continued)

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Foaming Tendency/ stability							
Sequence I at 24 °C	max	ASTM D892	ml/ml	150/0	150/0	150/0	150/0
Sequence II at 93 °C				80/0	80/0	80/0	80/0
Sequence III at 24 °C after 93 °C				150/0	150/0	150/0	150/0
Air release, 50 °C	max	ASTM D3427	min	7	7	10	13
Elastomer compatibility after 1 000 h at given temperature							
NBR 1 according to ISO 6072		ASTM D471	°C	60	80	-	-
HNBR/1 according to ISO 13226			°C	60	80	100	100
FKM/2 according to ISO 13226			°C	60	80	100	100
Change in shore A hardness			grade	±10	±10	±10	±10
Change in volume			%	−3 to +10	−3 to +10	−3 to +10	−3 to +10
Change in elongation	max		%	30	30	30	30
Change in tensile strength	max		%	30	30	30	30
Oxidation stability: Dry TOST test, time to reach ΔTAN [f] = 2 mg KOH/g	min	ISO 4263-3	h	1 000	1 000	1 000	1 000
Shear stability, tapered roller bearing, 20 h at 60 °C							
- Loss in kinematic viscosity at 40 °C	-	ISO 26422	%	Report	Report	Report	Report
- Loss in kinematic viscosity at 100 °C			%	Report	Report	Report	Report

Table 4 – Specifications for type HEPG hydraulic fluids, polyglycols (continued)

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	**-**	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Load-carrying properties, FZG A/8,3/90	min	ISO 14635-1	Fail load stage	-	10	10	10
Vane pump, Procedure A		ISO 20763					
Ring	max		mg	-	120	120	120
Vane	max		mg	-	30	30	30
Filterability, dry		ASTM D8385					
- Stage I filterability	min		%	80	80	80	80
- Stage II filterability.			%	60	60	60	60
Filterability, wet		ASTM D8277					
- Stage I filterability	min		%	Report	Report	Report	Report
- Stage II filterability			%	Report	Report	Report	Report

[a] For purposes of identification, dye may be used by agreement between supplier and end user.
[b] Criteria of performance or values of characteristics shall be negotiated between supplier and end user.
[c] Test Method ASTM D7042 may be used with bias correction for formulated oils. D445 is the referee method.
[d] Test Method 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.
[f] TAN = total acid number.

Table 5 – Specifications for type HEES hydraulic fluids, synthetic esters

Property	Limit	Test method	Unit	Requirement				
ISO-viscosity grade	-	JS ISO 3448	**-**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**
Density at 15 ˚C	-	ASTM D4052	kg/m^3	Report	Report	Report	Report	Report
Colour [a)]	-	ASTM D1500	-	Report	Report	Report	Report	Report
Appearance at 25 ˚C	-	Visual	-	clear and bright	clear and bright	clear and bright	clear and bright	clear and bright
Ash content by mass	-	ASTM D482	%	b)	b)	b)	b)	b)
Flash point	min	ASTM D92	˚C	165	175	185	195	205
Kinematic viscosity at −20 ˚C at 0 ˚C at 40 ˚C at 100 ˚C	 - max - min	ASTM D445 [c)]	 mm^2/s mm^2/s mm^2/s mm^2/s	 b) 300 19,8- 24,2 4,1	 b) 420 28,8-35,2 5,0	 b) 780 41,4- 50,6 6,1	 b) 1 400 61,2-74,8 7,8	 b) 1 500 90,0-110 10,0
Viscosity Index	-	ASTM D2270	-	Report	Report	Report	Report	Report
Pour point	max	ASTM D97 [d)]	˚C	−21	−18	−15	−12	−9
Low temperature fluidity after 7 days	-	ASTM D2532	˚C	b)	b)	b)	b)	b)
Acid number	-	ASTM D974/ ASTM D664 [e)]	mg KOH/g	b)	b)	b)	b)	b)
Water content	max	ASTM D6304	mg/kg	1 000	1 000	1 000	1 000	1 000
Cleanliness level	-	ISO 4406	b)	b)	b)	b)	b)	b)
Copper corrosion, 100 ˚C 3 h	max	ASTM D130	rating	2	2	2	2	2
Rust prevention, 24 h: Procedure A Procedure B	-	ASTM D665	 - -	 Pass Pass	 Pass Pass	 Pass Pass	 Pass Pass	 Pass Pass

Table 5 – Specifications for type HEES hydraulic fluids, synthetic esters (continued)

Property	Limit	Test method	Unit	Requirement				
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**
Foaming Tendency/ stability								
Sequence I at 24 °C	max	ASTM D892	ml/ml	150/0	150/0	150/0	150/0	150/0
Sequence II at 93 °C				80/0	80/0	80/0	80/0	80/0
Sequence III at 24 °C after 93 °C				150/0	150/0	150/0	150/0	150/0
Air release, 50 °C	max	ASTM D3427	min	5	7	10	13	a)
Water separation								
Time to 3 ml emulsion at 54 °C	-	ASTM D1401	min	b)	b)	b)	b)	b)
Elastomer compatibility after 1 000 h at given temperature								
NBR 1 according to ISO 6072	-	ASTM D471	°C	60	80	80	-	-
HNBR/1 according to ISO 13226	-		°C	60	80	80	100	100
FKM/2 according to ISO 13226	-		°C	60	80	80	100	100
Change in shore A hardness	-		grade	±10	±10	±10	±10	±10
Change in volume	-		%	−3 to +10	−3 to +10	−3 to +10	−3 to +10	−3 to +10
Change in elongation	max		%	30	30	30	30	30
Change in tensile strength	max		%	30	30	30	30	30
Oxidation stability:								
Dry TOST test, time to reach ΔTAN f) = 2 mg KOH/g	-	ISO 4263-3	h	Report b)	Report b)	Report b)	Report b)	Report b)
RPVOT g)	-	ASTM D2272	min	Report	Report	Report	Report	Report
Shear stability, tapered roller bearing, 20 h at 60 °C								
- Loss in kinematic viscosity at 40 °C	-	ISO 26422	%	Report	Report	Report	Report	Report
- Loss in kinematic viscosity at 100 °C			%	Report	Report	Report	Report	Report

Table 5 – Specifications for type HEES hydraulic fluids, synthetic esters (continued)

Property	Limit	Test method	Unit	Requirement				
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**
Load-carrying properties, FZG A/8,3/90	min	ISO 14635-1	Fail load stage	-	10	10	10	10
Vane pump, Procedure A		ISO 20763						
Ring	max		mg	-	120	120	120	-
Vane	max		mg	-	30	30	30	-
Filterability, dry		ASTM D8385						
- Stage I filterability	min		%	80	80	80	80	80
- Stage II filterability.			%	60	60	60	60	60
Filterability, wet		ASTM D8277						
- Stage I filterability	min		%	Report	Report	Report	Report	Report
- Stage II filterability			%	Report	Report	Report	Report	Report

[a] For purposes of identification, dye may be used by agreement between supplier and end user.
[b] Criteria of performance or values of characteristics shall be negotiated between supplier and end user.
[c] Test Method ASTM D7042 may be used with bias correction for formulated oils. D445 is the referee method.
[d] Test Method 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.
[f] TAN = total acid number.
[g] RPVOT = rotating pressure vessel oxidation test.

Table 6 – Specifications for type HEPR hydraulic fluids, polyalphaolefins and other synthetic hydrocarbons

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Density at 15 °C	-	ASTM D4052	kg/m^3	Report	Report	Report	Report
Colour [a)]	-	ASTM D1500	-	Report	Report	Report	Report
Appearance at 25 °C	-	Visual	-	clear and bright	clear and bright	clear and bright	clear and bright
Ash content by mass	-	ASTM D482	%	b)	b)	b)	b)
Flash point	min	ASTM D92	°C	165	175	185	195
Kinematic viscosity at −20 °C at 0 °C at 40 °C at 100 °C	 - max - min	ASTM D445 [b)]	 mm^2/s mm^2/s mm^2/s mm^2/s	 b) 300 19,8- 24,2 4,1	 b) 420 28,8-35,2 5,0	 b) 780 41,4- 50,6 6,1	 b) 1 400 61,2-74,8 7,8
Viscosity Index	-	ASTM D2270	-	Report	Report	Report	Report
Pour point	max	ASTM D97 [d)]	°C	−21	−18	−15	−12
Low temperature fluidity after 7 days	-	ASTM D2532	°C	b)	b)	b)	b)
Acid number	max	ASTM D974/ ASTM D664 [e)]	mg KOH/g	b)	b)	b)	b)
Water content	max	ASTM D6304	mg/kg	1 000	1 000	1 000	1 000
Cleanliness level	-	ISO 4406	b)	b)	b)	b)	b)
Copper corrosion, 100 °C 3 h	max	ASTM D130	rating	2	2	2	2
Rust prevention, 24 h: Procedure A Procedure B	-	ASTM D665	 - -	 Pass Pass	 Pass Pass	 Pass Pass	 Pass Pass

Table 6 – Specifications for type HEPR hydraulic fluids, polyalphaolefins and other synthetic hydrocarbons (continued)

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	**-**	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Foaming Tendency/ stability							
Sequence I at 24 °C	max	ASTM D892	ml/ml	150/0	150/0	150/0	150/0
Sequence II at 93 °C				80/0	80/0	80/0	80/0
Sequence III at 24 °C after 93 °C				150/0	150/0	150/0	150/0
Air release, 50 °C	max	ASTM D3427	min	5	5	10	13
Water separation							
Time to 3 ml emulsion at 54 °C	-	ASTM D1401	min	b)	b)	b)	b)
Elastomer compatibility after							
1 000 h at given temperature							
NBR 1 according to ISO 6072			°C	60	80	-	-
HNBR/1 according to ISO 13226		ASTM D471	°C	60	80	100	100
FKM/2 according to ISO 13226			°C	60	80	100	100
Change in shore A hardness			grade	±10	±10	±10	±10
Change in volume			%	−3 to +10	−3 to +10	−3 to +10	−3 to +10
Change in elongation	max		%	30	30	30	30
Change in tensile strength	max		%	30	30	30	30
Oxidation stability:							
Dry TOST test, time to reach ΔTAN [f] = 2 mg KOH/g [)	min	ISO 4263-1	h	1 000	1 000	1 000	1 000
Shear stability, tapered roller bearing, 20 h at 60 °C							
- Loss in kinematic viscosity at 40 °C	-	ISO 26422	%	Report	Report	Report	Report
- Loss in kinematic viscosity at 100 °C			%	Report	Report	Report	Report

Table 6 – Specifications for type HEPR hydraulic fluids, polyalphaolefins and other synthetic hydrocarbons (continued)

Property	Limit	Test method	Unit	Requirement			
ISO-viscosity grade	-	JS ISO 3448	-	**VG 22**	**VG 32**	**VG 46**	**VG 68**
Load-carrying properties, FZG A/8,3/90	min	ISO 14635-1	Fail load stage	-	10	10	10
Vane pump, Procedure A Ring Vane	 max max	ISO 20763	 mg mg	 120 30	 120 30	 120 30	 120 30
Filterability, dry - Stage I filterability - Stage II filterability.	min	ASTM D8385	 % %	 80 60	 80 60	 80 60	 80 60
Filterability, wet - Stage I filterability - Stage II filterability	min	ASTM D8277	 % %	 Report Report	 Report Report	 Report Report	 Report Report

[a] For purposes of identification, dye may be used by agreement between supplier and end user.
[b] Criteria of performance or values of characteristics shall be negotiated between supplier and end user.
[c] Test Method ASTM D7042 may be used with bias correction for formulated oils. D445 is the referee method.
[d] Test Method 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.
[f] TAN = total acid number.
[g] RPVOT = rotating pressure vessel oxidation test.

Annex A
(informative)
Guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids

Table A – 1 – Guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids

Change of liquid pressure medium		Elements to be checked to determine whether the installation is suitable for the use of environmentally acceptable hydraulic fluids					Measures during and after changeover		
from	**to**	**Reservoir temperature** [a) b)]	**Seals, plastics, adhesives**	**Metallic materials**	**Filter elements** [c)]	**Paint coating**	**Remaining residual volume** [d)] **max.**	**Periods between oil changes**	**Periods between filter changes**
HH HL HM HV HD [g)] Engine oils	HETG	−10 °C to +70 °C	Industrial elastomers [e)]	Lead, tin and zinc in pure form should be avoided. Alloys of these metals are subject to possible corrosion [f)] in conjunction with aged liquids and at elevated temperatures.	Zinc-coated filter elements are subject to attack.	Compatibility with paint coating.	< 2 % (target). This is to ensure thorough cleansing, emptying and flushing of the installation.	Periods between changes depend on the installation and the application and should be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, it is necessary to have running investigations, for instance of water content, solid particle contamination, viscosity, acid value and infrared (IR), as well as spectrographic analyses.	Filter changes when converting to the new liquid and after 50 h. Further changes should be established bearing in mind the installation and application details.

Table A – 1 – Guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids (continued)

Change of liquid pressure medium		**Elements to be checked to determine whether the installation is suitable for the use of environmentally acceptable hydraulic fluids**					**Measures during and after changeover**		
from	**to**	**Reservoir temperature** [a) b)]	**Seals, plastics, adhesives**	**Metallic materials**	**Filter elements** [c)]	**Paint coating**	**Remaining residual volume max.** [d)]	**Periods between oil changes**	**Periods between filter changes**
HH HL HM HV HD [g)] Engine oils	HEES	−20 °C to +80 °C	Industrial elastomers [e)] Plastics and soluble adhesive compounds	Lead, tin and zinc in pure form should be avoided. Alloys of these metals are subject to possible corrosion [f)] in conjunction with aged liquids and at elevated temperatures.	Paper filter cartridges and zinc-coated filter elements are subject to attack.	Compatibility with paint coating.	< 2 % (target). This is to ensure thorough cleansing, emptying and flushing of the installation.	Periods between changes depend on the installation and the application and should be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, it is necessary to have running investigations, for instance of water content, solid particle contamination, viscosity, acid value and infrared (IR), as well as spectrographic analyses.	Filter changes when converting to the new liquid and after 50 h. Further changes should be established bearing in mind the installation and application details.

Table A – 1 – Guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids (continued)

Change of liquid pressure medium		**Elements to be checked to determine whether the installation is suitable for the use of environmentally acceptable hydraulic fluids**					**Measures during and after changeover**		
from	**to**	**Reservoir temperature** [a)] [b)]	**Seals, plastics, adhesives**	**Metallic materials**	**Filter elements** [c)]	**Paint coating**	**Remaining residual volume** [d)] **max.**	**Periods between oil changes**	**Periods between filter changes**
HH HL HM HV HD [g)] Engine oils	HEPR	−30 °C to +100 °C	Industrial elastomers [e)] Plastics and soluble adhesive compounds. An abrupt change from a mineral oil-based fluid to a HEPR-based product can lead to leakage of gaskets. This can lead to sealing problems.	Lead, tin and zinc in pure form should be avoided. Alloys of these metals are subject to possible corrosion [f)] in conjunction with aged liquids and at elevated temperatures.	Paper filter cartridges and zinc-coated filter elements are subject to attack.	Compatibility with paint coating.	< 2 % (target). This is to ensure thorough cleansing, emptying and flushing of the installation.	Periods between changes depend on the installation and the application and should be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, it is necessary to have running investigations, for instance of water content, solid particle contamination, viscosity, acid value and infrared (IR), as well as spectrographic analyses.	Filter changes when converting to the new liquid and after 50 h. Further changes should be established bearing in mind the installation and application details.

Table A – 1 – Guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids (continued)

Change of liquid pressure medium		**Elements to be checked to determine whether the installation is suitable for the use of environmentally acceptable hydraulic fluids**					**Measures during and after changeover**		
from	**to**	**Reservoir** [a] [b] **temperature**	**Seals, plastics, adhesives**	**Metallic materials**	**Filter elements** [c]	**Paint coating**	**Remaining residual volume max.** [d]	**Periods between oil changes**	**Periods between filter changes**
HH HL HM HV HD [g] Engine oils	HEPG [h]	−20 °C to +80 ˚C	Industrial elastomers [e] Plastics and soluble adhesive compounds. Non-resistant e.g. polycarbonates, polymethacrylates	Frictional combinations with aluminum, Lead, tin and zinc in pure form should be avoided as well as frictional combinations with aluminum. Alloys of these metals are subject to possible corrosion [f] in conjunction with aged liquids and at elevated temperatures.	Filter elements. Suction filters. Paper filter cartridges and zinc-coated filter elements are subject to attack.	Compatibility with paint coating.	< 1 % (target). This is to ensure thorough cleansing, emptying and flushing of the installation.	Periods between changes depend on the installation and the application and should be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, it is necessary to have running investigations, for instance of water content, solid particle contamination, viscosity, acid value and infrared (IR), as well as spectrographic analyses.	Filter changes when converting to the new liquid and after 50 h. Further changes should be established bearing in mind the installation and application details. Higher percentages of mineral oil shorten the periods between changes.

Table A – 1 – Guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids (continued)

Change of liquid pressure medium		**Elements to be checked to determine whether the installation is suitable for the use of environmentally acceptable hydraulic fluids**					**Measures during and after changeover**		
from	**to**	**Reservoir temperature** a) b)	**Seals, plastics, adhesives**	**Metallic materials**	**Filter elements** c)	**Paint coating**	**Remaining residual volume** d) **max.**	**Periods between oil changes**	**Periods between filter changes**

When changing from HETG, HEES and HEPR to HEPG, it is recommended for users to proceed in the same way as when changing from HL, HH, HM, HV to HEPG, due to possible miscibility problems.

a) Higher temperatures have an unfavorable influence on compatibility with seals and ageing characteristics.

b) In hydro systems, temperatures of up to 25 °C higher can be permitted for a short time or locally.

c) The manufacturer should be consulted for suitability.

d) The number of flushes depends on the installation. It is possible that the residual volumes quoted cause filtration or foaming problems.

e) Recommended industrial elastomers. Refer to footnote c.

f) There is at present no recognized procedure for assessment.

g) HD = heavy duty.

h) A density of more than 1 g/ml requires a reduction of about 20 % in the maximum permitted rotary speed of self-priming pumps.

Annex B
(Informative)
Bibliography

[1] JS 2422/2025, Lubricating oils – Hydraulic oils – Specifications for categories HH, HL, HM, HV and HG.
[2] JS 2422/2025, ISO 12922, Lubricating oils – Hydraulic oils – Specifications for hydraulic fluids in categories HFAE, HFAS, HFB, HFC, HFDR and HFDU.
[3] Official journal of the European Union 13/11/2018: Commission decision 2018/1702 establishing the EU Ecolabel Criteria for lubricants.
[4] ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories.

Reference

- ISO 15380:2023, Lubricants, industrial oils and related products (class L), Family H (Hydraulic systems) – Specifications for hydraulic fluids in categories HETG, HEPG, HEES and HEPR.
- JS 119:2022, Label Industrial products label.