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Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for hydraulic fluids in categories HETG, HEPG, HEES and HEPR

Lubrifiants, huiles industrielles et produits connexes (classe L) — Famille H (Systèmes hydrauliques) — Spécifications applicables aux fluides hydrauliques des catégories HETG, HEPG, HEES et HEPR

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 28, *Petroleum products and related products of synthetic or biological origin*, Subcommittee SC 4, *Classifications and specifications*.

This third edition cancels and replaces the second edition (ISO 15380:2011), which has been technically revised.

Introduction

The specifications for hydraulic fluids based upon mineral oils (H) are described in ISO 11158[1] while the specifications for fire-resistant hydraulic fluids (HF) are given in ISO 12922[2]. This International Standard gives specifications for environmentally acceptable hydraulic fluids (HE). These fluids are readily 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.

This International Standard contains three informative annexes. Annex A contains guidelines for changing fluids from mineral-based oils to environmentally acceptable fluids. Annex B contains additional information on shear stability. Annex C covers the disposal of hydraulic fluids.

Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for hydraulic fluids in categories HETG, HEPG, HEES and HEPR

WARNING — The handling and use of products as specified in this International Standard can be hazardous if suitable precautions are not observed. This International Standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. The environmentally acceptable fluids should not present any significant hazard to health when used correctly in hydraulic equipment, observing the supplier's handling recommendations.

1 Scope

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

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

Classification of fluids used in hydraulic application is defined in ISO 6743-4. This International Standard encompasses only four of the categories of environmentally acceptable fluids covered by ISO 6743-4. These categories are HETG, HEPG, HEES and HEPR. The minimum content of base fluid for each category shall not be less than 70 % (*m*/*m*).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2049, *Petroleum products — Determination of colour (ASTM scale)*

ISO 2160, *Petroleum products — Corrosiveness to copper — Copper strip test*

ISO 2592, *Determination of flash and fire points — Cleveland open cup method*

ISO 3016, *Petroleum products — Determination of pour point*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3170, *Petroleum liquids — Manual sampling*

ISO 3448, *Industrial liquid lubricants — ISO viscosity classification*

ISO 3675, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 4259, *Petroleum products — Determination and application of precision data in relation to methods of test*

ISO 4263-1, *Petroleum and related products — Determination of the ageing behaviour of inhibited oils and fluids — TOST test — Part 1: Procedure for mineral oils*

ISO 4263-3, *Petroleum and related products — Determination of the ageing behaviour 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 6245, *Petroleum products — Determination of ash*

ISO 6247, *Petroleum products — Determination of foaming characteristics of lubricating oils*

ISO 6296, *Petroleum products — Determination of water — Potentiometric Karl Fischer titration method*

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

ISO 6614, *Petroleum products — Determination of water separability of petroleum oils and synthetic fluids*

ISO 6618, *Petroleum products and lubricants — Determination of acid or base number — Colour-indicator titration method*

ISO 6619, *Petroleum products and lubricants — Neutralization number — Potentiometric titration method*

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 7120, *Petroleum products and lubricants — Petroleum oils and other fluids — Determination of rust-preventing characteristics in the presence of water*

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 9120, *Petroleum and related products — Determination of air-release properties of steam turbine and other oils — Impinger method*

ISO 9439, *Water quality — Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium — Carbon dioxide evolution test*

ISO 10634, *Water quality — Guidance for the preparation and treatment of poorly water-soluble organic compounds for the subsequent evaluation of their biodegradability in an aqueous medium*

ISO 11500, *Hydraulic fluid power — Determination of the particulate contamination level of a liquid sample by automatic particle counting using the light-extinction principle*

ISO 12185, *Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method*

ISO 12937, *Petroleum products — Determination of water — Coulometric Karl Fischer titration method*

ISO 14593, *Water quality — Evaluation of ultimate aerobic biodegradability of organic compounds in aqueous medium — Method by analysis of inorganic carbon in sealed vessels (CO_2 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/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 20763, *Petroleum and related products — Determination of anti-wear properties of hydraulic fluids — Vane pump method*

DIN 51554-3, *Testing of mineral oils; Test of susceptibility to ageing according to Baader; Testing at 95 °C*

ASTM D2532, *Standard Test Method for Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants*

3 Sampling

Sampling of hydraulic fluids for the purpose of this International Standard shall be carried out in accordance with the pertinent procedure specified in ISO 3170. A representative test specimen should be taken for analysis.

Any drum, barrel, tanker compartment or other type of container delivered to the end user may be sampled and analyzed at the purchaser's discretion.

4 Requirements of environmentally acceptable hydraulic fluids

For the purpose of this International Standard, hydraulic fluids shall be triglycerides, polyglycols, synthetic esters, polyalphaolefins and related hydrocarbon products. The classification of these hydraulic oils shall be in accordance with ISO 6743-4 for categories HETG, HEPG, HEES and HEPR. The minimum content of base fluid for each category shall not be less than 70 % (*m*/*m*).

Fluid classification should correspond to the major base stock component.

When tested using prescribed methods, the fluids' characteristics shall comply with limiting values set out in Table 1 to Table 5, where applicable.

The appearance of the delivered oils shall be clear and bright and free of any visible particulate matter when viewed under normal visible light at ambient temperature. The cleanliness level shall be expressed according to ISO 4406 and ISO 11500.

The precision (repeatability and reproducibility) of the test methods in this International Standard and the interpretation of the results shall be in accordance with ISO 4259, which shall be consulted in instances of uncertainty or dispute.

The environmental behaviour specifications for categories HETG, HEPG, HEES and HEPR are given in Table 1.

Table 1 — Environmental behaviour requirements for categories HETG, HEPG, HEES and HEPR

Characteristic of test	Unit	Requirement	Test method or applicable standard
Biodegradability, 28 days, min.	%	60	ISO 14593 or ISO 9439
Toxicity[a]			
Acute fish toxicity, 96 h, LC50, min.	mg/l	100	ISO 7346-2
Acute Daphnia toxicity, 48 h, EC50, min.	mg/l	100	ISO 6341
Bacterial inhibition, 3 h, EC50, min.	mg/l	100	ISO 8192
[a] Water-soluble fluids shall be tested according to the test method cited. Fluids with low water solubility shall be tested using water-accommodated fractions, prepared according to ISO 10634.			

The biodegradability and aquatic toxicity tests shall be performed in a laboratory operating in accordance with ISO/IEC 17025 or according to Good Laboratory Practice (GLP).

All other detailed specifications of each category mentioned in this International Standard are provided in Table 2 to Table 5, respectively and as indicated below:

— Table 2: category HETG;

— Table 3: category HEPG;

— Table 4: category HEES;

— Table 5: 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 the tables. These elements are taken from ISO 6743-4.

Table 2 — Specifications for type HETG hydraulic fluids, triglycerides

Characteristic of test	Unit	Requirement				Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	**ISO 3448**
Density at 15 °C	kg/m^3	—[a]	—[a]	—[a]	—[a]	ISO 12185 ISO 3675
Colour[b]	—	—[a]	—[a]	—[a]	—[a]	ISO 2049
Appearance at 25 °C	—	Clbr[c]	Clbr[c]	Clbr[c]	Clbr[c]	—
Ash content, max.	% (*m*/*m*)	—[d]	—[d]	—[d]	—[d]	ISO 6245
Flash point Cleveland open cup, min.	°C	165	175	185	195	ISO 2592
Kinematic viscosity						ISO 3104
at -20 °C, max.	mm^2/s	—[d]	—[d]	—[d]	—[d]	
at 0 °C, max.	mm^2/s	300	420	780	1 400	
at 40 °C, min. to max.	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	
Pour point, max.	°C	—[d]	—[d]	—[d]	—[d]	ISO 3016
Low temperature fluidity after 7 days	°C	—[d]	—[d]	—[d]	—[d]	ASTM D2532
Acid number,[e] max.	mg KOH/g	—[d]	—[d]	—[d]	—[d]	ISO 6618 ISO 6619
Water content	mg/kg	1 000	1 000	1 000	1 000	ISO 12937 ISO 6296
Cleanliness level, max	[d]	—[d]	—[d]	—[d]	—[d]	ISO 4406 ISO 11500
Copper corrosion, 100 °C 3 h, max.	rating	2	2	2	2	ISO 2160
Rust prevention, procedure A, 24 h	—	Pass	Pass	Pass	Pass	ISO 7120
Foam						ISO 6247
at 24 °C, max. (Sequence I)	ml	150/0	150/0	150/0	150/0	
at 93 °C, max. (Sequence II)	ml	80/0	80/0	80/0	80/0	
at 24 °C, max. (Sequence III)	ml	150/0	150/0	150/0	150/0	
Air release, 50 °C, max.	min	7	7	10	10	ISO 9120
Water separation Time to 3 ml emulsion at 54 °C, max.	min	—[d]	—[d]	—[d]	—[d]	ISO 6614

Table 2 *(continued)*

Characteristic of test	Unit	Requirement				Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	**ISO 3448**
Elastomer compatibility[f] after 1 000 h at given temperature						
NBR 1	°C	60	80	80	80	
HNBR	°C	60	80	80	80	
FKM 2	°C	60	80	80	80	
AU[g]	°C	60	80	80	80	
Change in shore A hardness, max.	grade	±10	±10	±10	±10	ISO 6072
Change in volume, max.	%	-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:						
Time to reach ΔTAN = 2 mg KOH/g, min.	h	—[ad]	—[ad]	—[ad]	—[ad]	ISO 4263-3 DIN 51554-3
Baader test, 95 °C, 72 h						
Increase in viscosity at 40 °C, max.	%	20	20	20	20	
Load-carrying properties, FZG A/8,3/90, min.	stage	—[h]	10	10	10	ISO 14635-1
Vane pump, Procedure A[i]						
Ring, max.	mg	120	120	120	120	ISO 20763
Vane, max.	mg	30	30	30	30	

[a] Report.

[b] For purposes of identification, dye may be used by agreement between supplier and end user.

[c] "Clear and bright" is abbreviated as Clbr.

[d] Criteria of performance or values of characteristics to be negotiated between supplier and end user.

[e] The initial acid number is given by the base fluids and the additives.

[f] The requirements for two of the listed elastomer types shall be met. The values are minimum requirements for standard reference elastomers. The elastomers are suitable for guidance and selection of the correct sealing material. Other materials and/or test conditions may be agreed between supplier and customer. The applicability to the behaviour of the elastomer used in practice should be considered.

[g] No hydrolytic stabilized elastomer exists for AU. Manufacturers produce stabilized AU materials for practical applications. It is recommended that users clarify this point with the elastomer manufacturer.

[h] Not applicable to viscosity grade 22.

[i] There are currently no precision data for the method when non-Eaton/Vickers test cartridges (e.g. Conestoga USA, Inc. and Tokimec) are used. Consequently, no absolute mass loss limits can be stipulated until the precision of V104C pump cartridges from the new supplier has been determined. In the interim, the limits previously established for Eaton/Vickers cartridges may be used for guidance. It should be noted that ISO 20763 supersedes BS 2000: Part 281, IP 281 and DIN 51389. For fluids evaluated under the aforementioned methods, the test data are considered to remain valid and no re-testing against ISO 20763 is required.

Table 3 — Specifications for type HEPG hydraulic fluids, polyglycols

Characteristic of test	Unit	Requirement				Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	**ISO 3448**
Density at 15 °C	kg/m^3	—[a]	—[a]	—[a]	—[a]	ISO 12185 ISO 3675
Colour[b]	—	—[a]	—[a]	—[a]	—[a]	ISO 2049
Appearance at 25 °C	—	Clbr[c]	Clbr[c]	Clbr[c]	Clbr[c]	—
Ash content, max.	% (*m*/*m*)	—[d]	—[d]	—[d]	—[d]	ISO 6245
Flash point Cleveland open cup, min.	°C	165	175	185	195	ISO 2592
Kinematic viscosity at –20 °C, max. at –0 °C, max. at –40 °C, max. at 100 °C, min.	 mm^2/s mm^2/s mm^2/s mm^2/s	 —[d] 300 19,8 to 24,2 4,1	 —[d] 420 28,8 to 35,2 5,0	 —[d] 780 41,4 to 50,6 6,1	 —[d] 1 400 61,2 to 74,8 7,8	ISO 3104
Pour point, max.	°C	-21	-18	-15	-12	ISO 3016
Low temperature fluidity after 7 days	°C	—[d]	—[d]	—[d]	—[d]	ASTM D2532
Acid number,[e] max.	mg KOH/g	—[d]	—[d]	—[d]	—[d]	ISO 6618 ISO 6619
Water content, max.	mg/kg	5 000	5 000	5 000	5 000	ISO 12937 ISO 6296
Cleanliness level, max	[d]	—[d]	—[d]	—[d]	—[d]	ISO 4406 ISO 11500
Copper corrosion, 100 °C 3 h, max.	rating	2	2	2	2	ISO 2160
Rust prevention, procedure A, 24 h	—	Pass	Pass	Pass	Pass	ISO 7120
Foam at 24 °C, max. (Sequence I) at 93 °C, max. (Sequence II) at 24 °C, max. (Sequence III)	 ml ml ml	 150/0 80/0 150/0	 150/0 80/0 150/0	 150/0 80/0 150/0	 150/0 80/0 150/0	ISO 6247
Air release, 50 °C, max.	min	7	7	10	10	ISO 9120
Elastomer compatibility[f] after 1 000 h at given temperature NBR 1 HNBR FKM 2 Change in shore A hardness, max. Change in volume, max. Change in elongation, max. Change in tensile strength, max.	 °C °C °C grade % % %	 60 60 60 ±10 -3 to +10 30 30	 80 80 80 ±10 -3 to +10 30 30	 — 100 100 ±10 -3 to +10 30 30	 — 100 100 ±10 -3 to +10 30 30	ISO 6072

Table 3 *(continued)*

Characteristic of test	Unit	Requirement				Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	**ISO 3448**
Oxidation stability: TOST test, time to reach ΔTAN = 2 mg KOH/g, min.	h	1 000	1 000	1 000	1 000	ISO 4263-3
Load-carrying properties, FZG A/8,3/90, min.	stage	—[g]	10	10	10	ISO 14635-1
Vane pump, Procedure A[h] Ring, max. Vane, max.	 mg mg	 120 30	 120 30	 120 30	 120 30	ISO 20763

[a] Report.

[b] For purposes of identification, dye may be used by agreement between supplier and end user.

[c] "Clear and bright" is abbreviated as Clbr.

[d] Criteria of performance or characteristics values to be negotiated between supplier and end user.

[e] The initial acid number is given by the base fluids and the additives.

[f] The requirements for two of the listed elastomer types shall be met. The values are minimum requirements for standard reference elastomers. The elastomers are suitable for guidance and selection of the correct sealing material. Other materials and/or test conditions may be agreed upon between supplier and customer. The applicability to the behaviour of the elastomer used in practice should be considered.

[g] Not applicable to Viscosity Grade 22.

[h] There are currently no precision data for the method when non-Eaton/Vickers test cartridges (e.g. Conestoga USA, Inc. and Tokimec) are used. Consequently, no absolute mass loss limits can be stipulated until the precision of V104C pump cartridges from the new supplier has been determined. In the interim, the limits previously established for Eaton/Vickers cartridges may be used for guidance. It should be noted that ISO 20763 supersedes BS 2000: Part 281, IP 281 and DIN 51389. For fluids evaluated under the aforementioned methods, the test data are considered to remain valid and no re-testing against ISO 20763 is required.

Table 4 — Specifications for type HEES hydraulic fluids, synthetic esters

Characteristic of test	Unit	Requirement					Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	**100**	**ISO 3448**
Density at 15 °C	kg/m^3	—[a]	—[a]	—[a]	—[a]	—[a]	ISO 12185 ISO 3675
Colour[b]	—	—[a]	—[a]	—[a]	—[a]	—[a]	ISO 2049
Appearance at 25 °C	—	Clbr[c]	Clbr[c]	Clbr[c]	Clbr[c]	Clbr[c]	-
Ash content, max.	% (*m*/*m*)	—[d]	—[d]	—[d]	—[d]	—[d]	ISO 6245
Flash point							
Cleveland open cup, min.	°C	165	175	185	195	205	ISO 2592
Kinematic viscosity							
at -20 °C, max.	mm^2/s	—[d]	—[d]	—[d]	—[d]	—[d]	
at 0 °C, max.	mm^2/s	300	420	780	1 400	1 500	ISO 3104
at 40 °C, min. to max.	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	
at 100 °C, min.	mm^2/s	4,1	5,0	6,1	7,8	10,0	
Pour point, max.	°C	-21	-18	-15	-12	-9	ISO 3016
Low temperature fluidity after 7 days	°C	—[d]	—[d]	—[d]	—[d]	—[d]	ASTM D2532
Acid number[e], max.	mg KOH/g	—[d]	—[d]	—[d]	—[d]	—[d]	ISO 6618 ISO 6619
Water content, max.	mg/kg	1 000	1 000	1 000	1 000	1 000	ISO 12937 ISO 6296
Cleanliness level, max	[d]	—[d]	—[d]	—[d]	—[d]	—[d]	ISO 4406 ISO 11500
Copper corrosion, 100 °C, 3 h, max.	rating	2	2	2	2	2	ISO 2160
Rust prevention, procedure A, 24 h		Pass	Pass	Pass	Pass	Pass	ISO 7120
Foam							
at 24 °C, max. (Sequence I)	ml	150/0	150/0	150/0	150/0	150/0	
at 93 °C, max. (Sequence II)	ml	80/0	80/0	80/0	80/0	80/0	ISO 6247
at 24 °C, max. (Sequence III)	ml	150/0	150/0	150/0	150/0	150/0	
Air release, 50 °C, (75°C for ISO VG 100), max.	min	7	7	10	10	14	ISO 9120
Water separation Time to 3 ml emulsion at 54 °C, max.	min	—[d]	—[d]	—[d]	—[d]	—[d]	ISO 6614

Table 4 *(continued)*

Characteristic of test	Unit	Requirement					Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	**100**	**ISO 3448**
Elastomer compatibility[f] after 1 000 h at given temperature							
NBR 1	°C	60	80	80	—	—	
AU	°C	60	80	80	—	—	
HNBR	°C	60	80	80	100	100	
FKM 2	°C	60	80	80	100	100	
Change in shore A hardness, max.	grade	±10	±10	±10	±10	±10	ISO 6072
Change in volume, max.	%	-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:							
Modified TOST, dry TOST, time to reach ΔTAN = 2 mg KOH/g, min.	h	—[a][d]	—[a][d]	—[a][d]	—[a][d]	—[a][d]	ISO 4263-3 DIN 51554-3
Baader test, 110 °C, 72 h							
Increase in viscosity at 40 °C, max.	%	20	20	20	20	20	
Load-carrying properties, FZG A/8,3/90, min.	stage	—[g]	10	10	10	10	ISO 14635-1
Vane pump. Procedure A[h]							ISO 20763
Ring, max.	mg	120	120	120	120	120	
Vane, max.	mg	30	30	30	30	30	

[a] Report.

[b] For purposes of identification, dye may be used by agreement between supplier and end user.

[c] "Clear and bright" is abbreviated as Clbr.

[d] Criteria of performance or values of characteristics to be negotiated between supplier and end user.

[e] The initial acid number is given by the base fluids and the additives.

[f] The requirements for two of the listed elastomer types shall be met. The values are minimum requirements for standard reference elastomers. The elastomers are suitable for guidance and selection of the correct sealing material. Other materials and/or test conditions may be agreed upon between supplier and customer. The applicability to the behaviour of the elastomer used in practice should be considered.

[g] Not applicable to Viscosity Grade 22.

[h] There are currently no precision data for the method when non-Eaton/Vickers test cartridges (e.g. Conestoga USA, Inc. and Tokimec) are used. Consequently, no absolute mass loss limits can be stipulated until the precision of V104C pump cartridges from the new supplier has been determined. In the interim, the limits previously established for Eaton/Vickers cartridges may be used for guidance. It should be noted that ISO 20763 supersedes BS 2000: Part 281, IP 281 and DIN 51389. For fluids evaluated under the aforementioned methods, the test data are considered to remain valid and no re-testing against ISO 20763 is required.

Table 5 — Specifications for type HEPR hydraulic fluids, polyalphaolefins and other synthetic hydrocarbons

Characteristic of test	Unit	Requirement				Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	ISO 3448
Density at 15 °C	kg/m^3	—[a]	—[a]	—[a]	—[a]	— [a]
Colour[b]	—	—[a]	—[a]	—[a]	—[a]	ISO 2049
Appearance at 15 °C	—	Clbr[c]	Clbr[c]	Clbr[c]	Clbr[c]	—
Ash content, max.	% (*m*/*m*)	—[d]	—[d]	—[d]	—[d]	ISO 6245
Flash point Cleveland open cup, min.	°C	165	175	185	195	ISO 2592
Kinematic viscosity						ISO 3104
at -20 °C, max.	mm^2/s	—[d]	—[d]	—[d]	—[d]	
at 0 °C, max.	mm^2/s	300	420	780	1 400	
at 40 °C, min. to max.	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	
Pour point, max.	°C	-21	-18	-15	-12	ISO 3016
Low temperature fluidity after 7 days	°C	—[d]	—[d]	—[d]	—[d]	ASTM D2532
Acid number[e], max.	mg KOH/g	—[d]	—[d]	—[d]	—[d]	ISO 6618 ISO 6619
Water content	mg/kg	1 000	1 000	1 000	1 000	ISO 12937 ISO 6296
Cleanliness level, max	[d]	—[d]	—[d]	—[d]	—[d]	ISO 4406 ISO 11500
Copper corrosion, 100 °C, 3 h, max.	rating	2	2	2	2	ISO 2160
Rust prevention, procedure A, 24 h		Pass	Pass	Pass	Pass	ISO 7120
Foam						ISO 6247
at 24 °C, max. (Sequence I)	ml	150/0	150/0	150/0	150/0	
at 93 °C, max. (Sequence II)	ml	80/0	80/0	80/0	80/0	
at 24 °C, max. (Sequence III)	ml	150/0	150/0	150/0	150/0	
Air release, 50 °C, max.	min	7	7	10	10	ISO 9120
Water separation Time to 3 ml emulsion at 54 °C, max.	min	—[d]	—[d]	—[d]	—[d]	ISO 6614

Table 5 *(continued)*

Characteristic of test	Unit	Requirement				Test method or applicable standard
Viscosity grade		**22**	**32**	**46**	**68**	ISO 3448
Elastomer compatibility[f] after 1 000 h at given temperature						
NBR 1	°C	60	80	—	—	ISO 6072
HNBR	°C	60	80	100	100	
FKM 2	°C	60	80	100	100	
Change in shore A hardness, max.	grade	±10	±10	±10	±10	
Change in volume, max.	%	-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: TOST test, time to reach ΔTAN = 2 mg KOH/g, min.	h	1 000	1 000	1 000	1 000	ISO 4263-1
Load carrying properties, FZG A/8,3/90, min.	Stage	—[g]	10	10	10	ISO 14635-1
Vane pump, Procedure A[h]						ISO 20763
Ring, max.	mg	120	120	120	120	
Vane, max.	mg	30	30	30	30	

[a] Report.

[b] For purposes of identification, dye may be used by agreement between supplier and end user.

[c] "Clear and bright" is abbreviated as Clbr.

[d] Criteria of performance or values of characteristics to be negotiated between supplier and end user.

[e] The initial acid number is given by the base fluids and the additives.

[f] The requirements for two of the listed elastomer types shall be met. The values are minimum requirements for standard reference elastomers. The elastomers are suitable for guidance and selection of the correct sealing material. Other materials and/or test conditions may be agreed upon between supplier and customer. The applicability to the behaviour of the elastomer used in practice should be considered.

[g] Not applicable to Viscosity Grade 22.

[h] There are currently no precision data for the method when non-Eaton/Vickers test cartridges (e.g. Conestoga USA, Inc. and Tokimec) are used. Consequently, no absolute mass loss limits can be stipulated until the precision of V104C pump cartridges from the new supplier has been determined. In the interim, the limits previously established for Eaton/Vickers cartridges may be used for guidance. It should be noted that ISO 20763 supersedes BS 2000: Part 281, IP 281 and DIN 51389. For fluids evaluated under the aforementioned methods, the test data are considered to remain valid and no re-testing against ISO 20763 is required.

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[ab] temperature	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 are to 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. 1 %	Periods between changes depend upon the installation and the application and have to be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, running investigations, for instance of water content, solid particle contamination, viscosity, NN and IR, as well as spectrographic analyses, are necessary.	Filter change when converting to the new liquid and after 50 h. Further changes have to be established bearing in mind the installation and application details.
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 are to 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. 1 %	Periods between changes depend upon the installation and the application and have to be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, running investigations, for instance of water content, solid particle contamination, viscosity, NN and IR, as well as spectrographic analyses, are necessary.	Filter changes when converting to the new liquid and after 50 h. Further changes have to be established bearing in mind the installation and application details.

Table A.1 *(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[ab] temperature**	**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 could lead to leakage of gaskets. This can lead to sealing problems.	Lead, tin and zinc in pure form are to 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. 1 %	Periods between changes depend upon the installation and the application and have to be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, running investigations, for instance of water content, solid particle contamination, viscosity, NN and IR, as well as spectrographic analyses, are necessary.	Filter changes when converting to the new liquid and after 50 h. Further changes have to be established bearing in mind the installation and application details.
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. poly-carbonates, poly-methacrylates	Frictional combinations with aluminium. Lead, tin and zinc in pure form are to be avoided as well as frictional combinations with aluminium. 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. 0,50 %	Periods between changes depend upon the installation and the application and have to be agreed with the manufacturer of the liquid. In order to determine the length of time between changeovers, running investigations, for instance of water content, solid particle contamination, viscosity, NN and IR, as well as spectrographic analyses, are necessary.	Filter changes when converting to the new liquid and after 50 h. Further changes have to be established bearing in mind the installation and application details. Higher percentages of mineral oil shorten the periods between changes.

Table A.1 *(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[ab] temperature**	**Seals, plastics, adhesives**	**Metallic materials**	**Filter elements[c]**	**Paint coating**	**Remaining residual volume[d], max**	**Periods between oil changes**	**Periods between filter changes**

NOTE 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 unfavourable influence on compatibility with seals and ageing characteristics.

[b] In hydrosystems, temperatures of up to 25 °C and higher can be permitted for a short time or locally.

[c] Manufacturer to be consulted for suitability.

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

[e] Recommended industrial elastomers. Refer to footnote [c].

[f] At present, there is no recognized procedure for assessment.

[g] HD stands for heavy duty. To include fluid discrepancy and detergency.

[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)

Additional information on shear stability

Type HEES and HEPG hydraulic fluids containing polymers may be tested against shear stability by test methods according to ISO 20844[3].

Requirements and test conditions should be agreed upon between the supplier and end user.

Annex C
(informative)

Disposal of hydraulic fluids

All HE fluids for disposal should be collected in separate containers and discarded in a responsible manner in compliance with government regulations and industrial safety standards.

The suppliers of HE fluids should provide end users with recommended guidelines/procedures for the safe disposal of fluids.

Bibliography

[1] ISO 11158:2009, incorporating corrigendum March 2010, *Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for categories HH, HL, HM, HV and HG*

[2] ISO 12922:2012, *Lubricants, industrial oils and related products (class L) — Family H (Hydraulic systems) — Specifications for hydraulic fluids in categories HFAE, HFAS, HFB, HFC, HFDR and HFDU*

[3] ISO 20844, *Petroleum and related products — Determination of the shear stability of polymer-containing oils using a diesel injector nozzle*

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