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Third edition
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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

Lubrifiants, huiles industrielles et produits connexes (classe L) — Famille H (systèmes hydrauliques) — Spécifications applicables aux fluides hydrauliques des catégories HFAE, HFAS, HFB, HFC, HFDR et HFDU

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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 of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, Subcommittee SC 4, *Classifications and specifications*.

This third edition cancels and replaces the second edition (ISO 12922:2012), which has been technically revised. The main changes compared with the previous edition are as follows:

— an introduction and a terms and definitions clause have been added;

— the methods specified for measuring water content in water-based fluid types HFA/HFB/HFC have been revised;

— the oxidation requirements for HFDU fluids have been increased.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Hydraulic fluids constitute the largest segment of the industrial lubricant market. Although mineral oil-based fluids are by far the most widely used type of hydraulic fluid, there are some applications where the use of these fluids could constitute a fire hazard. In order to reduce the risk to operatives in such circumstances, fire-resistant or less flammable fluids that increase operator safety have been developed. However, the following points should be noted.

— Even fire-resistant fluids can ignite at very high temperatures and the flammability behaviour of the fluids specified in this document covers a very wide range. It is therefore necessary to know the level of hazard in order to select the appropriate fluid.

— The properties of these fluids can be significantly different to those of conventional mineral oil-based products. For example, some fire-resistant fluids contain water. It might therefore be necessary to design the system for their use. It should also not be assumed that synthetic, non-aqueous fluids can replace mineral oil products without system modifications. Some fluids, for example, are incompatible with the elastomers used with mineral oils.

To enable the satisfactory operation of fire-resistant hydraulic fluids, it is recommended that this document is read in conjunction with ISO 7745.

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

WARNING — The handling and use of products as specified in this document can be hazardous if suitable precautions are not observed. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1 Scope

This document specifies the minimum requirements of unused fire-resistant and less flammable hydraulic fluids for hydrostatic and hydrodynamic systems in general industrial applications. It is not intended for use in aerospace or power-generation applications, where different requirements apply. It provides guidance for suppliers and end users of these less hazardous fluids and to the manufacturers of hydraulic equipment in which they are used.

Of the categories covered by ISO 6743-4, which classifies the different types of fluids used in hydraulic applications, only the following are detailed in this document: HFAE, HFAS, HFB, HFC, HFDR and HFDU.

Types HFAE, HFAS, HFB, HFC and HFDR are "fire-resistant" fluids as defined by ISO 5598. Most HFDU fluids, while displaying an improvement in combustion behaviour over mineral oil, fall outside this definition and are more appropriately considered as "less flammable" fluids.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 760, *Determination of water — Karl Fischer method (General method)*

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

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 4259-2, *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 4263-2, *Petroleum and related products — Determination of the ageing behaviour of inhibited oils and fluids — TOST test — Part 2: Procedure for category HFC hydraulic fluids*

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 4404-1, *Petroleum and related products — Determination of the corrosion resistance of fire-resistant hydraulic fluids — Part 1: Water-containing fluids*

ISO 4404-2, *Petroleum and related products — Determination of the corrosion resistance of fire-resistant hydraulic fluids — Part 2: Non-aqueous fluids*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6072, *Rubber — Compatibility between hydraulic fluids and standard elastomeric materials*

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

ISO 6296:2000, *Petroleum products — Determination of water — Potentiometric Karl Fischer titration method*

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 7745, *Hydraulic fluid power — Fire-resistant (FR) fluids — Requirements and guidelines for use*

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

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

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 14935, *Petroleum and related products — Determination of wick flame persistence of fire-resistant fluids*

ISO 15029-1, *Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids — Part 1: Spray flame persistence — Hollow-cone nozzle method*

ISO 15029-2, *Petroleum and related products — Determination of spray ignition characteristics of fire-resistant fluids — Part 2: Spray test — Stabilised flame heat release method*

ISO 20623, *Petroleum and related products — Determination of the extreme-pressure and anti-wear properties of lubricants — Four-ball method (European conditions)*

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

ISO 20764, *Petroleum and related products — Preparation of a test portion of high-boiling liquids for the determination of water content — Nitrogen purge method*

ISO 20783-1, *Petroleum and related products — Determination of emulsion stability of fire-resistant fluids — Part 1: Fluids in category HFAE*

ISO 20783-2, *Petroleum and related products — Determination of emulsion stability of fire-resistant fluids — Part 2: Fluids in category HFB*

ISO 20823, *Petroleum and related products — Determination of the flammability characteristics of fluids in contact with hot surfaces — Manifold ignition test*

ISO 20843, *Petroleum and related products — Determination of pH of fire-resistant fluids within categories HFAE, HFAS and HFC*

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

EN 14832, *Petroleum and related products — Determination of the oxidation stability and corrosivity of fire-resistant phosphate ester fluids*

EN 14833, *Petroleum and related products — Determination of the hydrolytic stability of fire-resistant phosphate ester fluids*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Sampling

The sampling of hydraulic fluids for the purposes of this document shall be carried out in accordance with the appropriate procedure described in ISO 3170. A representative sample shall be evaluated.

Any drum, barrel, tanker, compartment or any type of container delivered to the end user may be sampled and analysed at the request of the purchaser.

5 Requirements for fire-resistant hydraulic fluids and less flammable hydraulic fluids

For the purposes of this document, fluids shall be classified according to ISO 6743-4. Guidelines for their selection and use can be found in ISO 7745 and CEN/TR 14489[1]. The latter also includes information on health and safety requirements.

Where applicable and when tested in accordance with the specified methods, fluids shall meet the limit values indicated in Table 1 (HFAE and HFAS fluids), Table 2 (HFB and HFC fluids) and Table 3 (HFDR and HFDU fluids). It should be noted that a significant variation exists in the level of fire-resistance displayed by the different fluid types.

The majority of test methods specified within Tables 1 to 3 contain a statement of precision (repeatability and reproducibility). ISO 4259-2, which covers the use of precision data in the interpretation of test results, shall be used in cases of dispute.

NOTE For the purposes of this document, the terms "% (m/m)" and "% (V/V)" are used to represent, respectively, the mass fraction and the volume fraction of a material.

Table 1 — Requirements for fluids in categories HFAE and HFAS

Characteristic or test	Unit	Specifications		Test method
		Category HFAE[a,b,c,d]	Category HFAS[a,b,c,d]	
Composition		Oil-in-water emulsions typically containing ≥ 95 % water (V/V), (+5 °C to +50 °C, ISO 7745)	Chemical solutions in water typically containing ≥ 95 % water (V/V), (+5 °C to +50 °C, ISO 7745)	
Viscosity at 40 °C ..... maximum	mm^2/s	5	5	ISO 3104
Appearance		[e]	[f]	
Water content	% (V/V)	[g]	[g]	ISO 6296[h]
Foaming tendency/stability at:				ISO 6247
+25 °C ..... maximum	ml/ml	300/10	300/10	
+50 °C ..... maximum	ml/ml	300/10	300/10	
+25 °C ..... maximum	ml/ml	300/10	300/10	
pH at 20 °C		6,7 to 10,0	6,7 to 10,0	ISO 20843
Emulsion stability (50 °C/600 h):	rating	2A to 2R	[i]	ISO 20783-1
— free oil ..... maximum	% (V/V)	Trace	[i]	
— cream ..... maximum	% (V/V)	0,5	[i]	
Corrosion protection:				ISO 4404-1
— visual rating of metals ..... maximum	rating	3	3	
— visual rating of the fluid	rating	[g]	[g]	
— mass changes of metal strips ..... maximum	mg			
— steel, copper and brass		−11 to +5	−11 to +5	
— aluminium		−5 to +5	−5 to +5	
— zinc		−22 to +5	−22 to +5	
Elastomer compatibility: 60 °C/168 h[j]				ISO 6072
NBR 1, HNBR 1 and FKM 2 elastomers:				
— relative volume change ..... minimum	%	0	0	
..... maximum	%	+7	+7	
— relative hardness change ..... minimum	IRHD[k]	−7	−7	
..... maximum	IRHD[k]	+2	+2	
— change in tensile strength	%	[l]	[l]	
— elongation at break	%	[l]	[l]	

Table 1 *(continued)*

Characteristic or test	Unit	Specifications		Test method
		Category HFAE[a,b,c,d]	Category HFAS[a,b,c,d]	

[a] These products are normally supplied as concentrates and are diluted with water by the end user. To ensure the rapid and complete mixing of the finished fluid, the viscosity of the concentrate at 20 °C should be 350 mm^2/s maximum.

[b] The limits given in this table can be applied at the dilution recommended by the supplier when using water selected from one of the following sources:

— test waters listed in ISO 4404-1 and in ISO 20783-1;

— distilled or de-ionized water;

— mains water supplied by the user.

Tests should be carried out before commercial use and the results, if reported, shall indicate the type of (test) water and the dilution level used.

[c] The viscosity of these fluids is very low and they may be used only in equipment especially designed for such products.

[d] As a result of their very high water content, these fluids are expected to possess excellent fire-resistance.

[e] Report the appearance. With HFAE fluids this can vary from transparent to opaque depending upon the formulation and the composition of the diluent.

[f] HFAS fluids are transparent. When examined in daylight at ambient temperature using a clear glass container of approximately 10 cm in diameter, they should be clear and bright, and free from any visible particulate matter.

[g] Limits are to be negotiated between the supplier and the user.

[h] ISO 6296 covers the mass fraction range 0,003 % (m/m) to 0,100 % (m/m). To use ISO 6296 to measure the water content of HFAE and HFAS fluids, proceed as follows:

— use a 10 µl syringe to take the test sample;

— dry the 10 µl syringe as described in ISO 6296:2000, 7.2.3;

— withdraw a 5 µl to 10 µl sample and titrate in accordance with ISO 6296:2000, 7.2.5.

Note that the precision of this procedure may differ from the values given in ISO 6296.

[i] The requirement is not relevant to this fluid type.

[j] ISO 6072 also specifies a long term (1 000 h) test but no limits are available. Guidance on acceptable test data under these conditions was last available in ISO 6072:2002, Annex C. NBR 1, HNBR 1 and FKM 2 are standard reference elastomers, the compositions of which are given in ISO 6072. They are the elastomer types most widely used, but not exclusively so, with the above fluids. The data provide a useful guide to the compatibility with HFAE and HFAS fluids, but can give results that are different from commercially available rubbers of the same nominal type. If case of doubt about the compatibility, contact the elastomer manufacturer.

[k] International rubber hardness degree.

[l] Report only on request.

Table 2 — Requirements for fluids in categories HFB and HFC

Characteristic or test	Unit	Specifications		Test method
		Category HFB[a]	Category HFC[a]	
Composition		Water-in-oil emulsions, typically containing ≥ 40 % water (% m/m) (+5 °C to +50 °C, ISO 7745)	Water polymer solutions, typically containing ≥ 35 % water (% m/m) (−20 °C to +50 °C, ISO 7745)	
Viscosity grade		46; 68; 100	22; 32; 46; 68	ISO 3448
Appearance		[b]	[c]	
Water content	% (m/m)	[d]	[d]	ISO 6296[e]
Density at 15 °C	kg/m^3	[f]	[f]	ISO 3675 ISO 12185
pH at 20 °C		[b]	6,7 to 10,0	ISO 20843
Viscosity at 40 °C	mm^2/s	[f]	[f]	ISO 3104
Corrosion protection:				ISO 4404-1
— visual assessment of the metals ..... maximum	rating	3	3	
— visual assessment of the fluid	rating	[d]	[d]	
— mass changes of strips ..... maximum	mg			
— steel, copper and brass		−11 to +5	−11 to +5	
— aluminium		−5 to +5	−5 to +5	
— zinc		−22 to +5	−22 to +5	
Foaming tendency/stability at:				ISO 6247
+25 °C ..... maximum	ml/ml	[b]	300/10	
+50 °C ..... maximum	ml/ml	[b]	300/10	
+25 °C ..... maximum	ml/ml	[b]	300/10	
Air release at 50 °C ..... maximum	min	[b]	20; 20; 25; 25	ISO 9120
Emulsion stability:				ISO 20783-2
a) 1 000 h at 20 °C:				
— surface oil ..... maximum	ml	10	[b]	
— accumulated free water ..... maximum	ml	2	[b]	
— change in water content at 425 ml .... maximum	%	5	[b]	
— change in water content at 125 ml .... maximum	%	5	[b]	
b) 48 h at 70 °C:				ISO 20783-2
— surface oil ..... maximum	ml	3	[b]	
— accumulated free water ..... maximum	ml	1	[b]	
c) 336 h at −10 °C/168 h at +20 °C:				ISO 20783-2
— surface oil ..... maximum	ml	2	[b]	
— accumulated free water ..... maximum	ml	1	[b]	
— change in water content at 5 ml ..... maximum	%	15	[b]	
— mean change in water content at 5 ml ... maximum	%	10	[b]	

Table 2 *(continued)*

Characteristic or test	Unit	Specifications		Test method
		Category HFB[a]	Category HFC[a]	
Shear stability: 17,5 MPa (175 bar)/250 cycles[g]:				ISO 20844
— viscosity change at 20 °C ..... maximum	%	±15	[f]	
— viscosity change at 40 °C ..... maximum	%	±15	[f]	
— viscosity change at 100 °C ..... maximum	%	[b]	[b]	
— pH change ..... maximum		[b]	±1,0	
— water content change ..... maximum	%	5	8	
— acid number change ..... maximum	mg KOH/g	±0,50	[b]	ISO 6618[h] ISO 6619[h]
Elastomer compatibility: 60 °C/168 h[i]				ISO 6072
NBR 1 and HNBR 1 elastomers:				
— relative volume change ..... minimum	%	0	0	
— ..... maximum	%	+7	+7	
— relative hardness change ..... minimum	IRHD[j]	−7	−7	
— ..... maximum	IRHD[j]	+2	+2	
— change in tensile strength	%	[k]	[k]	
— elongation at break	%	[k]	[k]	
Fire-resistance Spray ignition characteristics[l]:				
— time to extinguishment of flame ..... maximum	s	30	30	ISO 15029-1
— ignitability factor ..... minimum	RI[m]	[f]	[f]	ISO 15029-2
Wick flame persistence: — mean flame persistence .....maximum	s	60	60	ISO 14935
Manifold ignition test:				ISO 20823
— ignition temperature ..... minimum	°C	650	600	
— flame propagation ..... minimum	rating	[f]	[f]	
Ageing properties[n]:				ISO 4263-2
— pH value after test ..... minimum		[b]	4	
— insolubles ..... maximum	%	[b]	4	
Lubrication performance				
Vane pump:				ISO 20763
— total of ring and vane wear ..... maximum	mg	[b]	[d,o]	
4-ball machine:				ISO 20623
— wear scar diameter ..... maximum	mm	[d]	[d]	
FZG gear test:				ISO 14635-1
— failure load stage ..... minimum	load stage	[b]	[d]	

Table 2 *(continued)*

Characteristic or test	Unit	Specifications		Test method
		Category HFB[a]	Category HFC[a]	
[a] These fluids are supplied as the finished product.				
[b] The requirement is not relevant to this fluid type.				
[c] When examined in daylight at ambient temperature using a clear glass container of approximately 10 cm in diameter, the appearance of the delivered fluid shall be clear and bright, and free of any visible particulate matter.				
[d] Limits are to be agreed between the supplier and the user.				
[e] ISO 6296 covers the mass fraction range 0,003 % (m/m) to 0,100 % (m/m). To use ISO 6296 to measure the water content of HFB and HFC fluids, proceed as follows: — use a 10 µl syringe to take the test sample; — dry the 10 µl syringe as described in ISO 6296:2000, 7.2.3; — withdraw a 5 µl to 10 µl sample and titrate in accordance with ISO 6296:2000, 7.2.5. Note that the precision of this procedure may differ from the values given in ISO 6296.				
[f] Value or rating to be reported by the supplier. No limit is specified.				
[g] For fluids with a viscosity greater than 10 mm^2/s at 20 °C.				
[h] The method should be agreed between the fluid suppler and the user. For dyed fluids, ISO 6619 should be used.				
[i] ISO 6072 also specifies a long term (1 000 h) test but no limits are available. Guidance on acceptable test data under these conditions was last available in ISO 6072:2002, Annex C. NBR 1 and HNBR 1 are standard reference elastomers, the compositions of which are given in ISO 6072. They are the elastomer types most widely used, but not exclusively so, with the above fluids. The data provide a useful guide to the compatibility of this seal type with HFB and HFC fluids, but can give results that are different from commercially available elastomers of the same nominal type. If case of doubt about the compatibility, contact the elastomer manufacturer.				
[j] International rubber hardness degree.				
[k] Report only on request.				
[l] The methods in the ISO 15029 series measure different fluid characteristics under conditions that are not necessarily comparable. Limits on ISO 15029-2:2018 have not yet been established.				
[m] Ignitability factor.				
[n] The test duration is 200 h.				
[o] In view of the non-availability of test cartridges from the original supplier, other sources have been investigated. As yet, no precision data are available on the alternative cartridges when testing the above fluid types and no limits can, therefore, be specified. For guidance, the limits for HFC fluids specified in ISO 20763:2004, 13.2, were a ring and vane mass loss of < 50 mg and < 180 mg, respectively.				

Table 3 — Requirements for fluids in categories HFDR and HFDU

Characteristic or test	Unit	Specifications		Test method
		Category HFDR[a]	Category HFDU[a]	
Composition		Synthetic fluids free of water consisting of phosphate esters (–20 °C to +70 °C/ 150 °C[b], ISO 7745)	Synthetic fluids free of water and of other compositions (–20 °C to +70 °C/ 150 °C[b], ISO 7745)	
Viscosity grade		15; 22; 32; 46; 68; 100	15; 22; 32; 46; 68; 100	ISO 3448
Appearance		[c]	[c]	
Acid number	mg KOH/g	[d,e]	[d,e]	ISO 6618 ISO 6619
Water content ..... maximum	% (m/m)	0,1	0,1	ISO 760 ISO 20764[f]
Density at 15 °C	kg/m^3	[d]	[d]	ISO 3675 ISO 12185
Viscosity at 40 °C	mm^2/s	[d]	[d]	ISO 3104
Foaming tendency/stability at:				ISO 6247
+25 °C ..... maximum	ml/ml	300/10	300/10	
+93 °C ..... maximum	ml/ml	300/10	300/10	
+25 °C ..... maximum	ml/ml	300/10	300/10	
Air release at 50 °C ..... maximum	min	8; 10; 12; 15; 25; 30	8; 10; 12; 15; 25; 30	ISO 9120
Corrosion protection:				ISO 4404-2
— visual assessment of metals ..... maximum	rating	3	3	
— visual assessment of fluid	rating	[g]	[g]	
— mass changes of metal strip ..... maximum	mg			
— steel, copper and brass		–11 to +5	–11 to +5	
— aluminium		–5 to +5	–5 to +5	
— zinc		–22 to +5	–22 to +5	
Rust-preventing characteristics	rating	[d]	[d]	ISO 7120
Corrosiveness to copper	rating	[d]	[d]	ISO 2160
Shear stability, 17,5 MPa (175 bar)/250 cycles:				ISO 20844
— viscosity change at 20 °C ..... maximum	%	±10	±10	
— viscosity change at 40 °C ..... maximum	%	±5	±5	
— viscosity change at 100 °C ..... maximum	%	±7	±7	
— acid number change ..... maximum	mg KOH/g	±0,5	±0,5	ISO 6618[e] ISO 6619[e]
Elastomer compatibility: 100 °C/168 h[h]:				ISO 6072
— FKM 2, EPDM 1 types (HFDR fluids)				
— FKM 2, NBR 1, NBR 2 types (HFDU fluids)				
— relative volume change ..... minimum	%	0	0	
..... maximum	%	+7	+7	
— relative hardness change ..... minimum	IRHD[i]	–7	–7	
..... maximum	IRHD[i]	+2	+2	
— change in tensile strength	%	[j]	[j]	
— elongation at break	%	[j]	[j]	

Table 3 *(continued)*

Characteristic or test	Unit	Specifications		Test method
		Category HFDR[a]	Category HFDU[a]	
Fire-resistance				
Spray ignition characteristics[k]:				
— time to extinguishment of flame ..... maximum	s	30	30	ISO 15029-1
— ignitability factor ..... minimum	RI[l]	[d]	[d]	ISO 15029-2
Wick flame persistence:				ISO 14935
— mean flame persistence ..... maximum	s	60	[d]	
Manifold ignition test:				ISO 20823
— ignition temperature ..... minimum	°C	700	400	
— flame propagation ..... minimum	rating	[d]	[d]	
Oxidation stability:				EN 14832
— acid number increase ..... maximum	mg KOH/g	1,5	[m]	
— mass losses ..... maximum	mg		[m]	
— iron		1		
— copper		2		
Oxidation life ..... minimum	h	[m]	250	ISO 4263-3
Hydrolytic stability:				EN 14833
— acid number increase ..... maximum	mg KOH/g	[d]	[d]	
Lubrication performance				
Vane pump:				ISO 20763
— total of ring and vane wear ..... maximum	mg	[d,n]	[d,n]	
4-ball wear test:				ISO 20623
— wear scar diameter ..... maximum	mm	[g]	[g]	
FZG gear test:				ISO 14635-1
— failure load stage ..... minimum	load stage	[g]	[g]	

[a] These fluids are supplied as the finished product.

[b] The higher temperature indicates the approximate upper limit for a short-term operation. This will depend on whether the application is hydrostatic or hydrodynamic and, for HFDU fluids, on the chemical composition of the fluid. Where doubt exists, clarification should be sought from the equipment manufacturer and/or fluid supplier.

[c] When examined in daylight at ambient temperature using a clear glass container of approximately 10 cm in diameter, the appearance of the delivered fluid shall be clear and bright, and free of any visible particulate matter.

[d] Value or rating to be reported by the supplier. No limit is specified.

[e] The method is to be agreed between the supplier and the user. For dyed fluids, ISO 6619 should be used.

[f] ISO 20764 is applied in instances where interference by certain chemicals is to be avoided.

[g] Limits are to be negotiated between the supplier and the user.

[h] ISO 6072 also specifies a long term (1 000 h) test but no limits are available. Guidance on acceptable test data under these conditions was last available in ISO 6072:2002, Annex C. EPDM 1, FKM 2, NBR 1 and NBR 2 are standard reference elastomers, the compositions of which are given in ISO 6072. They are the elastomer types most widely used, but not exclusively so, with the above fluids. The data provide a useful guide to the compatibility with HFDR and HFDU fluids, but can give results that are different from commercially available elastomers of the same nominal type. EPDM 1 and FKM 2 are normally suitable for use with HFDR fluids, with the exception of the combination of FKM 2 and alkyl phosphate esters. The NBR 1 and NBR 2 reference elastomers are not suitable for use with HFDR fluids and NBR 1 might not be suitable for use with all HFDU fluids. If case of doubt about the compatibility, contact the elastomer manufacturer.

[i] International rubber hardness degree.

[j] Report only on request.

[k] The methods in the ISO 15029 series measure different fluid characteristics under conditions that are not necessarily comparable. Limits on ISO 15029-2:2018 have not yet been established.

[l] Ignitability factor.

[m] The requirement is not relevant to this fluid type.

[n] In view of the non-availability of test cartridges from the original supplier, other sources have been investigated. As yet, no precision data are available on the alternative cartridges when testing the above fluid types and no limits can, therefore, be specified. For guidance, the limits for both HFDR and HFDU fluids specified in ISO 20763:2004, 13.2, were a vane and ring mass loss of < 30 mg and < 120 mg, respectively.

Bibliography

[1] CEN/TR 14489:2005, *Fire-resistant hydraulic fluids — Classification and specification — Guidelines on selection for the protection of safety, health and the environment*

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