INTERNATIONAL STANDARD

ISO 11158

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Lubricants, industrial oils and related products (class L) — Family H (hydraulic systems) — Specifications for categories HH, HL, HM, HV and HG

Lubrifiants, huiles industrielles et produits connexes (classe L) — Famille H (systèmes hydrauliques) — Spécifications des catégories HH, HL, HM, HV et HG

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 11158 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 4, *Classifications and specifications*.

This second edition cancels and replaces the first edition (ISO 11158:1997), which has been technically revised.

This corrected version of ISO 11158:2009 incorporates the corrections to the first line, right-hand column of the header of Tables 2 to 4.

Lubricants, industrial oils and related products (class L) — Family H (hydraulic systems) — Specifications for categories HH, HL, HM, HV and HG

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 to determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies the minimum requirements for new mineral oil hydraulic fluids and is intended for hydraulic systems, particularly for hydrostatic hydraulic fluid power application. The purpose of this International Standard is for the guidance of suppliers and end users of mineral oil hydraulic fluids and for the direction of equipment manufacturers of hydraulic systems.

This International Standard is written in a general form so that its application can accommodate various climatic conditions throughout the world. This International Standard also stipulates the requirements for mineral-oil hydraulic fluids at the time of delivery.

Classification of fluids used in hydraulic applications is defined in ISO 6743-4. Of the categories covered by ISO 6743-4, only five types of mineral oil based fluids are covered in this International Standard. These categories are HH, HL, HM, HV and HG.

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.

ISO 2049:1996, *Petroleum products — Determination of colour (ASTM scale)*

ISO 2160:1998, *Petroleum products — Corrosiveness to copper — Copper strip test*

ISO 2592:2000, *Determination of flash and fire points — Cleveland open cup method*

ISO 2909:2002, *Petroleum products — Calculation of viscosity index from kinematic viscosity*

ISO 3016:1994, *Petroleum products — Determination of pour point*

ISO 3104:1994, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3105:1994, *Glass capillary kinematic viscometers — Specifications and operating instructions*

ISO 3170:2004, *Petroleum liquids — Manual sampling*

ISO 3448:1992, *Industrial liquid lubricants — ISO viscosity classification*

ISO 3675:1998, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 4259:2006, *Petroleum products — Determination and application of precision data in relation to methods of test*

ISO 4263-1:2003, *Petroleum and related products — Determination of the ageing behaviour of inhibited oils and fluids — TOST test — Part 1: Procedure for mineral oils*

ISO 4406:1999, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

ISO 5598:2008, *Fluid power systems and components — Vocabulary*

ISO 6072:2002, *Hydraulic fluid power — Compatibility between fluids and standard elastomeric materials*

ISO 6247:1998, *Petroleum products — Determination of foaming characteristics of lubricating oils*

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

ISO 6614:1994, *Petroleum products — Determination of water separability of petroleum oils and synthetic fluids*

ISO 6618:1997, *Petroleum products and lubricants — Determination of acid or base number — Colour-indicator titration method*

ISO 6619:1988, *Petroleum products and lubricants — Neutralization number — Potentiometric titration method*

ISO 6743-4:1999, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

ISO 7120:1987, *Petroleum products and lubricants — Petroleum oils and other fluids — Determination of rust-preventing characteristics in the presence of water*

ISO 9120:1997, *Petroleum and related products — Determination of air-release properties of steam turbine and other oils — Impinger method*

ISO 12937:2000, *Petroleum products — Determination of water — Coulometric Karl Fischer titration method*

ISO 13357-1:2002, *Petroleum products — Determination of the filterability of lubricating oils — Part 1: Procedure for oils in the presence of water*

ISO 13357-2:2005, *Petroleum products — Determination of the filterability of lubricating oils — Part 2: Procedure for dry oils*

ISO 14635-1:2000, *Gears — FZG test procedures — Part 1: FZG test method A/8,3/90 for relative scuffing load-carrying capacity of oils*

ISO 20763:2004, *Petroleum and related products — Determination of anti-wear properties of hydraulic fluids — Vane pump method*

ISO 20764:2003, *Petroleum and related products — Preparation of a test portion of high-boiling liquids for the determination of water content — Nitrogen purge method*

AFNOR XP T 60-183:1994, *Lubrifiants, huiles industrielles et produits connexes pour glissières de machines-outils — Pouvoir lubrifiant antisaccade (Lubricants, industrial oils and related products for machine tool slideways — Anti-stick-slip lubricating ability)*

CEC L-45-A-99, *Viscosity Shear Stability of Transmission Lubricants*[1)]

3 Sampling

Sampling of hydraulic oils for the purpose of this International Standard shall be carried out in accordance with the pertinent procedure described in ISO 3170. 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.

4 Terms and definitions

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

5 Requirements of mineral oil hydraulic fluids

For the purpose of this International Standard, oils shall be refined petroleum oils. The classification of these hydraulic oils shall be in accordance with ISO 6743-4.

Oils, when tested under prescribed methods, shall be in concurrence 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, under normal visible light at ambient temperature.

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

Detailed specifications of each category mentioned in this International Standard are provided hereafter in Tables 1 to 5 and as indicated below:

— Table 1, category HH;

— Table 2, category HL;

— Table 3, category HM;

— Table 4, category HV;

— Table 5, category HG;

Composition, properties and typical applications of each category are reported at the head of each table. These elements are taken from ISO 6743-4.

NOTE For the purposes of this International Standard, the term "% (m/m)" is used to represent the mass fraction of a material.

1) This test method will become ISO 26422 *Petroleum and related products — Determination of shear stability of lubricating oils containing polymers — Method using a tapered roller bearing.*

Table 1 — Specifications for category HH mineral oil hydraulics fluids

Characteristics	Units	Non-inhibited mineral oils								
		Requirements								Test method
Viscosity grade (ISO 3448)	—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Kinematic viscosity at 40 °C: minimum/maximum	mm^2/s [a]	9,00 – 11,0	13,5 – 16,5	19,8 – 24,2	28,8 – 35,2	41,4 – 50,6	61,2 – 74,8	90,0 – 110	135 – 165	ISO 3104 and ISO 3105
Viscosity index	—	b	b	b	b	b	b	b	b	ISO 2909
Density at 15 °C	kg/m^3	b	b	b	b	b	b	b	b	ISO 3675
Colour [c]	—	b	b	b	b	b	b	b	b	ISO 2049
Appearance at 25 °C [d]	—	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Visual
Cleanliness	—	e	e	e	e	e	e	e	e	—
Flash point:										
— Cleveland open cup, minimum	°C	125	140	165	175	185	195	205	215	ISO 2592
Pour point, maximum	°C	–15	–12	–9	–6	–6	–6	–6	–6	ISO 3016
Acid number, maximum	mg KOH/g	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	ISO 6618 or ISO 6619
Water content, maximum	% (*m/m*)	0,025	0,025	0,025	0,025	0,025	0,025	0,025	0,025	ISO 6296 or ISO 12937 or ISO 20764
Water separation:										ISO 6614
— time to 3 ml emulsion at 54 °C, maximum	min	b	b	b	b	b	b	—	—	
— time to 3 ml emulsion at 82 °C, maximum	min	—	—	—	—	—	—	b	b	
Elastomer compatibility [f] NBR 1, 100 °C, 168 h	—	b	b	b	b	b	b	b	b	ISO 6072

[a] Square millimetres per second (mm^2/s) is equivalent to centistokes (cSt).

[b] Report.

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

[d] Clear-bright is abbreviated as Clbr.

[e] The requirements of the cleanliness of the hydraulic fluid is system-dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end-user. It should be noted that the fluid is exposed to various influences during transport and storage; the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.

[f] The definition of compatibility for types of elastomers other than NBR 1 (e.g. FPM, EPDM, AU) may be agreed between the supplier and the end users.

Table 2 — Specifications for category HL mineral oil hydraulics fluids

Characteristics		Units	Oils of HH type with improved anti-rust and anti-oxidation properties								Test method
			Requirements								
Viscosity grade (ISO 3448)		—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Kinematic viscosity at:											ISO 3104 and ISO 3105
–20 °C	maximum	mm^2/s [a]	600	—	—	—	—	—	—	—	
0 °C	maximum	mm^2/s [a]	90	150	300	420	780	1 400	2 560	4 500	
40 °C	minimum/maximum	mm^2/s [a]	9,00 – 11,0	13,5 – 16,5	19,8 – 24,2	28,8 – 35,2	41,4 – 50,6	61,2 – 74,8	90,0 – 110	135 – 165	
100 °C	minimum	mm^2/s [a]	2,50	3,20	4,10	5,00	6,10	7,80	9,90	14,0	
Viscosity index		—	b	b	b	b	b	b	b	b	ISO 2909
Density at 15 °C		kg/m^3	b	b	b	b	b	b	b	b	ISO 3675
Colour [c]		—	b	b	b	b	b	b	b	b	ISO 2049
Appearance at 25 °C [d]		—	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Visual
Cleanliness		—	e	e	e	e	e	e	e	e	—
Flash point:											ISO 2592
— Cleveland open cup,	minimum	°C	125	140	165	175	185	195	205	215	
Pour point,	maximum	°C	–30	–27	–21	–18	–15	–12	–12	–12	ISO 3016
Acid number,	maximum [f]	mg KOH/g	b	b	b	b	b	b	b	b	ISO 6618 or ISO 6619
Water content,	maximum	% (*m/m*)	0,025	0,025	0,025	0,025	0,025	0,025	0,025	0,025	ISO 6296 or ISO 12937 or ISO 20764
Water separation: [g]											ISO 6614
— time to 3 ml emulsion at 54 °C,	maximum	min	30	30	30	30	30	30	—	—	
— time to 3 ml emulsion at 82 °C,	maximum	min	—	—	—	—	—	—	30	30	
Copper corrosion, 100 °C, 3 h,	maximum	class	2	2	2	2	2	2	2	2	ISO 2160
Rust prevention, 24 h:											ISO 7120
— Procedure A		—	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	
— Procedure B		—	b	b	b	Pass	Pass	Pass	Pass	Pass	

Table 2 (*continued*)

Characteristics	Units	Oils of HH type with improved anti-rust and anti-oxidation properties								
		Requirements								Test method
Viscosity grade (ISO 3448)	—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Foam:										ISO 6247
— Sequence I, maximum	ml	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0	
— Sequence II, maximum	ml	80/0	80/0	80/0	80/0	80/0	80/0	80/0	80/0	
— Sequence III, maximum	ml	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0	
Air release:										ISO 9120
— at 50 °C, maximum	min	5	5	5	5	10	10	—	—	
— at 75 °C	min	—	—	—	—	—	—	b	b	
Elastomer compatibility [h] NBR 1, 100 °C, 168 h										ISO 6072
— relative increase in volume	%	0 to 18	0 to 15	0 to 15	0 to 12	0 to 12	0 to 10	0 to 10	0 to 10	
— change in Shore A hardness	—	0 to –10	0 to –8	0 to –8	0 to –7	0 to –7	0 to –6	0 to –6	0 to –6	
Oxidation stability:										ISO 4263-1
— increase in acid number after 1 000 h, maximum	mg KOH/g	2,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0	
— insoluble sludge	mg	b	b	b	b	b	b	b	b	

a Square millimetres per second (mm^2/s) is equivalent to centistokes (cSt).

b Report.

c For the purposes of identification, dye may be used by agreement between the supplier and the end-user.

d Clear-bright is abbreviated as Clbr.

e The requirements of the cleanliness of the hydraulic fluid is system-dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end-user. It should be noted that the fluid is exposed to various influences during transport and storage; the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.

f Initial acid number is influenced by the presence of functional moieties in the additive package.

g This method is not required for fluids with detergent properties.

h The definition of compatibility for types of elastomers other than NBR 1 (e.g. FPM, EPDM, AU) may be agreed between the supplier and the end-users.

Table 3 — Specifications for category HM mineral oil hydraulics fluids

Characteristics		Units	Oils of HL type with improved anti-wear and filterability properties [a]								Test method
			Requirements								
Viscosity grade (ISO 3448)		—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Kinematic viscosity at:											
–20 °C	maximum	mm^2/s [b]	600	—	—	—	—	—	—	—	
0 °C	maximum	mm^2/s [b]	90	150	300	420	780	1 400	2 560	4 500	ISO 3104 and ISO 3105
40 °C	minimum/maximum	mm^2/s [b]	9,00 – 11,0	13,5 – 16,5	19,8 – 24,2	28,8 – 35,2	41,4 – 50,6	61,2 – 74,8	90,0 – 110	135 – 165	
100 °C	minimum	mm^2/s [b]	2,50	3,20	4,10	5,00	6,10	7,80	9,90	14,0	
Viscosity index		—	c	c	c	c	c	c	c	c	ISO 2909
Density at 15 °C		kg/m^3	c	c	c	c	c	c	c	c	ISO 3675
Colour [d]		—	c	c	c	c	c	c	c	c	ISO 2049
Appearance at 25 °C [e]		—	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Visual
Cleanliness		—	f	f	f	f	f	f	f	f	—
Flash point:											
— Cleveland open cup,	minimum	°C	125	140	165	175	185	195	205	215	ISO 2592
Pour point,	maximum	°C	–30	–27	–21	–18	–15	–12	–12	–12	ISO 3016
Acid number,	maximum [g]	mg KOH/g	c	c	c	c	c	c	c	c	ISO 6618 or ISO 6619
Water content,	maximum	% (*m/m*)	0,025	0,025	0,025	0,025	0,025	0,025	0,025	0,025	ISO 6296 or ISO 12937 or ISO 20764
Water separation: [h]											ISO 6614
— time to 3 ml emulsion at 54 °C,	maximum	min	30	30	30	30	30	30	—	—	
— time to 3 ml emulsion at 82 °C,	maximum	min	—	—	—	—	—	—	30	30	
Copper corrosion, 100 °C, 3 h,	maximum	class	2	2	2	2	2	2	2	2	ISO 2160
Rust prevention, 24 h:											ISO 7120
— Procedure A		—	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	
— Procedure B		—	c	c	c	Pass	Pass	Pass	Pass	Pass	

Table 3 (*continued*)

Characteristics		Oils of HL type with improved anti-wear and filterability properties [a]								
	Units	Requirements								Test method
Viscosity grade (ISO 3448)	—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Foam:										ISO 6247
— Sequence I, maximum	ml	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0	
— Sequence II, maximum	ml	80/0	80/0	80/0	80/0	80/0	80/0	80/0	80/0	
— Sequence III, maximum	ml	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0	
Air release:										ISO 9120
— at 50 °C, maximum	min	5	5	5	5	10	13	—	—	
— at 75 °C	min	—	—	—	—	—	—	c	c	
Elastomer compatibility [i] NBR 1, 100 °C, 168 h										ISO 6072
— relative increase in volume	%	0 to 18	0 to 15	0 to 15	0 to 12	0 to 12	0 to 10	0 to 10	0 to 10	
— change in Shore A hardness	—	0 to –10	0 to –8	0 to –8	0 to –7	0 to –7	0 to –6	0 to –6	0 to –6	
Oxidation stability:										ISO 4263-1
— increase in acid number after 1 000 h, maximum	—	2,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0	
— insoluble sludge	mg	c	c	c	c	c	c	c	c	
Wear protection, FZG A/8,3/90, minimum	Fail load stage	—	—	—	10	10	10	10	10	ISO 14635-1
Wear protection, vane pump [j]										ISO 20763, procedure A
— weight loss cam ring, maximum	mg	—	—	—	120	120	120	—	—	
— weight loss vanes, maximum	mg	—	—	—	30	30	30	—	—	
Filterability, dry										ISO 13357-2
— Stage I filterability, minimum [k]	%	80	80	80	80	80	80	80	80	
— Stage II filterability, minimum [l]	%	60	60	60	60	60	60	60	60	
Filterability, wet										ISO 13357-1
— Stage I filterability, minimum [k]	%	50	50	50	50	50	50	50	—	
— Stage II filterability, minimum [l]	%	50	50	50	50	50	50	50	—	

Table 3 (*continued*)

Characteristics	Oils of HL type with improved anti-wear and filterability properties [a]									
	Units	Requirements								Test Method
Viscosity grade (ISO 3448)	—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—

[a] A typical application is for general hydraulics.

[b] Square millimetres per second (mm^2/s) is equivalent to centistokes (cSt).

[c] Report.

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

[e] Clear-bright is abbreviated as Clbr.

[f] The requirements of the cleanliness of the hydraulic fluid is system-dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end-user. It should be noted that the fluid is exposed to various influences during transport and storage; the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.

[g] Initial acid number is influenced by the presence of functional moieties in the additive package.

[h] This method is not required for fluids with detergent properties.

[i] The definition of compatibility for types of elastomers other than NBR 1 (e.g. FPM, EPDM, AU) may be agreed between the supplier and the end-users.

[j] There are currently no precision data for the method when non-Eaton/Vickers test cartridges [e.g. Conestoga (USA, Inc.[2)] and Tokimec[2)]] 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 (all parts). For fluids evaluated under the aforementioned methods, the test data are considered to remain valid and no re-testing against ISO 20763 is required.

[k] The stage I determination is based upon a comparison of the mean flow rate of a fluid through a test membrane with its initial flow rate. Oils having good stage I filterability, but only a poor stage II performance (see footnote l), are unlikely to give performance problems in use, unless extremely fine system filters are utilized.

[l] The stage II determination is based upon the ratio between the initial flow rate of fluid through the test membrane and the rate at the end of the test. It is considered that this part of the procedure is a more severe test, and is more sensitive to the presence of gels and fine silts in the oil. Silts and gels can be present in an oil when it is produced, or can be formed as an oil ages, especially when hot. An oil with good stage II filterability is unlikely to give filtration problems even in the most extreme conditions, and with fine (less than 5 µm) filtration present. Thus, it is suitable for use in more critical hydraulic and lubrication systems.

2) This information is given for the convenience of users of this International Standard and does not constitute an endorsement or exclusive recommendation of these products by ISO. Equivalent products may be used if it can be demonstrated that they lead to the same results.

Table 4 — Specifications for category HV mineral oil hydraulics fluids

Characteristics		Units	Oils of HM type with improved viscosity/temperature properties [a]								Test method
			Requirements								
Viscosity grade (ISO 3448)		—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Kinematic viscosity at:											ISO 3104 and ISO 3105
–20 °C	maximum	mm^2/s [b]	c	c	c	c	c	c	c	c	
0 °C	maximum	mm^2/s [b]	c	c	c	c	c	c	c	c	
40 °C	minimum/maximum	mm^2/s [b]	9,00 – 11,0	13,5 – 16,5	19,8 – 24,2	28,8 – 35,2	41,4 – 50,6	61,2 – 74,8	90,0 – 110	135 – 165	
100 °C	minimum	mm^2/s [b]	c	c	c	c	c	c	c	c	
Viscosity index		—	140	140	140	140	140	140	140	120	ISO 2909
Density at 15 °C		kg/m^3	c	c	c	c	c	c	c	c	ISO 3675
Colour [d]		—	c	c	c	c	c	c	c	c	ISO 2049
Appearance at 25 °C [e]		—	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Clbr	Visual
Cleanliness		—	f	f	f	f	f	f	f	f	—
Flash point:											ISO 2592
— Cleveland open cup,	minimum	°C	125	125	175	175	180	180	180	200	
Pour point,	maximum	°C	–39	–39	–39	–30	–27	–24	–21	–18	ISO 3016
Acid number,	maximum [g]	mg KOH/g	c	c	c	c	c	c	c	c	ISO 6618 or ISO 6619
Water content,	maximum	% (*m/m*)	0,025	0,025	0,025	0,025	0,025	0,025	0,025	0,025	ISO 6296 or ISO 12937 or ISO 20764
Water separation: [h]											ISO 6614
— time to 3 ml emulsion at 54 °C,	maximum	min	30	30	30	30	30	30	—	—	
— time to 3 ml emulsion at 82 °C,	maximum	min	—	—	—	—	—	—	30	30	
Copper corrosion, 100 °C, 3 h,	maximum	class	2	2	2	2	2	2	2	2	ISO 2160
Rust prevention, 24 h:											ISO 7120
— Procedure A		—	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	
— Procedure B		—	c	c	c	Pass	Pass	Pass	Pass	Pass	

Table 4 (*continued*)

Characteristics		Units	Oils of HM type with improved viscosity/temperature properties [a]								Test method
			Requirements								
Viscosity grade (ISO 3448)		—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Foam:											ISO 6247
— Sequence I,	maximum	ml	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0	
— Sequence II,	maximum	ml	80/0	80/0	80/0	80/0	80/0	80/0	80/0	80/0	
— Sequence III,	maximum	ml	150/0	150/0	150/0	150/0	150/0	150/0	150/0	150/0	
Air release:											ISO 9120
— at 50 °C,	maximum	min	5	5	5	5	13	13	—	—	
— at 75 °C		min	—	—	—	—	—	—	c	c	
Elastomer compatibility [i] NBR 1, 100 °C, 168 h											ISO 6072
— relative increase in volume		%	0 to 18	0 to 15	0 to 15	0 to 12	0 to 12	0 to 10	0 to 10	0 to 10	
— change in Shore A hardness		—	0 to –10	0 to –8	0 to –8	0 to –7	0 to –7	0 to –6	0 to –6	0 to –6	
Oxidation stability:											ISO 4263-1
— increase in acid number after 1 000 h,	maximum	—	2,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0	
— insoluble sludge		mg	c	c	c	c	c	c	c	c	
Wear protection, FZG A/8,3/90,	minimum	Fail load stage	—	—	—	10	10	10	10	10	ISO 14635-1
Wear protection, vane pump [j]											ISO 20763, procedure A
— weight loss cam ring,	maximum	mg	—	—	—	120	120	120	—	—	
— weight loss vanes,	maximum	mg	—	—	—	30	30	30	—	—	
Filterability, dry											ISO 13357-2
— Stage I filterability,	minimum [k]	%	80	80	80	80	80	80	80	80	
— Stage II filterability,	minimum [l]	%	60	60	60	60	60	60	60	60	
Filterability, wet											ISO 13357-1
— Stage I filterability,	minimum [k]	%	50	50	50	50	50	50	50	—	
— Stage II filterability,	minimum [l]	%	50	50	50	50	50	50	50	—	

Table 4 (*continued*)

Characteristics	Oils of HM type with improved viscosity/temperature properties [a]									
	Units	Requirements								Test Method
Viscosity grade (ISO 3448)	—	**VG 10**	**VG 15**	**VG 22**	**VG 32**	**VG 46**	**VG 68**	**VG 100**	**VG 150**	—
Shear stability, tapered roller bearing, 20 h at 60 °C										CEC L-45-A-99 [m]
— loss in kinematic viscosity at 40 °C	%	c	c	c	c	c	c	c	c	
— loss in kinematic viscosity at 100 °C	%	c	c	c	c	c	c	c	c	

a A typical application is in mobile construction and marine equipment.

b Square millimetres per second (mm^2/s) is equivalent to centistokes (cSt).

c Report.

d For the purposes of identification, dye may be used by agreement between the supplier and the end-user.

e Clear-bright is abbreviated as Clbr.

f The requirements of the cleanliness of the hydraulic fluid is system-dependent. Cleanliness level expressed according to ISO 4406 may be established by agreement between the supplier and the end-user. It should be noted that the fluid is exposed to various influences during transport and storage; the cleanliness level required for the system should be guaranteed by careful filtering of the hydraulic fluid when filling.

g Initial acid number is influenced by the presence of functional moieties in the additive package.

h This method is not required for fluids with detergent properties.

i The definition of compatibility for types of elastomers other than NBR 1 (e.g. FPM, EPDM, AU) may be agreed between the supplier and the end users.

j There are currently no precision data for the method when non-Eaton/Vickers test cartridges [e.g. Conestoga, USA, Inc.[3)] and Tokimec[3)]] 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 (all parts). For fluids evaluated under the aforementioned methods, the test data are considered to remain valid and no re-testing against ISO 20763 is required.

k The stage I determination is based upon a comparison of the mean flow rate of a fluid through a test membrane with its initial flow rate. Oils having good stage I filterability, but only a poor stage II performance (see footnote l), are unlikely to give performance problems in use, unless extremely fine system filters are utilized.

l The stage II determination is based upon the ratio between the initial flow rate of fluid through the test membrane and the rate at the end of the test. It is considered that this part of the procedure is a more severe test, and is more sensitive to the presence of gels and fine silts in the oil. Silts and gels can be present in an oil when it is produced, or can be formed as an oil ages, especially when hot. An oil with good stage II filterability is unlikely to give filtration problems even in the most extreme conditions, and with fine (less than 5 µm) filtration present. Thus, it is suitable for use in more critical hydraulic and lubrication systems.

m Test method will become ISO 26422.

3) This information is given for the convenience of users of this International Standard and does not constitute an endorsement or exclusive recommendation of these products by ISO. Equivalent products may be used if it can be demonstrated that they lead to the same results.