# 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, HR, HV and HG

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



Reference number
ISO 11158:1997(E)

## 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.

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.

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

Annexes A and B of this International Standard are for information only.





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

**WARNING — The handling and use of products as specified in this International Standard may 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.**



## 1 Scope

This International Standard specifies the requirements of 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 of 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, six types only of mineral oil based fluids are embraced in this specification. These categories are: HH, HL, HM, HR, HV and HG.

NOTE — Although specifications given in this International Standard refer only to mineral oil based hydraulic fluids, this specification can be applicable to certain types of hydrocarbon synthetic fluids e.g. polyalphaolefin (type HS).

## 2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2049:1996, *Petroleum products — Determination of colour.*

ISO 2160:—[1], *Petroleum products — Corrosiveness to copper — Copper strip test.*

ISO 2592:—[2], *Petroleum products — Determination of flash and fire points — Cleveland open cup method.*

1) To be published. (Revision of ISO 2160:1985)
2) To be published. (Revision of ISO 2592:1973)

ISO 2719:1988, *Petroleum products and lubricants — Determination of flash point — Pensky-Martens closed cup method.*

ISO 2909:1981, *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 3170:1988, *Petroleum liquids — Manual sampling.*

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

ISO 3675:—[3], *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method.*

ISO 4259:1992, *Petroleum products — Determination and application of precision data in relation to methods of test.*

ISO 4406:—[4], *Hydraulic fluid power — Fluids — Code for defining the level of contamination by solid particles.*

ISO 5598:1985, *Fluid power systems and components — Vocabulary.*

ISO 6072:1986, *Hydraulic fluid power — Compatibility between elastomeric materials and fluids.*

ISO 6247:—[5], *Petroleum products — Determination of foaming characteristics of lubricating oils.*

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 6743-4:1982, *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 products — Determination of air-release properties of petroleum steam turbine and other oils — Impinger method.*

BS 2000:Part 281:1993, *Determination of anti-wear properties of hydraulic fluids. Vane pump method.*

DIN 51354-2:1990, *Testing of lubricants — FZG gear test rig — Method A/8,3/90 for lubricating oils.*

DIN 51777-1:1983, *Testing of mineral oil hydrocarbons and solvents — Determination of water content according to Karl Fischer — Direct method.*



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3) To be published. (Revision of ISO 3675:1993)
4) To be published. (Revision of ISO 4406:1987)
5) To be published.

DIN 51777-2:1974, *Testing of mineral oil hydrocarbons and solvents — Determination of water content according to Karl Fischer — Indirect method.*

ASTM D 1744-92, *Determination of Water in Liquid Petroleum Products by Karl Fischer Reagent.*

ASTM D 2882-90, *Indicating the Wear Characteristics of Petroleum and Non-petroleum Hydraulic Fluids in a Constant Volume Vane Pump.*

ASTM D 4310-91, *Determination of the Sludging and Corrosion Tendencies of Inhibited Mineral Oils.*

CEC L-14-A-1988[6], *Evaluation of the mechanical shear stability of lubricating oils containing polymers.*

## 3 Sampling

Sampling of hydraulic oils for the purpose of this International Standard shall be carried out in accordance with pertinent procedure described in ISO 3170. The sample shall be evaluated on a representative portion.

NOTE — 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 Definitions

For the purposes of this International Standard, the vocabulary in ISO 5598 applies.

## 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 tables 1 to 6, 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 cleanliness level shall be expressed according to ISO 4406.



6) CEC L-45-T:1993, *Viscosity shear stability of transmission lubricants* (tapered roller bearing rig based on DIN 51350-6:1982[8], is emerging as an alternative method.

The **precision** (repeatability and reproducibility) of the test methods for this International Standard and the interpretation of the results shall be dictated by 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 6 and as indicated below.

| Table No. | Category |
|---|---|
| 1 | HH |
| 2 | HL |
| 3 | HM |
| 4 | HR |
| 5 | HV |
| 6 | 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.

## Table 1 — Specifications for category HH mineral oil hydraulic fluids

| Characteristic | Non-inhibited mineral oils | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Units | Requirements | | | | | | | | Test Method |
| **Viscosity grade (ISO 3448)** | — | **VG 10** | **VG 15** | **VG 22** | **VG 32** | **VG 46** | **VG 68** | **VG 100** | **VG 150** | |
| Density at 15 °C | $kg/dm^3$ | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 3675 |
| Colour [2] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2049 |
| Appearance at 25 °C [3] | — | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Visual |
| Flash point: | | | | | | | | | | |
| — Cleveland open cup, minimum | °C | 100 | 140 | 140 | 160 | 180 | 180 | 180 | 180 | ISO 2592 |
| — Pensky-Martens closed cup, minimum | °C | 88 | 128 | 128 | 148 | 168 | 168 | 168 | 168 | ISO 2719 |
| Kinematic viscosity at 40 °C: | | | | | | | | | | ISO 3104 and |
| — minimum-maximum | $mm^2/s$ [4] | 9,0 - 11,0 | 13,5 - 16,5 | 19,8 - 24,2 | 28,8 - 35,2 | 41,4 - 50,6 | 61,2 - 74,8 | 90 - 110 | 135 - 165 | ISO 3105 |
| Viscosity index | 1 | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2909 |
| 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 |
| Water content, maximum | % (*m/m*) | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | ASTM D 1744 or DIN 51777-1 or DIN 51777-2 [5] ISO 6614 |
| Water separation: | | | | | | | | | | |
| — time to 3 ml emulsion at 54 °C | min | 1) | 1) | 1) | 1) | 1) | 1) | — | — | |
| — time to 3 ml emulsion at 82 °C | min | — | — | — | — | — | — | 1) | 1) | |
| Elastomer compatibility [6] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6072 |

1) Report only.
2) For the purposes of identification, dye may be used by agreement between supplier and end user.
3) Clear-bright is abbreviated as Clbr. Cleanliness level expressed according to ISO 4406 may be established by agreement between supplier and end user.
4) Square millimetres per second ($mm^2/s$) is equivalent to centistokes (cSt).
5) DIN 51777-2 is applied to instances where interference by certain chemicals can be avoided. Free alkali, oxidizing and reducing agents, mercaptans, certain nitrogenous substances, or other materials that react with iodine, interfere.
6) The type of elastomer and definition of compatibility are to be agreed between supplier and end user.

## Table 2 — Specifications for category HL mineral oil hydraulic fluids

| Characteristic | 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** | |
| Density at 15 °C | $kg/dm^3$ | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 3675 |
| Colour [2] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2049 |
| Appearance at 25 °C [3] | — | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Visual |
| Flash point: | | | | | | | | | | |
| — Cleveland open cup, minimum | °C | 100 | 140 | 140 | 160 | 180 | 180 | 180 | 180 | ISO 2592 |
| — Pensky-Martens closed cup, minimum | °C | 88 | 128 | 128 | 148 | 168 | 168 | 168 | 168 | ISO 2719 |
| Kinematic viscosity at 40 °C, | | | | | | | | | | ISO 3104 and |
| — minimum-maximum | $mm^2/s$ [4] | 9,0 - 11,0 | 13,5 - 16,5 | 19,8 - 24,2 | 28,8 - 35,2 | 41,4 - 50,6 | 61,2 - 74,8 | 90 - 110 | 135 - 165 | ISO 3105 |
| Viscosity index | 1 | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2909 |
| Pour point, maximum | °C | -30 | -21 | -18 | -15 | -12 | -12 | -12 | -12 | ISO 3016 |
| Acid number [5] | mg KOH/g | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6618 |
| Water content | % (*m/m*) | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | ASTM D 1744 or DIN 51777-1 or DIN 51777-2 [6] |
| Copper corrosion, 100 °C, 3 h, maximum | Class | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | ISO 2160 |
| Rust prevention, procedure A | — | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | ISO 7120 |
| Foam: — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | ISO 6247 |
| — at 93,5 °C, maximum | ml | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | |
| — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | |
| Air release, 50 °C, maximum | min | 5 | 5 | 5 | 5 | 10 | 10 | 17 | 25 | ISO 9120 |
| Water separation: | | | | | | | | | | ISO 6614 |
| — time to 3 ml emulsion at 54 °C | min | 30 | 30 | 30 | 30 | 30 | 30 | — | — | |
| — time to 3 ml emulsion at 82 °C | min | — | — | — | — | — | — | 30 | 30 | |
| Elastomer compatibility [7] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6072 |
| Oxidation stability, 1 000 h: | | | | | | | | | | ASTM D 4310 |
| — delta acid number, maximum | mg KOH/g | — | — | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | |
| — insoluble sludge | mg | — | — | 1) | 1) | 1) | 1) | 1) | 1) | |

1) Report only.
2) For the purposes of identification, dye may be used by agreement between supplier and end user.
3) Clear-bright is abbreviated as Clbr. Cleanliness level expressed according to ISO 4406 may be established by agreement between supplier and end user.
4) Square millimetres per second ($mm^2/s$) is equivalent to centistokes (cSt).
5) Initial acid number is influenced by the presence of functional moieties in the total additive package.
6) DIN 51777-2 is applied to instances where interference by certain chemicals can be avoided. Free alkali, oxidizing and reducing agents, mercaptans, certain nitrogenous substances, or other materials that react with iodine, interfere.
7) The type of elastomer and definition of compatibility are to be agreed between supplier and end user.

## Table 3 — Specifications for category HM mineral oil hydraulic fluids

| Characteristic | Units | Oils of HL type with improved anti-wear properties - A typical application is for general hydraulics | | | | | | | | Test method |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Requirements | | | | | | | | |
| **Viscosity grade (ISO 3448)** | | **VG 10** | **VG 15** | **VG 22** | **VG 32** | **VG 46** | **VG 68** | **VG 100** | **VG 150** | |
| Density at 15 °C | $kg/dm^3$ | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 3675 |
| Colour [2] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2049 |
| Appearance at 25 °C [3] | — | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Visual |
| Flash point: | | | | | | | | | | |
| — Cleveland open cup, minimum | °C | 100 | 140 | 140 | 160 | 180 | 180 | 180 | 180 | ISO 2592 |
| — Pensky-Martens closed cup, minimum | °C | 88 | 128 | 128 | 148 | 168 | 168 | 168 | 168 | ISO 2719 |
| Kinematic viscosity at 40 °C: | | | | | | | | | | ISO 3104 and |
| — minimum-maximum | $mm^2/s$ [4] | 9,0 - 11,0 | 13,5 - 16,5 | 19,8 - 24,2 | 28,8 - 35,2 | 41,4 - 50,6 | 61,2 - 74,8 | 90 - 110 | 135 - 165 | ISO 3105 |
| Viscosity index | 1 | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2909 |
| Pour point, maximum | °C | -30 | -21 | -18 | -15 | -12 | -12 | -12 | -12 | ISO 3016 |
| Acid number [5] | mg KOH/g | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6618 |
| Water content | % *(m/m)* | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | ASTM D 1744 or DIN 51777-1 or DIN 51777-2 [6] |
| Copper corrosion, 100 °C, 3 h, maximum | Class | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | ISO 2160 |
| Rust prevention, procedure A | — | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | ISO 7120 |
| Foam: — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | ISO 6247 |
| — at 93,5 °C, maximum | ml | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | |
| — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | |
| Air release, 50 °C, maximum | min | 5 | 5 | 5 | 5 | 10 | 13 | 21 | 32 | ISO 9120 |
| Water separation: | | | | | | | | | | ISO 6614 |
| — time to 3 ml emulsion at 54 °C | min | 30 | 30 | 30 | 30 | 30 | 30 | — | — | |
| — time to 3 ml emulsion at 82 °C | min | — | — | — | — | — | — | 30 | 30 | |
| Elastomer compatibility [7] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6072 |
| Oxidation stability, 1 000 h. | | | | | | | | | | ASTM D 4310 |
| — delta acid number, maximum | mg KOH/g | — | — | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | |
| — insoluble sludge | mg | | | 1) | 1) | 1) | 1) | 1) | 1) | |
| Wear protection, FZG A/8,3/90, minimum [8] | Fail stage | — | — | — | 10 | 10 | 10 | 10 | 10 | DIN 51354-2 |
| Vane pump [9] | mg | — | — | 1) | 1) | 1) | 1) | — | — | BS 2000: part 281 or ASTM D 2882 |

1) Report only.
2) For the purposes of identification, dye may be used by agreement between supplier and end user.
3) Clear-bright is abbreviated as Clbr. Cleanliness level expressed according to ISO 4406 may be established by agreement between supplier and end user.
4) Square millimetres per second ($mm^2/s$) is equivalent to centistokes (cSt).
5) Initial acid number is influenced by the presence of functional moieties in the total additive package.
6) DIN 51777-2 is applied to instances where interference by certain chemicals can be avoided. Free alkali, oxidizing and reducing agents, mercaptans, certain nitrogenous substances, or other materials that react with iodine, interfere.
7) The type of elastomer and definition of compatibility are to be agreed between supplier and end user.
8) Applicable from ISO VG 32 to ISO VG 150.
9) Applicable from ISO VG 22 to ISO VG 68.

## Table 4 — Specifications for category HR mineral oil hydraulic fluids

| Characteristic | Oils of HL type with improved viscosity/temperature properties | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Units | Requirements | | | | | | | | Test method |
| **Viscosity grade (ISO 3448)** | — | **VG 10** | **VG 15** | **VG 22** | **VG 32** | **VG 46** | **VG 68** | **VG 100** | **VG 150** | |
| Density at 15 °C | $kg/dm^3$ | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 3675 |
| Colour [2] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2049 |
| Appearance at 25 °C [3] | — | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Visual |
| Flash point: | | | | | | | | | | |
| — Cleveland open cup, minimum | °C | 100 | 100 | 140 | 160 | 160 | 180 | 180 | 180 | ISO 2592 |
| — Pensky-Martens closed cup, minimum | °C | 88 | 88 | 128 | 148 | 148 | 168 | 168 | 168 | ISO 2719 |
| Kinematic viscosity at 40 °C: | | | | | | | | | | ISO 3104 and |
| — minimum-maximum | $mm^2/s$ [4] | 9,0 - 11,0 | 13,5 - 16,5 | 19,8 - 24,2 | 28,8 - 35,2 | 41,4 - 50,6 | 61,2 - 74,8 | 90 - 110 | 135 - 165 | ISO 3105 |
| Viscosity index, minimum [5] | 1 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | ISO 2909 |
| Pour point, maximum | °C | -42 | -42 | -42 | -36 | -36 | -30 | - 21 | -12 | ISO 3016 |
| Acid number [6] | mg KOH/g | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6618 |
| Water content | % (*m/m*) | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | ASTM D 1744 or DIN 51777-1 or DIN 51777-2 [7] |
| Copper corrosion, 100 °C, 3 h, maximum | Class | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | ISO 2160 |
| Rust prevention, procedure A | — | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | ISO 7120 |
| Foam: — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | ISO 6247 |
| — at 93,5 °C, maximum | ml | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | |
| — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | |
| Air release, 50 °C, maximum | min | 7 | 7 | 7 | 7 | 12 | 12 | 20 | 28 | ISO 9120 |
| Water separation: | | | | | | | | | | ISO 6614 |
| — time to 3 ml emulsion at 54 °C | min | 1) | 1) | 1) | 1) | 1) | 1) | — | — | |
| — time to 3 ml emulsion at 82 °C | min | — | — | — | — | — | — | 1) | 1) | |
| Elastomer compatibility [8] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6072 |
| Shear stability, 250 cycles: | | | | | | | | | | CEC L-14-A-88 |
| — viscosity loss 40 °C, maximum | % | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | |
| Oxidation stability: | | | | | | | | | | ASTM D 4310 |
| — delta acid number, maximum | mg KOH/g | — | — | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | |
| — insoluble sludge | mg | — | — | 1) | 1) | 1) | 1) | — | — | |

1) Report only.
2) For the purposes of identification, dye may be used by agreement between supplier and end user.
3) Clear-bright is abbreviated as Clbr. Cleanliness level expressed according to ISO 4406 may be established by agreement between supplier and end user.
4) Square millimetres per second ($mm^2/s$) is equivalent to centistokes (cSt).
5) These limits would not apply to fluids made in HC-HI (hydrocracked - hydro isomerized) mineral oil.
6) Initial acid number is influenced by the presence of functional moieties in the total additive package.
7) DIN 51777-2 is applied to instances where interference by certain chemicals can be avoided. Free alkali, oxidizing and reducing agents, mercaptans, certain nitrogenous substances, or other materials that react with iodine, interfere.
8) The type of elastomer and definition of compatibility are to be agreed between supplier and end user.

## Table 5 — Specifications for category HV mineral oil hydraulic fluids

| Characteristic | Oils of HM type with improved viscosity/temperature properties - A typical application is in mobile construction and marine equipment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Units | Requirements | | | | | | | | Test method |
| **Viscosity grade (ISO 3448)** | — | **VG 10** | **VG 15** | **VG 22** | **VG 32** | **VG 46** | **VG 68** | **VG 100** | **VG 150** | |
| Density at 15 °C | $kg/dm^3$ | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 3675 |
| Colour [2] | | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 2049 |
| Appearance at 25 °C [3] | — | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Clbr | Visual |
| Flash point: | | | | | | | | | | |
| — Cleveland open cup, minimum | °C | 100 | 100 | 140 | 160 | 180 | 180 | 180 | 180 | ISO 2592 |
| — Pensky-Martens closed cup, minimum | °C | 88 | 88 | 128 | 148 | 168 | 168 | 168 | 168 | ISO 2719 |
| Kinematic viscosity at 40 °C: | | | | | | | | | | ISO 3104 and |
| — minimum-maximum | $mm^2/s$ [4] | 9,0 - 11,0 | 13,5 - 16,5 | 19,8 - 24,2 | 28,8 - 35,2 | 41,4 - 50,6 | 61,2 - 74,8 | 90 - 110 | 135 - 165 | ISO 3105 |
| Viscosity index, minimum [5] | 1 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | ISO 2909 |
| Pour point, maximum | °C | -42 | -42 | -42 | -36 | -36 | -30 | -21 | -12 | ISO 3016 |
| Acid number [6] | mg KOH/g | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6618 |
| Water content, maximum | % (*m/m*) | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | ASTM D 1744 or DIN 51777-1 or DIN 51777-2 [7] |
| Copper corrosion, 100 °C, 3 h, maximum | Class | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | ISO 2160 |
| Rust prevention, procedure A | — | Pass | Pass | Pass | Pass | Pass | Pass | Pass | Pass | ISO 7120 |
| Foam: — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | ISO 6247 |
| — at 93,5 °C, maximum | ml | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | 75/0 | |
| — at 24 °C, maximum | ml | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | 150/0 | |
| Air release, 50 °C, maximum | min | 7 | 7 | 7 | 7 | 12 | 12 | 20 | 28 | ISO 9120 |
| Water separation: | | | | | | | | | | ISO 6614 |
| — time to 3 ml emulsion at 54 °C | min | 1) | 1) | 1) | 1) | 1) | 1) | — | — | |
| — time to 3 ml emulsion at 82 °C | min | — | — | — | — | — | — | 1) | 1) | |
| Shear stability, 250 Cycles: | | | | | | | | | | CEC L-14-A-88 |
| — viscosity loss 40 °C, maximum | % | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | |
| Elastomer compatibility [8] | — | 1) | 1) | 1) | 1) | 1) | 1) | 1) | 1) | ISO 6072 |
| Oxidation stability, 1 000 h: | | | | | | | | | | ASTM D 4310 |
| — delta acid number maximum | mg KOH/g | — | — | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | 2,0 | |
| — insoluble sludge | mg | — | — | 1) | 1) | 1) | 1) | 1) | 1) | |
| Wear protection, FZG A/8,3/90 [9] | Fail Stage | — | — | — | 10 | 10 | 10 | 10 | 10 | DIN 51354-2 |
| Vane pump [10] | mg | — | — | 1) | 1) | 1) | 1) | — | — | BS 2000:part 281 or ASTM D 2882 |

1) Report only.
2) For the purposes of identification, dye may be used by agreement between supplier and end user.
3) Clear-bright is abbreviated as Clbr. Cleanliness level expressed according to ISO 4406 may be established by agreement between supplier and end user.
4) Square millimetres per second ($mm^2/s$) is equivalent to centistokes (cSt).
5) These limits would not apply to fluids made in HC-HI (hydrocracked - hydro isomerized) mineral oil.
6) Initial acid number is influenced by the presence of functional moieties in the total additive package.
7) DIN 51777-2 is applied to instances where interference by certain chemicals can be avoided. Free alkali, oxidizing and reducing agents, certain nitrogenous substances or other materials that react with iodine interfere.
8) The type of elastomer and definition of compatibility are to be agreed between supplier and end user.
9) Applicable from ISO VG 32 to ISO VG 150.
10) Applicable from ISO VG 22 to ISO VG 68.

## Table 6 — Specifications for category HG mineral oil hydraulic fluids

| Characteristic | Oils of HM type with improved anti-stick/slip properties - A typical application is for machines with combined hydraulic and plain bearing way lubrication system where vibration or intermittent sliding (slip/stick) at low speed is to be minimized | | | |
|---|---|---|---|---|
| | Units | Requirements | | Test method |
| **Viscosity grade (ISO 3448)** | — | **VG 32** | **VG 68** | |
| Density at 15 °C | kg/dm³ | 1) | 1) | ISO 3675 |
| Colour [2] | — | 1) | 1) | ISO 2049 |
| Appearance at 25 °C [3] | — | Clbr | Clbr | Visual |
| Flash point: | | | | |
| — Cleveland open cup, minimum | °C | 160 | 180 | ISO 2592 |
| — Pensky-Martens closed cup, minimum | °C | 148 | 168 | ISO 2719 |
| Kinematic viscosity at 40 °C: | | | | ISO 3104 and |
| — minimum-maximum | mm²/s [4] | 28,8 - 35,2 | 61,2 - 74,8 | ISO 3105 |
| Viscosity index | 1 | 1) | 1) | ISO 2909 |
| Pour point, maximum | °C | -9 | -9 | ISO 3016 |
| Acid number [5] | mg KOH/g | 1) | 1) | ISO 6618 |
| Water content, maximum | % (*m/m*) | 0,05 | 0,05 | ASTM D 1744 or DIN 51777-1 or DIN 51777-2 [6] |
| Copper corrosion, 100 °C, 3 h, maximum | Class | 2 | 2 | ISO 2160 |
| Rust prevention, procedure A | — | Pass | Pass | ISO 7120 |
| Foam: — at 24 °C, maximum | ml | 150/0 | 150/0 | ISO/DIS 6247 |
| — at 93,5 °C, maximum | ml | 75/0 | 75/0 | |
| — at 24 °C, maximum | ml | 150/0 | 150/0 | |
| Elastomer compatibility [7] | — | 1) | 1) | ISO 6072 |
| Wear protection, FZG A/8,3/90 | Fail stage | 10 | 10 | DIN 51354-2 |
| Vane pump | mg | 1) | 1) | BS2000:part 281 or ASTM D 2882 |

1) Report only.
2) For the purposes of identification, dye may be used by agreement between supplier and end user.
3) Clear-bright is abbreviated as Clbr. Cleanliness level expressed according to ISO 4406 may be established by agreement between supplier and end user.
4) Square millimetres per second (mm²/s) is equivalent to centistokes (cSt).
5) Initial acid number is influenced by the presence of functional moieties in the total additive package.
6) DIN 51777-2 is applied to instances where interference by certain chemicals can be avoided. Free alkali, oxidizing reducing agents, mercaptans, certain nitrogenous substances, or other materials that react with iodine, interfere.
7) The type of elastomer and definition of compatibility are to be agreed between supplier and end user.