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Lubricants, industrial oils and related products (class L) — Family C (gears) —

Part 1: Specifications for lubricants for enclosed gear systems

Lubrifiants, huiles industrielles et produits connexes (classe L) — Famille C (engrenages) —

Partie 1: Spécifications des lubrifiants pour systèmes d'engrenages sous carter

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Contents

Page

Foreword

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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 document 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).

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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 12925-1:2018), which has been technically revised. It also incorporates the Amendment ISO 12925-1/Amd1:2020.

The main changes are as follows:

— in Table 6, a specification regarding the protection level against micro-pitting for category CKSMP has been added;

— the environmental requirements for environmentally acceptable products have been updated.

A list of all the parts of ISO 12925 can be found on the ISO website.

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

Lubricants for gear systems are used in diverse types of gear designs, ranging from simple parallel spur gears to bevel gears (spur, skew or spiral), worm gears and hypoid gears. Industrial gear systems, which are either of open type or enclosed type, vary in size from small enclosed systems used in machine tools to very large systems used in mining, steel mills and cement plants.

Lubricants for these applications vary in composition from refined straight mineral oils to more complex blends, based on mineral oils, synthetic oils (e.g. poly α-olefins, esters, poly-glycols), to vegetable oils and derivatives and friction-modifying additives and/or extreme-pressure. ISO 3448 viscosity grades vary depending on the type of application. They can range from the low viscosity ISO VG 32 to high viscosity ISO VG 1 500. These grades can vary even more for the very low velocities and very high loads. In exceptional cases, viscosity grades may be even higher. Temperature conditions to which the gear systems are exposed also vary considerably, not only due to the ambient conditions of operation, but also depending on the sliding between the gear teeth, on the size of the casings, on the presence on the circulating systems of heat exchangers, on the vicinity of heat sources as in the cement industry or in the steel industry.

Greases may also be used for the splash lubrication of enclosed gears or for the application on open gear teeth.

This document covers the lubricants applied in enclosed gear systems which, at the time of publication, are the most current encountered in the industry. Since the first edition of this document (ISO 12925-1:1996), the requirements for lubricants for enclosed gear systems have largely changed to suit new gear technologies and applications. More demanding requirements have emerged with respect to extreme pressure properties (i.e. resistance to micro-pitting, ability to lubricate low velocity mechanisms, resistance to pitting), foaming and air release characteristics. In addition, there is a greater need for environmentally acceptable products.

This document does not cover the extreme cases of use in terms of gear design, temperature and extreme conditions. For use in exceptional conditions, suppliers and purchasers of lubricants can mutually agree on the testing methods and the acceptability criteria of the products, which is not covered in this document.

Lubricants, industrial oils and related products (class L) — Family C (gears) —

Part 1: Specifications for lubricants for enclosed gear systems

1 Scope

This document establishes the specifications relative to family C (gears) for lubricants, industrial oils and related products of class L (see ISO 6743-6). This document deals only with lubricants for enclosed gear systems. Lubricants for open gears and greases for gears (enclosed or open) are covered by the other parts of the ISO 12925 series (i.e. ISO 12925-2 and ISO 12925-3).

This document is intended to be read in conjunction with ISO 6743-6. The following categories specified in ISO 6743-6 are covered by this document: CKB, CKC, CKD, CKE, CKSMP, CKTG, CKES, CKPG, CKPR, CSPG, CSPR, CTPG and CTPR.

Detailed information about the different types of gear, and lubricants, and their selection for gearbox design and service conditions can be found in ISO/TR 18792.

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 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

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

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

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

ISO 3016, *Petroleum and related products from natural or synthetic sources — 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 4259-2, *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 4263-1, *Petroleum and related products — Determination of the ageing behaviour of inhibited oils and fluids — TOST test — Part 1: Procedure for mineral oils*

ISO 4263-4, *Petroleum and related products — Determination of the ageing behaviour of inhibited oils and fluids — TOST test — Part 4: Procedure for industrial gear oils*

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

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 6743-6, *Lubricants, industrial oils and related products (class L) — Classification — Part 6: Family C (Gears)*

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*

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

ISO 12152, *Lubricants, industrial oils and related products — Determination of the foaming and air release properties of industrial gear oils using a spur gear test rig — Flender foam test procedure*

ISO 12185, *Crude petroleum, petroleum products and related products — Determination of density — Laboratory density meter with an oscillating U-tube sensor*

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 (CO2 headspace test)*

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

ISO 14669, *Water quality — Determination of acute lethal toxicity to marine copepods (Copepoda, Crustacea)*

ISO 16221, *Water quality — Guidance for determination of biodegradability in the marine environment*

ISO 19291, *Lubricants — Determination of tribological quantities for oils and greases — Tribological test in the translatory oscillation apparatus*

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

EN 16807, *Liquid petroleum products — Bio-lubricants — Criteria and requirements of bio-lubricants and bio-based lubricants*

EN 17181, *Lubricants — Determination of aerobic biological degradation of fully formulated lubricants in an aqueous solution — Test method based on CO_2-production*

ASTM D2711, *Standard Test Method for Demulsibility Characteristics of Lubricating Oils*

ASTM D6081, *Standard Practice for Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation*

ASTM D6866, *Standard Test Method for Determining the Biobased Content of Solid, Liquid and Gaseous Samples using Radiocarbon Analysis*

DIN 3990-16, *Determination of the micro-pitting load carrying capacity of lubricants using FZG-test method GT-C/8,3/90*

DIN 51819-3, *Testing of lubricants — Mechanical-dynamic testing in the roller bearing test apparatus FE8 — Part 3: Test method for lubricating oils, axial cylindrical roller bearing*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Sampling

Sampling of gear oils for the purpose of this document 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.

5 Environmental requirements for categories CKTG, CKES, CKPG, CKPR

5.1 General

For the purpose of this document, environmentally acceptable gear oils are either triglycerides of mainly vegetable origin, synthetic esters, polyglycols (homo and or co-polymers of ethylene glycol, propylene glycol, butylene glycols), poly α-olefins and related hydrocarbons. The classification of these gear oils shall be in accordance with ISO 6743-6 for categories CKTG, CHES, CKPG, CKPR. The minimum category-defining base oil type content for each category shall be in accordance with the requirements of Table 1.

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

Category	Mass fraction	Category defining base fluid [a] type content of the total fluid formulation	Total base fluid mass fraction of the fluid formulation
CKTG	%	≥ 50	≥ 70
CKES	%	≥ 50	≥ 70
CKPG	%	≥ 50	≥ 70
CKPR	%	≥ 50	≥ 70

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

Environmentally acceptable lubricants shall comply with the requirements of EN 16807, as follows: CKTG, CKES, CKPG, and CKPR shall comply with the toxicity requirements. Additionally, CKTG and CKES shall comply with the biodegradability and carbon of biological origin requirements given in Table 2. The requirements published in EN 16807 are intended as baseline requirements for all bio-based lubricants, and represent minimum requirements compared to, for example, the European Ecolabel for Lubricants[8]. With the exception of content of carbon of biological origin, these requirements can also be minimum requirements for other types of environmental standards existing in the world.

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

The use of bio-accumulative products in environmentally compatible gear oils should be minimized, whenever possible. Very persistent and very bio-accumulative (vPvB) substances shall be avoided.

The characteristics of the fluids shall comply with the limiting values set out in Table 2 and with the limiting values of the relevant fluid category set out in Tables 3 to 15. The test methods and standards listed in Tables 2 to 15 shall apply.

Table 2 — Environmental requirements for categories CKTG, CKES, CKPG and CKPR

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

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

[b] Applies only to bio-based products.

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

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

5.2 Biodegradability

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

5.3 Acute daphnia or copepods toxicity

In case of dispute, the referee method for conformity to the invertebrate requirement shall be ISO 6341.

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

6 Specifications

Lubricants of each category (CKB, CKC, CKD, CKSMP, CKE, CKTG, CKES, CKPG, CKPR, CSPG, CSPR, CTPG or CTPR) shall be in accordance with the corresponding specification given in Tables 3 to 15, as indicated below:

— Table 3: category CKB;

— Table 4: category CKC;

— Table 5: category CKD;

— Table 6: category CKSMP;

— Table 7: category CKE;

— Table 8: category CKTG;

— Table 9: category CKES;

— Table 10: category CKPG;

— Table 11: category CKPR;

— Table 12: category CSPG;

— Table 13: category CSPR;

— Table 14: category CTPG;

— Table 15: category CTPR.

The composition, properties and typical applications of each category are stated at the top of the tables. These elements shall be in accordance with ISO 6743-6.

7 Precision

Most of the test methods specified in Table 3 to Table 15 contain a precision statement. In cases of dispute, the procedure described in ISO 4259-2 shall apply. In such cases, it is expected that the conditions specified in ISO 4259-1, ISO 4259-3 and ISO 4259-4 are met.

Table 3 — Specifications for lubricants for enclosed gear systems of category CKB

Composition and properties: Refined mineral oils with oxidation stability, corrosion protection (ferrous and non-ferrous metals) and antifoam properties.
Typical application: Gears operating under light to moderate loads.

Property		Test method	Unit	Specifications										
Viscosity class		ISO 3448		VG 32	VG 46	VG 68	VG 100	VG 150	VG 220	VG 320	VG 460	VG 680	VG 1 000	VG 1 500
Kinematic viscosity at 40 °C	min.	ISO 3104	mm^2/s	28,8	41,4	61,2	90	135	198	288	414	612	900	1 350
	max.			35,2	50,6	74,8	110	165	242	352	506	748	1 100	1 650
Appearance		[a]		Bright and clear					Bright					
Viscosity index, min.		ISO 2909		90								85		
Density		ISO 12185 or ISO 3675	kg/m^3	Report										
Mass fraction of water, max.		ISO 12937 or ISO 20764	%	< 0,1										
Acid number		ISO 6618 or ISO 6619	mg KOH/g	Report										
Pour point, max.		ISO 3016	°C	−12				−9				−3		
Flash point, min.		ISO 2592	°C	180			200							
Foaming Tendency/stability, max. Sequence I at 24 °C Sequence II at 93 °C Sequence III at 24 °C after 93 °C		ISO 6247	 ml/ml ml/ml ml/ml	100/10 100/10 100/10										
Corrosiveness to copper 3 h, 100 °C, max.		ISO 2160	class	2										
Demulsibility [b] Test temperature 54 °C Time to reach ≤ 3 ml emulsion, max. Test temperature 82 °C Time to reach ≤ 3 ml emulsion, max.		ISO 6614	 min min	30 —			—	30	—					
Demulsibility (45 ml water) [b] Procedure A Free water volume, min. Emulsion volume, max. Water in oil, max.		ASTM D2711	 ml ml %	—				30 2,0 0,5	30 4,0 2,0					

Key

IRHD international rubber hardness degree

VG viscosity grade

[a] At the time of publication, there is no accepted test method. Visual observation shall be reported as indicated. The objective is to ensure that the lubricant does not appear turbid or contain suspended or settled impurities.

[b] This characteristic does not apply to products containing detergents and dispersing agents, or to hygroscopic products.

[c] The elastomer compatibility with the reference elastomer SRE-NBR 28/SX is not a quality criterion. Correlation to elastomers used in practice should be checked. The values serve as guidance for the selection of elastomers used in practice by the elastomer manufacturer. For information, the formerly used limits (7 days at 100 °C) are reported here as follows: volume change: 0 %/+10 %; IRHD hardness change: −10 %/+5 %; tensile strength change: max. +30 %; elongation at break change: max. +30 %.

[d] This refers to the standard reference elastomer according to ISO 13226.