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Ships and marine technology — Lubricating oil systems — Guidance for grades of cleanliness and flushing

Navires et technologie maritime — Circuits d'huile de graissage — Guide relatif aux degrés de propreté et de rinçage

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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 28520 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

Ships and marine technology — Lubricating oil systems — Guidance for grades of cleanliness and flushing

1 Scope

This International Standard provides guidance for flushing of lubricating oil systems, and grading of the resultant cleanliness. The flushing process is twofold:

— to remove dirt from the erection and installation, and

— to demonstrate that the pipes and the system as a whole is sufficiently clean.

Crankcase and, where applicable, gearbox etc. are cleaned separately before flushing, and requirements relating to this are also specified in this International Standard. Similar considerations apply to the system tank and other components of the system.

For this International Standard, the cleaning process is considered as "washing through" when the Reynolds number, R_e, is $\leqslant$ 3 000, and "flushing" when the $R_e \geqslant$ 3 000.

NOTE If available, any original equipment manufacturer requirements for flushing take precedence over the requirements outlined in this International Standard.

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

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 28521[1)], *Ships and marine technology — Hydraulic oil systems — Guidance for grades of cleanliness and flushing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1) To be published.

3.1
main engine
ME
prime mover used for propulsion of the vessel or to drive a ship's generator

3.2
turbocharger
TC
centrifugal blower driven by exhaust-gas turbines and used to supercharge an engine

3.3
lubricating oil
LO
petroleum product designed to reduce friction and heat between moving parts in internal combustion engines

3.4
Reynolds number
R_e
dimensionless ratio of the internal flow forces to the viscous forces within a fluid

NOTE An indicator of the flow characteristics (laminar or turbulent) of a moving fluid.

4 Recommended degrees of pipe cleaning

This clause specifies the recommended degrees of pipe cleaning during and after prefabrication for pipes or parts, possibly followed by inside surface treatment.

To ensure the best possible conditions for flushing, individual prefabricated parts should be made and cleaned, before erection on-board.

4.1 Degrees of pipe cleaning during/after prefabrication

Concerning prefabrication of pipes and parts, it is recommended that these are completely cleaned inside, which means that all welds associated with the welding of pipe sections and pipe branches should be smooth and free of slag, welding spatter, burns and porosities. Fillet welds on flanges should be smooth and finely grounded and should also be free of roundings as these can damage part of the joint faces. Concerning possible subsequent chemical acid-cleaning or mechanical blast-cleaning, the degree of cleaning should correspond to Sa 2 1/2 as specified in ISO 8501-1.

Steel sand should not be used for shot blasting, due to the risk of adhesion by magnetism or rusting; copper (Cu) slag should be used instead. Sealing surfaces are to be mechanically well protected during shot blasting.

4.2 Inside surface treatment

In order to maintain the above-mentioned degree of cleaning before erection on-board, it is recommended that the inside of the pipes be treated with an appropriate oil product.

Painting the inside with appropriate paint is sometimes prescribed by various manufacturers, and any such requirements should be followed.

5 Cleaning of system components

Shot blasting, grinding, painting and welding should not be executed in the near vicinity during cleaning operations on the items listed in 5.1 to 5.4.

5.1 Pumps, valves, filters, oil coolers, etc.

System oil requirements shall be requested from suppliers of these auxiliaries.

5.2 Engine crankcase

When engines (especially large engines) are delivered without cleaned and sealed lubricating oil systems, including the crankcase, the crankcase shall be cleaned before flushing. This can be done as follows.

a) Blank-offs are placed on each oil drain to the engine mainframe. Starting at the top of one cylinder block at a time, the inside of the crankcase is washed down with oil to remove rough particles. During this task the engine crankshaft is turned at regular intervals so that chains, chain wheels, and the crankshaft are washed down and cleaned.

b) A thin, non-drying oil, is recommended (about SAE 10 to 30 cSt), the remainder of which is compatible with the system oil, which can dissolve the rust-prevention product which the engine has been coated with when delivered. System oil (SAE 30 – 90 cSt or SAE 40 – 175 cSt) may be employed instead, provided the oil is heated to 55 °C to 60 °C. In practice, 200 l to 400 l per cylinder have proven to be sufficient, with the same quantity used for camshaft drive.

When the camshaft drive is cleaned, the thrust bearing cover is removed, if possible, and the thrust bearing is washed down. Furthermore, the thrust-bearing ahead and astern thrust-pads are taken out for wiping if possible. Ensure that the flash point of the oil is not too low (danger of fire).

Some rust prevention oils can influence the foam characteristic of the system oil; this occurrence can be limited in the following way. The work can be partly done from the outside of the crank and shaft casting through various inspection covers. After an appropriate amount of time, allowing for dripping and draining, the dirty flush oil and deposited sediments shall be removed from the oil sump. The inside of the engine is then wiped with lint-free and non-frayed cloths, and an inspection is made before the actual flushing is commenced.

5.3 Gearbox

If gears are delivered with no cleaned and sealed lubrication oil systems, including pump and pipes, the gears shall be cleaned before flushing.

5.3.1 Sealed gearboxes

For sealed gearboxes, external piping, filters and pumps, see 6.3.1.

5.3.2 Non-sealed gearboxes

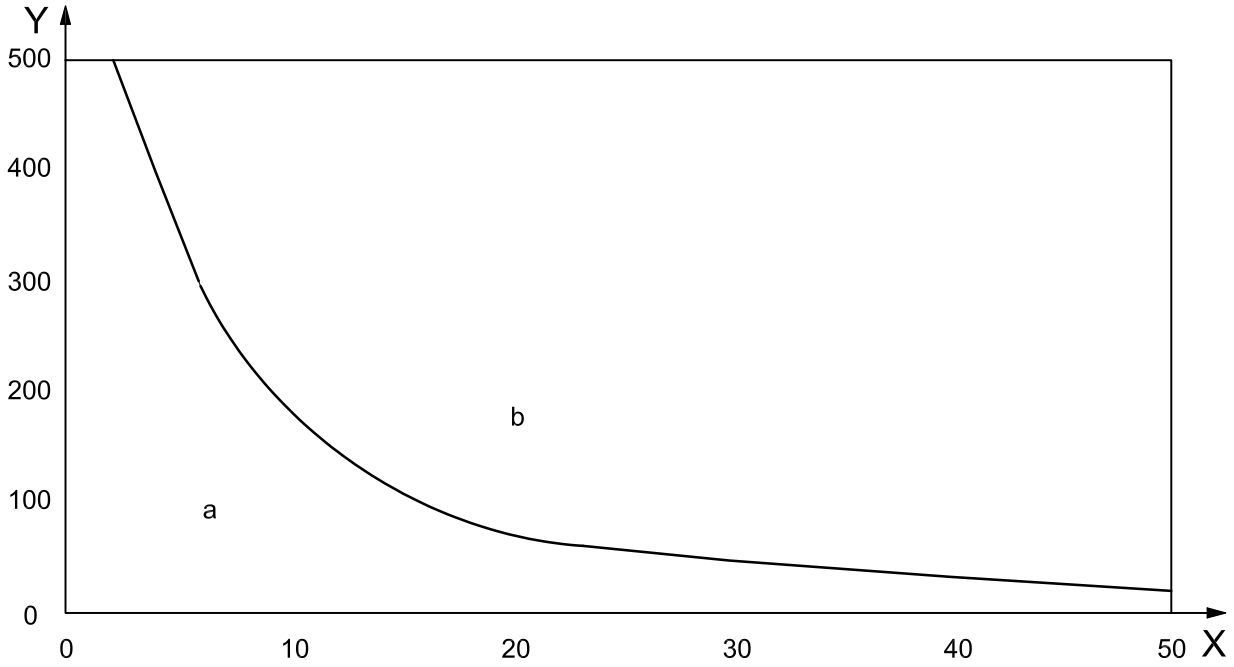
For non-sealed gearboxes (when assembling gearboxes, including external pump, piping, filters and coolers) see 6.3.2.

5.3.3 Choice of cleanliness level

The most impurity-sensitive components in a gearbox are, typically, ball- and roller-bearings. Information concerning required bearing-cleanliness may be obtained from the bearing supplier, but shall in all cases be stated by the gearbox supplier.

To a wide extent, the demand for life cycle and bearing load conditions shall guide the choice of cleanliness level.

Bearing manufacturers have developed a bearing-lifetime theory, which among other items includes the influence of impurities on service lifetime based on system lubrication oil. Figures 1 and 2 show the relationship between size and hardness of impurities, how harmful they are to bearing life, and how important it is to focus on cleanliness.



Key

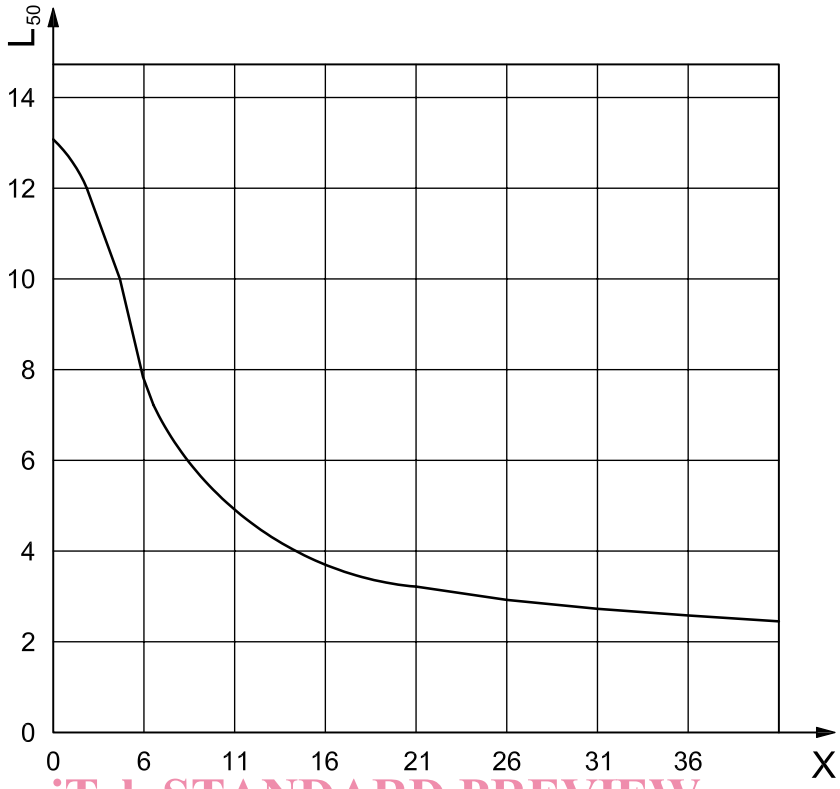
X grain hardness, expressed in Vickers hardness (HV)
Y grain size, expressed in micrometres

[a] Harmless.

[b] Harmful.

NOTE In the calculation of these results the following parameters are used: friction coefficient, μ, 0,1; oil film thickness 0,4 ∝m; hardness of outer track and roller 800 HV.

Figure 1 — Attrition particle's damaging effects with relation to their size and hardness



Key

L_{50} bearing lifetime, expressed in million revolutions
X absolute filter fineness, expressed in micrometres

Figure 2 — Bearing lifetime (L_{50}) as a function of filter fineness

Table 1 indicates proposals for the degree of cleanliness for the various gear types.

Gear type, in this context, is a specification that combines and includes such characteristics as speed, load variation and lifetime frequent start-stop.

Table 1 — Level of cleanliness for the various types of gear

Type of gear	Level of cleanliness after approved flushing	Level of cleanliness after commissioning trial	Max. allowable contamination during service	Typical service oil filter
	ISO 4406	ISO 4406	ISO 4406	$\beta_x > 75$
1	16/14/11	17/15/12	18/16/13	3-5 µm
2	17/15/12	18/16/13	19/17/14	5-10 µm
3	18/16/13	19/17/14	20/18/15	5-10 µm
4	21/19/16	22/20/17	23/21/19	20-50 µm

The classification of type of gear (number) is explained as follows.

1) Demand for long service life, high operational reliability, high gear load, rpm (> 3 000), frequent start-stop, such as on ferries with gas turbines on short crossings, and high loaded gear with multiple power take-off (PTO).