International Standard

ISO 8838

Plain bearings — Water-lubricated plain bearing materials

Paliers lisses — Matériaux de paliers lisses lubrifiés à l'eau

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Foreword

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This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 7, *Special types of plain bearings*.

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

Water-lubricated bearings are widely used in fields such as submersible pumps, marine stern tubes, hydroelectric generator turbines, water treatment equipment, water valves and rolling equipment for steelmaking.

Water-lubricated plain bearings are used for the following conditions or reasons:

a) oil or greases cannot be used due to equipment usage conditions;

b) there is plenty of water available as a lubricant around the equipment;

c) even if water for lubrication leaks, it does not pollute the environment like oil or grease.

However, when using water as a lubricant, it is necessary to take the following into account:

— water freezes at 0 °C or below and becomes vapor at 100 °C or above, at normal pressure, therefore losing load carrying capacity;

— water has low viscosity in comparison with oil;

— water cannot support a high load because the increase in viscosity that occurs in oil lubrication (elastohydrodynamic lubrication: EHL) when it is under high pressure cannot be expected in water.

— water does not have the ability that oil and grease have to prevent corrosion on shafts and bearings.

While water-lubricated plain bearings have been used in various fields around the world and the water that is used as a lubricant has its own specific features differing from oil, there have been no International Standards that apply to water-lubricated plain bearings thus far.

Plain bearings — Water-lubricated plain bearing materials

1 Scope

This document specifies requirements for the selection and use of water-lubricated plain bearing materials used in different equipment and plants under various lubrication conditions, such as

— fluid-film lubrication condition,

— mixed lubrication condition, and

— condition comprising a non-lubrication condition which shifts to a fluid-film lubrication condition.

In addition, this document also specifies requirements for mating (shaft) material, the lubrication method and for items to consider during the design of water-lubricated plain bearing materials.

The water used as a lubricant is pure water, tap water, river water or seawater. This document does not apply to the water solution of chemicals, refrigerants, liquid fuels, etc.

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 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 4378-1, *Plain bearings — Terms, definitions, classification and symbols — Part 1: Design, bearing materials and their properties*

ISO 4378-2, *Plain bearings — Terms, definitions, classification and symbols — Part 2: Friction and wear*

ISO 4378-3, *Plain bearings — Terms, definitions, classification and symbols — Part 3: Lubrication*

ISO 8044, *Corrosion of metals and alloys — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1043-1, ISO 4378-1, ISO 4378-2, ISO 4378-3 and ISO 8044 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 https://www.electropedia.org/

4 Plain bearing materials and mating (shafts) materials

4.1 Bearing materials

4.1.1 General

Depending on the equipment, bearings are used in the following lubrication conditions:

a) bearing is constantly immersed in water;

b) there is no lubrication at first and water is supplied after the start of operation;

c) water is forcibly supplied from the beginning.

When required to operate without lubrication, a bearing material with a self-lubricating property shall be selected. When used in seawater, a bearing material that does not cause galvanic corrosion shall be selected.

NOTE In addition to the materials listed below, the bearing materials listed in ISO 19259 and ISO 20054 are also used for water-lubricated bearing materials.

4.1.2 Wood-based material

Lignum vitae or materials such as maple and beech impregnated with wax can be used.

Wood-based material has self-lubricating properties.

4.1.3 Carbon-based material

Artificial graphite with or without the following can be used:

a) impregnated resin (phenolic resin, etc.);

b) low melting point metals (such as Cu, Sn, Cu-Sn alloy, etc.).

Carbon-based material has self-lubricating properties, however, there is a risk of galvanic corrosion when used in seawater.

NOTE Terms related to galvanic corrosion are defined in ISO 8044.

4.1.4 Rubber-based material

Natural rubber (NR) or synthetic rubber, such as chloroprene rubber (CR), acrylonitrile-butadiene rubber (NBR), and styrene-butadiene rubber (SBR), can be used.

NOTE Other rubber-based materials are defined in ISO 1629.

These rubber-based materials are typically bonded to the inner surface of the metal tube or fibre-reinforced plastic tube. They are resistant to abrasive wear, however, they do not have self-lubricating properties.

4.1.5 Thermosetting resin-based material

Thermosetting resin such as phenolic resin and unsaturated polyester resin reinforced with fibre or woven fabric, and, as needed, added with fillers such as graphite, carbon fibre and polytetrafluoroethylene (PTFE) to improve sliding characteristics can be used.

Thermosetting resin-based material has self-lubricating properties and impact load resistance.

4.1.6 Fluoro resin-based material

Fluoro resin such as PTFE, tetrafluoroethylene-perfluoroalkylvinylether copolymer resin (PFA) and tetrafluoroethylene-hexafluoropropylene copolymer resin (FEP) added with fillers such as glass fibre and carbon fibre to improve wear resistance can be used.

Fluoro resin-based material is used as solid type or multilayer type bonded to a metal substrate. It has self-lubricating properties.

4.1.7 Thermoplastic resin-based material

Thermoplastic resin such as polyamide (PA), polyoxymethylene (POM), polyphenylenesulfide (PPS), polyetheretherketone (PEEK), polyurethane (PU) and polyethersulfone (PES) added with fillers such as glass fibre, carbon fibre and PTFE to improve wear resistance and lubricity can be used.

Thermoplastic resin-based material has self-lubricating properties.

4.1.8 Ceramic-based material

Silicon nitride (Si_3N_4), silicon carbide (SiC) or Sialon (Si_3N_4-Al_2O_3) can be used.

These ceramic-based materials are resistant to abrasive wear, however, they do not have self-lubricating properties.

4.1.9 Cermet-based material

Composite materials of ceramics and metals, such as tungsten carbide (WC) based alloy or titanium carbide (TiC) based alloy, are the most commonly used among cermet-based materials. Cromium carbide (Cr_3C_2) alloy is used for a coating on a metal substrate.

These cermet-based materials are resistant to abrasive wear, however, they do not have self-lubricating properties.

4.2 Mating (shaft) materials

4.2.1 General

Lubricating water does not prevent corrosion like oil or grease, so the mating shaft selected shall be corrosion resistant. A material with high surface hardness, preferably HV 600 or higher and wear resistance should be selected, in case hard foreign matter, such as sand, enters between sliding surfaces of the bearing and mating shaft.

However, when using a rubber bearing, the shaft does not need to have a hard surface, because the elastic deformation of the rubber traps hard foreign matters resulting in less damage to the shaft.

4.2.2 Copper alloy

A bronze sleeve should be fitted on to a steel shaft for marine propulsion shafts.

4.2.3 Stainless steel

Austenitic, martensitic, two-phase precipitation hardening stainless steel, high nitrogen steel or the like should be used.

NOTE Chemical composition, mechanical properties, etc. of stainless steels are described in ISO 16143-2.

4.2.4 Plating

Hard chromium plated steel shaft should be used.

4.2.5 Ceramics

Ceramic material such as silicon carbide (SiC), silicon nitride (Si_3N_4) and Sialon (Si_3N_4-Al_2O_3) should be used.

For small size, e.g. shaft diameters of 20 mm or less, it is recommended to use for a solid type, and for larger size than that, it is recommended to fit on a steel shaft as a sleeve, but the aforementioned values are not limiting as the dimensions depend on the manufacturing capacity of the shaft.

4.2.6 Cermet

A WC based alloy or TiC based alloy should be used by fitting it as a sleeve on a steel shaft.

5 Characteristics, applications, manufacturing method and compatible combinations

In order to assist in selecting material, an outline of the characteristics, applications and the manufacturing method of water-lubricated bearings, and the compatible combinations of water-lubricated bearing materials and shaft materials is given in Annex A.

6 Water supply method

6.1 General

Water lubrication may be achieved by the following means:

a) water surrounding the equipment;

b) water in a tank attached to the equipment;

c) or tap water supply where pressure is needed.

6.2 Forced water supply

Where this method is used, water such as river water and seawater are forcibly supplied to the sliding surface of a plain bearing from the outside by using a pump or the like. For tap water, supplied water pressure is used.

A great cooling effect is expected when using river water and seawater. A filter or a centrifugal separator is often used in order to remove foreign matters. Both are used together when high cleanliness is required.

6.3 Circulating water supply

Water stored in a tank that is attached to the equipment is mechanically circulated and supplied to the sliding surface of a bearing.

As the tank attached to the equipment has a small capacity, the cooling effect is limited. However, it has the benefit that it limits foreign matters from entering the equipment.

6.4 Immersed in water

The sliding surface of the bearing is immersed in the surrounding water such as seawater and river water without the use of force-feed means.

This method is suitable when a large amount of water exists around the equipment.

It is recommended to use a filter or a centrifugal separator in order to remove foreign matter from water supplied to the sliding surface.