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Pumps — Shaft-sealing systems for centrifugal and rotary pumps

Pompes — Dispositifs d'étanchéité de l'arbre pour pompes centrifuges et rotatives

[Revision of first edition (ISO 21049:2004)]

ICS 23.080; 23.100.60; 83.140.50

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO-lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five-month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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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 21049 was prepared by Technical Committee ISO/TC 115, *Pumps*, Subcommittee SC 3, *Installation and special applications*, in collaboration with Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, SC 6, *Processing equipment and systems*.

This second edition cancels and replaces the first edition (ISO 21049:2004), which has been technically revised.

Introduction

This International Standard is based on the accumulated knowledge and experience of manufacturers and users of equipment in the petroleum, natural gas and chemical industries, but its use is not restricted to these industries.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

The purpose of this International Standard is to assist purchasers with the selection and operation of mechanical seals for pumps.

In this International Standard, where practical, US Customary units are included in brackets for information.

A bullet (●) at the beginning of a clause or subclause indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on data sheets or stated in the enquiry or purchase order (see examples in Annex C).

Pumps — Shaft-sealing systems for centrifugal and rotary pumps

1 Scope

This International Standard specifies requirements and gives recommendations for sealing systems for centrifugal and rotary pumps used in the petroleum, natural gas and chemical industries. It is applicable mainly for hazardous, flammable and/or toxic services where a greater degree of reliability is required for the improvement of equipment availability and the reduction of both emissions to the atmosphere and life-cycle sealing costs. It covers seals for pump shaft diameters from 20 mm (0,75 in) to 110 mm (4,3 in).

This International Standard is also applicable to seal spare parts and can be referred to for the upgrading of existing equipment. A classification system for the seal configurations covered by this International Standard into categories, types, arrangements and orientations is provided.

This International Standard is a stand-alone seal standard and is referenced normatively in ISO 13709. It is applicable to both new and retrofitted pumps, and to pumps other than ISO 13709 pumps (e.g. ASME B73.1, ASME B73.2 and API 676 pumps).

This International Standard might also be referenced by other machinery standards such as other pumps, compressors and agitators. Users are cautioned that this International Standard is not specifically written to address all of the potential applications that a purchaser may specify. This is especially true for the size envelope specified for ISO 21049 seals. The purchaser and seal vendor shall mutually agree on the features taken from this International Standard and used in the application.

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 7 (all parts), *Pipe threads where pressure-tight joints are made on the threads*

ISO 261, *ISO general-purpose metric screw threads — General plan*

ISO 262, *ISO general-purpose metric screw threads — Selected sizes for screws, bolts, and nuts*

ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 724, *ISO general-purpose metric screw threads — Basic dimensions*

ISO 965 (all parts), *ISO general-purpose metric screw threads — Tolerances*

ISO 7005-1, *Metallic flanges — Part 1: Steel flanges*

ISO 10438 (all parts), *Petroleum, petrochemical and natural gas industries — Lubrication, Shaft-sealing and control-oil systems and auxiliaries*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 15649, *Petroleum and natural gas industries — Piping*

IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

AISI, *Standards, codes and specifications of the American Iron and Steel Institute* [1)]

API RP 520 (all parts), *Sizing, selection, and installation of pressure-relieving devices in refineries* [2)]

API Std 526, *Flanged steel pressure relief valves*

ASME V, *ASME Boiler and pressure vessel code, Section V, Non-destructive examination* [3)]

ASME VIII, *ASME Boiler and pressure vessel code, Section VIII, Rules for the construction of pressure vessels*

ASME IX, *ASME Boiler and pressure vessel code, Section IX, Welding and brazing qualifications*

ASME B1.1, *Unified inch screw threads (UN and UNR thread form)*

ASME B1.20.1, *Pipe threads, general purpose, inch*

ASME B16.11, *Forged fittings, socket-welding and threaded*

ASME B16.20, *Metallic gaskets for pipe flanges — Ring joint, spiral-wound, and jacketed*

ASME B31.3, *Process Piping*

ASME B73.1, *Specification for horizontal end suction centrifugal pumps for chemical process*

ASME B73.2, *Specification for vertical in-line centrifugal pumps for chemical process*

ASME PTC 8.2, *Centrifugal pumps, performance test codes*

AWS D1.1, *Structural welding code — Steel* [4)]

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1) Available from the American Iron and Steel Institute: 1140 Connecticut Ave., Suite 705, Washington, D.C. 20036, USA.

2) Available from the American Petroleum Institute, 1220 L Street, NW, Washington, D.C. 20005-4070, USA.

3) Available from the American Society of Mechanical Engineers: Three Park Avenue, New York, NY 10016-5990, USA.

EN 287 (all parts), *Approval testing of welders — Fusion welding* [5)]

EN 288 (all parts), *Specification and approval of welding procedures for metallic materials*

EN 13445 (all parts), *Unfired pressure vessels*

EPA Method 21, Appendix A of Title 40, Part 60 of the U.S. Code of Federal Regulations, *Environmental Protection Agency, United States* [6)]

NEMA 250, *Enclosures for electrical equipment (1 000 volts maximum)* [7)]

NFPA 70, *National Electrical Code* [8)]

Title 1, Part A, Section 112, *U.S. National Emission Standards for Hazardous Air Pollutants (NESHAPs) (Clean Air Act Amendment)* [9]

3 Terms and Definitions

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

3.1
anti-rotation device
device used to prevent rotation of one component relative to an adjacent component in a seal assembly

EXAMPLES Key, pin.

3.2
arrangement 1 seal
see 4.1.4

3.3
arrangement 2 seal
see 4.1.4

3.4
arrangement 3 seal
see 4.1.4

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4) Available from the American Welding Society, 550 N.W. Le Jeune Rd, Miami, FL 33126, USA.

5) Comité Européen de Normalisation, 36, rue de Stassart, B-1050 Brussels, Belgium.

6) Available from the National Archives and Records Administration, 700 Pennsylvania Avenue, N.W., Washington, D.C. 20408, USA.

7) Available from the National Electrical Manufacturers Association, 1300 North 17th Street, Rosslyn, VA 22209, USA.

8) Available from the National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

9) Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Mail Code 3213A, Washington, D.C. 20460, USA.

3.5
atmospheric leakage collector
external reservoir arranged to capture liquid seal leakage from an arrangement 1 seal

3.6
auxiliary sleeve
separate sleeve mounted on the outer diameter of the seal shaft sleeve that facilitates assembly of seal components.

3.7
back-to-back configuration
dual seal in which both of the flexible elements are mounted between the mating ring. The sealed fluid is on the ID of the inner seal and the barrier or buffer fluid is on the OD of the inner and outer seal.

3.8
balanced seal
mechanical seal in which the fluid closing forces have been modified through seal design

NOTE In this International Standard the seal balance ratio is less than 1 (see balance ratio calculation in Annex F).

3.9
barrier fluid
externally supplied fluid at a pressure above the pump seal chamber pressure, introduced into an Arrangement 3 seal to completely isolate the process liquid from the environment

3.10
barrier/buffer seal chamber
component or aggregate of components which form the cavity into which the outer seal of a pressurized or unpressurized dual seal is installed and in which a barrier or buffer fluid is circulated.

3.11
bellows seal
type of mechanical seal which uses a flexible metal bellows to provide secondary sealing and spring loading

3.12
buffer fluid
externally supplied fluid, at a pressure lower than the pump seal chamber pressure, used as a lubricant and/or to provide a diluent in an Arrangement 2 seal

3.13
cartridge seal
completely self-contained unit (including seal faces, flexible elements, seal gland plate sleeve which is pre-assembled and preset before installation

3.14
category 1 seal
see 4.1.2

3.15
category 2 seal
see 4.1.2

3.16
category 3 seal
see 4.1.2

3.17
connection
threaded or flanged joint that mates a port to a pipe or to a piece of tubing

3.18
contacting seal
seal design in which the mating faces are not designed to intentionally create aerodynamic or hydrodynamic forces to sustain a specific separation gap

NOTE Contacting seals can actually develop a full fluid film but this is not typical. Contacting seals do not incorporate geometry, e.g. grooves, pads, face waviness, to ensure that the faces do not touch. The amount of contact is generally very low and permits reliable operation with low leakage.

3.19
containment device
seal or bushing which is intended to manage leakage from the inner or outer seal and divert it to a location determined by the user. See Annex F for further description

3.20
containment seal
special version of an outer seal used in Arrangement 2 and which normally operates in a vapour (gas buffer or not buffer) but will seal the process fluid for a limited time in the event of an inner seal failure. See 4.2

3.21
containment seal chamber
component or aggregate of components which form the the cavity into which the containment seal is installed

3.22
containment seal chamber leakage collector
reservoir, connected by pipework to the containment seal chamber for the purpose of collecting condensed leakage from the inner seal of an Arrangement 2.

3.23
crystallizing fluid
fluid which is in the process of forming solids or which may form solids due to dehydration or chemical reaction

3.24
distributed flush system
arrangement of holes, passages, baffles, etc., designed to promote an even distribution of flush fluid around the circumference of the seal faces.

NOTE these are normally required when piping plans provide flush into the seal chamber

3.25
drive collar
external part of the seal cartridge that transmits torque to the seal sleeve and prevents axial movement of the seal sleeve relative to the shaft

3.26
dual mechanical seal
Arrangement 2 or Arrangement 3 seal of any type

3.27
dynamic sealing-pressure rating
highest pressure differential that the seal assembly can continuously withstand at the maximum allowable temperature while the shaft is rotating

NOTE Thereafter, the seal retains its static sealing pressure rating.

3.28
dynamic secondary seal
secondary seal which is designed to slide or move relative to other components to allow axial movement of the flexible element.

3.29
engineered seal
mechanical seal for applications with service conditions outside the operation scope of Type A, B and C seals

NOTE Engineered seals are not required to meet any of the design or testing requirements of this International Standard.

3.30
external circulating device
device located outside of the seal/buffer/barrier chamber to circulate seal chamber fluid through a cooler or barrier/buffer fluid reservoir

3.31
face-to-back configuration
dual seal in which one mating ring is mounted between the two flexible elements and one flexible element is mounted between the two mating rings and the pump process fluid is on the OD of the inner seal and barrier of buffer fluid is on the ID of both the inner and outer seal.

3.32
face-to-face configuration
dual seal in which both of the mating rings are mounted between the flexible elements and the pump process fluid is on the ID of the inner seal and barrier or buffer fluid is on the OD of both the inner and outer seal

3.33
fixed bushing
cylindrical device with a close clearance to the shaft or sleeve which restricts flow between two regions and which does not have a clearance on the outer diameter relative to the housing in which it is mounted

3.34
fixed throttle bushing
one-piece cylindrical device that is fitted to the stationary part of the containment seal chamber and has a radial clearance to a rotating component. It is used to help isolate one region from another and assist in channelling liquid leakage to an exit port. The design is intended to maintain a fixed radial clearance over the operating life of the seal. These devices have a low L/D ratio 0,2 or lower.

3.35
flashing
rapid change in fluid state from liquid to gas

NOTE In a dynamic seal, this can occur when frictional energy is added to the fluid as it passes between the primary seal faces, or when fluid pressure is reduced below the fluid's vapour pressure because of a pressure drop across the seal faces.

3.36
flashing hydrocarbon
flashing fluid
liquid hydrocarbon or other fluid with an absolute vapour pressure greater than 0,1 MPa [1 bar] [14,7 psi] at the pumping temperature, or a fluid that will readily boil at ambient conditions

3.37
flexible element
combination of elements which accommodate axial movement ~~of~~ between rotating and stationary parts

3.38
flexible graphite
exfoliated and recompressed graphite material used for static (secondary seal) gaskets in mechanical seal design, from cryogenic to hot service

3.39
floating bushing
cylindrical device with a close clearance to the shaft or sleeve which restricts flow between two regions and which has a clearance on the outer diameter relative to the housing in which it is mounted to allow radial motion (“floating”) of the bushing should it come in contact with the rotating shaft or sleeve

3.40
fluoroelastomer
FKM
saturated polymer in which hydrogen atoms have been replaced with fluorine. It is characterized by excellent hydrocarbon and general chemical resistance.

3.41
flush, noun
fluid which is introduced into the seal chamber on the process fluid side in close proximity to the seal faces and typically used for cooling and lubricating the seal faces and/or to keep them clean

3.42
gland plate
gland end plate
pressure retaining component(s) similar to a flange which connects the stationary assembly of a mechanical seal to the seal chamber

NOTE A gland plate may consist of more than one pressure containing component for example the two gland plates often used in a dual seal

3.43
hook sleeve
sleeve, with a step or hook at the product end, placed over the shaft to protect it from wear and corrosion

NOTE The step is usually abutted against the impeller to hold it in place with a gasket between the shaft and the step (hook).

3.44
inner seal
(Arrangement 2 and Arrangement 3) the seal closest to the pump impeller or process fluid

3.45
internally-mounted seal
seal configuration in which the seal is mounted within the boundaries of the seal chamber or containment seal chamber or and gland plate

3.46
internal circulating device
device located in the seal buffer/barrier chamber to circulate fluid through a cooler or barrier/buffer fluid reservoir

NOTE There are various designs to achieve radial or axial flow. The internal circulating device can be integral with other seal parts or a separate part. (This device was formerly known as a “pumping ring”).

3.47
leakage concentration
measure of the concentration of a volatile organic compound or other regulated emission in the environment immediately surrounding the seal

3.48
leakage rate
volume or mass of fluid passing through a seal in a given length of time

3.49
light hydrocarbon
hydrocarbon liquid that will readily boil at ambient conditions

NOTE Typically this definition includes pure and mixed streams of pentane (C_5) and lighter liquids.

3.50
mating ring
disk- or toroidal-shaped member, mounted either on a sleeve or in a housing such that it does not move axially relative to the sleeve or the housing on or which it is mounted, and, which provides