INTERNATIONAL STANDARD

ISO 15783

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Seal-less rotodynamic pumps — Class II — Specification

Pompes rotodynamiques sans dispositif d'étanchéité d'arbre — Classe II — Spécifications

Reference number
ISO 15783:2002(E)

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15783 was prepared by Technical Committee ISO/TC 115, *Pumps*, Subcommittee SC 1, *Dimensions and technical specifications of pumps*.

Annex A forms a normative part of this International Standard. Annexes B, C, D, E, F and G are for information only.

Introduction

This International Standard is the first of a series dealing with technical specifications for seal-less pumps; they correspond to two classes of technical specifications, Classes I and II, of which Class I is the more severe requirements.

Where a decision may be required by the purchaser, or agreement is required between the purchaser and manufacturer/supplier, the relevant text is highlighted with • and is listed in annex G.

Seal-less rotodynamic pumps — Class II — Specification

1 Scope

1.1 This International Standard specifies the requirements for seal-less rotodynamic pumps that are driven with permanent magnet coupling (magnet drive pumps) or with canned motor, and which are mainly used in chemical processes, water treatment and petrochemical industries. Their use can be dictated by space, noise, environment or safety regulations.

Seal-less pumps are pumps where an inner rotor is completely contained in a pressure vessel holding the pumped fluid. The pressure vessel or primary containment device is sealed by static seals such as gaskets or O-rings.

1.2 Pumps will normally conform to recognized standard specifications (e.g. ISO 5199, explosion protection, electromagnetic compatibility), except where special requirements are specified herein.

1.3 This International Standard includes design features concerned with installation, maintenance and operational safety of the pumps, and defines those items to be agreed upon between the purchaser and manufacturer/supplier.

1.4 Where conformity to this International Standard has been requested and calls for a specific design feature, alternative designs may be offered providing that they satisfy the intent of this International Standard and they are described in detail. Pumps which do not conform with all requirements of this International Standard may also be offered providing that the deviations are fully identified and described.

Whenever documents include contradictory requirements, they should be applied in the following sequence of priority:

a) purchase order (or inquiry, if no order placed), see annexes D and E;

b) data sheet (see annex A) or technical sheet or specification;

c) this International Standard;

d) other standards.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 76, *Rolling bearings — Static load ratings*

ISO 281, *Rolling bearings — Dynamic load ratings and rating life*

ISO 3274, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane*

ISO 3746, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

ISO 5199, *Technical specifications for centrifugal pumps — Class II*

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

ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

ISO 7005-3, *Metallic flanges — Part 3: Copper alloy and composite flanges*

ISO 9906, *Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1 and 2*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*

EN 12162, *Liquid pumps — Safety requirements — Procedure for hydrostatic testing*

3 Terms and definitions

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

3.1
magnetic drive pump
MDP
pump in which the shaft power of the drive is transferred to the impeller of the pump by means of a permanent magnetic field, which passes through a containment barrier (shell) to an inner rotor having permanent magnets or an induction device

3.2
canned motor pump
CMP
pump in which the stator of an electric motor is separated from the rotor by a sealed containment barrier (liner)

NOTE 1 The rotor runs in the liquid being pumped or in another liquid.

NOTE 2 The shaft power is transmitted by means of an electromagnetic field.

3.3
seal-less rotodynamic pump
⟨general⟩ pump design in which the impeller shaft also carries the rotor of either a canned induction motor or a synchronous or an asynchronous magnetic drive

NOTE The design does not use a dynamic shaft seal as a primary containment device. Static seals are the means used for containing the fluid.

3.3.1
hydraulic end
that end of the pump which transfers mechanical energy into the liquid being pumped

3.3.2
power drive end
that end of the pump containing the magnetic coupling (MDP) or the motor (CMP) which provides the mechanical energy necessary for the operation of the hydraulic end

3.3.3
lubrication and cooling flow
flow necessary in a magnetic drive in the area between the inner magnet and the containment shell, or in a canned motor between the rotor and the sleeve, for dissipation of the heat due to inherent eddy current losses in metallic containment shells and frictional heat generation from bearings, and for lubrication

NOTE Internal pump bearings are lubricated and cooled by the pumped fluid or an external, compatible flushing fluid.

3.3.4
close coupled
⟨MDP⟩ coupling arrangement in which the motor is supplied with a flange adapter which mounts directly onto the casing or body of the pump and in which the outer magnet ring is mounted onto the motor shaft

3.3.5
separately coupled
⟨MDP⟩ arrangement in which the motor and pump have separate mounting arrangements with the outer magnet ring mounted on its own shaft, supported by rolling bearings, and connected to the motor shaft by means of a flexible coupling

3.3.6
air gap
⟨MDP⟩ radial distance between the inner diameter (ID) of the outer magnet assembly and the outer diameter (OD) of the containment shell

3.3.7
liquid gap
⟨MDP⟩ radial distance between the ID of the shell and the OD of the rotor sheath

3.3.8
liquid gap
⟨CMP⟩ radial distance between the ID of the liner and the OD of the rotor sheath

3.3.9
total gap
magnetic gap
⟨MDP⟩ radial distance between the ID of the outer magnets and the OD of the inner magnets/torque ring

3.3.10
total gap
magnetic gap
⟨CMP⟩ total distance between the ID of the stator laminations and the OD of the rotor lamination

3.3.11
radial load
⟨MDP and CMP⟩ load perpendicular to the pump shaft and drive shaft due to unbalanced hydraulic loading on the impeller, mechanical and magnetic rotor unbalance, rotor assembly weight, and forces of the fluid circulating through the drive

3.3.12
axial load
⟨MDP⟩ load in line with the pump shaft caused by hydraulic forces acting on the impeller shrouds and inner magnet assembly

3.3.13
axial load
⟨CMP⟩ load in line with the pump shaft caused by hydraulic forces acting on the impeller shrouds and rotor

3.3.14
hydraulic load balance
axial load equalization by means of an impeller design, impeller balance holes or vanes, or by balancing through variable orifices in the drive section and hydraulics

3.4
starting torque
maximum net torque transmitted to the driven components during a hard (full voltage) start-up of the unit

NOTE It is affected by the inertia of the pump and motor rotors, the starting torque capacity of the motor and the power versus speed requirements of the liquid end.

3.5
break-out torque
torque load applied to the drive shaft with the rotor locked at the point at which magnetic decoupling occurs

3.6
locked rotor torque
maximum torque that a motor will develop when prevented from turning

3.7
eddy currents
electrical currents generated in a conductive material when strong magnetic fields are rotated around it

3.8
magnetic coupling
device which transmits torque through the use of magnet(s) attached to the drive and driven shafts

3.9
inner magnet ring
rows of magnets operating within the containment shell, driven by the outer magnet ring

NOTE The inner magnet ring is mounted on the same rotating element as the pump impeller.

3.10
outer magnet ring
rows of permanent magnets securely fixed to a carrier, evenly spaced to provide a uniform magnetic field

NOTE The outer magnet ring, while rotating, transmits power through a containment shell, driving the inner magnet ring or torque ring.

3.11 Eddy currents

3.11.1
eddy current drive
asynchronous magnetic coupling consisting of a permanent outer magnet ring and an inner torque ring containing a network of conductive rods supported on a mild steel core

NOTE The rotating outer magnet ring generates eddy currents in the copper rods which convert the core to an electromagnet. The electromagnet follows the rotating outer magnet ring but at a slightly slower speed due to slip.

3.11.2
eddy current loss
power loss resulting from eddy currents

NOTE The energy in these eddy currents is normally dissipated as heat due to the electrical resistance of the material.

3.11.3
torque ring
laminations and conductors mounted on the rotor in which electric currents are induced in an eddy current drive

3.11.4
decouple
failure of a synchronous magnetic coupling to rotate synchronously, or the stall condition of an eddy current drive

3.11.5
slip
speed differential between the torque ring and outer magnet ring in an eddy current drive pump or between the running speed and the synchronous speed in a CMP

3.11.6
demagnetization
permanent loss of magnetic attraction due to temperature or modification of the field

3.12 Containment

3.12.1
sheath
thin-walled hermetically sealed enclosure fitted to the inner rotor enclosing the inner magnet ring (MDP) or rotor laminations (CMP)

See Figures 1 and 2.

3.12.2
shell
hermetically sealed enclosure fitted within the total-gap between the inner and outer magnet rings of an MDP and which provides for the primary containment of the pumped liquid

See Figure 2.

3.12.3
liner
hermetically sealed enclosure fitted to the ID of the stator assembly of a CMP and providing for the primary containment of the pumped liquid

See Figure 1.

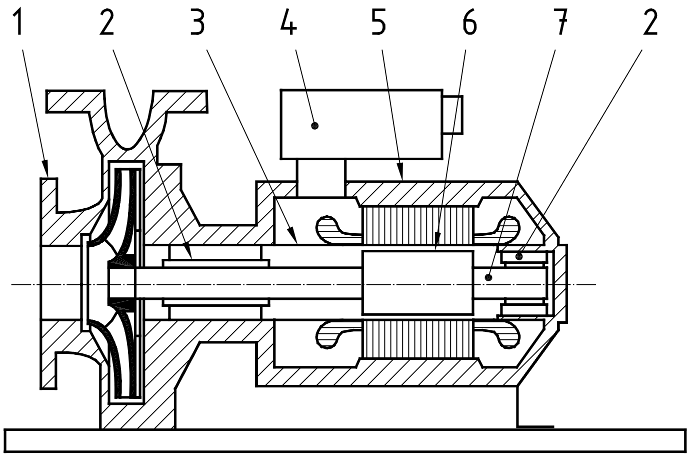
3.12.4
secondary containment
backup pressure-containing system using static seals only to contain leakage in the event of failure of the primary containment by shell or by liner, and including provisions to indicate a failure of the containment shell or liner

3.12.5
drive shaft
⟨MDP⟩ outer shaft of the magnetic drive coupling

3.12.6
secondary control
minimization of release of pumped liquid in the event of failure of the containment shell or stator liner

3.12.7
secondary control system
combination of devices (including, for example, a secondary pressure casing, a mechanical seal) that, in the event of leakage from the containment shell or stator liner, minimizes and safely directs the release of pumped liquid

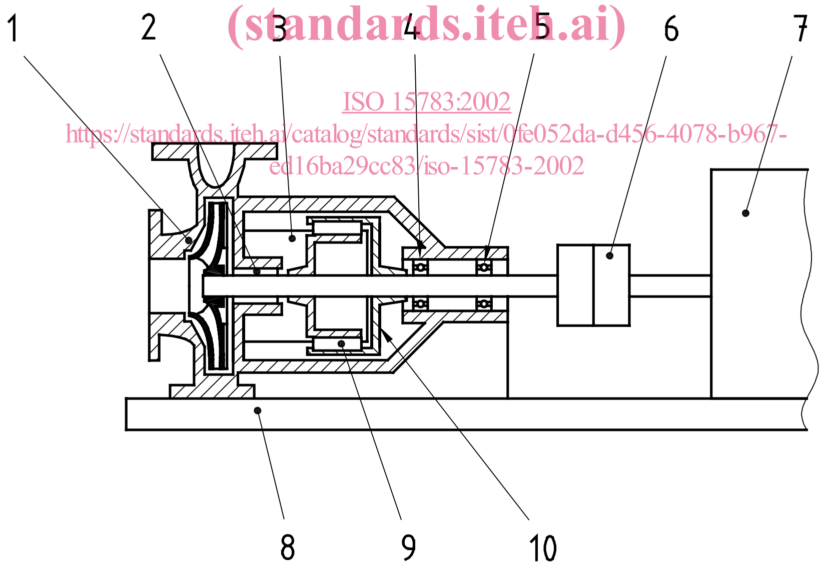
NOTE It includes provision(s) to indicate a failure of the containment shell or liner.



Key

1 Hydraulic end
2 Bearing
3 Liner
4 Terminal box
5 Stator assembly
6 Rotor sheath
7 Rotor

Figure 1 — Example of a canned motor pump (CMP)



Key

1 Hydraulic end
2 Bearing
3 Shell
4 Bearing housing
5 Rolling bearing
6 Coupling
7 Prime mover
8 Baseplate
9 Sheath: inner magnet ring
10 Outer magnet ring

Figure 2 — Example of a magnetic drive pump (MDP)

4 Design

4.1 General

4.1.1 Characteristic curve

The characteristic curve shall indicate the permitted operating range of the pump. Pumps should have a stable characteristic curve. In addition, the characteristic curves for the smallest and largest impeller diameters shall also be shown.

Minimum and maximum continuous stable flows at which the pump can operate without exceeding the noise, vibration and temperature limits imposed by this International Standard shall clearly be stated by the manufacturer/supplier.

4.1.2 Net Positive Suction Head (NPSH)

• The NPSH required (NPSHR) shall be based on cold water testing as determined by testing in accordance with ISO 9906 unless otherwise agreed.

The manufacturer/supplier shall make available a typical curve as a function of flow for water. NPSHR curves shall be based upon a head drop of 3 % (NPSH3).

Correction factors for hydrocarbons shall not be applied to the NPSHR curves.

Pumps shall be selected such that the minimum NPSH available (NPSHA) in the installation exceeds the NPSHR of the pump by at least the specified safety margin. This safety margin shall be not less than 0,5 m, but the manufacturer/supplier may specify a significantly higher margin depending on factors including the following:

— size, type, specific speed, hydraulic geometry or design of the pump;

— operating speed or inlet velocity;

— the pumped liquid and temperature;

— the cavitation erosion resistance of the construction materials.

4.1.3 Outdoor installation

The pumps shall be suitable for outdoor installation under normal ambient conditions.

• Local regulations or extraordinary ambient conditions, such as high or low temperatures, corrosive environment, sandstorms, for which the pump is required to be suitable shall be specified by the purchaser.

4.2 Prime movers

4.2.1 General

The following shall be considered when determining the power/speed requirements of the pump.

a) The application and method of operation of the pump. For example, in an installation intended for parallel operation, the possible performance range with only one pump in operation, taking into account the system characteristic.

b) The position of the operating point on the pump characteristic curve.

c) The circulation flow for lubrication of bearings and removal of heat losses (especially for pumps with low rates of flow).

d) Properties of the pumped liquid (viscosity, solids content, density).

e) Power loss, including slip loss through transmission (only magnet drive pumps).

f) Atmospheric conditions at the pump site.

g) Starting method of the pump:

— if a pump (e.g. a stand-by pump) is started automatically then consideration shall be given to whether the pump may start against a closed valve, or whether the pump may start against an open valve or be pumping into an empty pipeline; i.e. operates within a pumping system in which the pump pressure is provided only for pipeline friction losses.

h) For variable speed arrangements the minimum continuous speed shall be indicated by the manufacturer/supplier to ensure proper cooling and lubrication of the bearings.

Prime movers required as drivers for seal-less pumps covered by this International Standard shall have power output ratings at least equal to the percentage of rated power input given in Figure 3, this value never being less than 1 kW.

Where it appears that this will lead to unnecessary oversizing of the driver, an alternative proposal shall be submitted for the purchaser's approval.

4.2.2 Magnetic drive pumps

When determining the permanent magnetic drive to be used, the following points shall be taken into consideration in addition to the points a) to h) listed under 4.2.1.

a) The magnetic drive shall be selected for the allowed operating range with the selected impeller diameter at operating temperature and taking into consideration the characteristics of the liquid to be pumped.

• If the density of the liquid of the normal operation is below 1 000 kg/m^3 special agreements between the manufacturer/supplier and purchaser for testing and cleaning shall be made.

b) Heat generated by eddy current losses, power losses in the shell, power losses in the bearings and power losses due to liquid circulation shall be removed by pumped liquid or by supply of external cooling fluid.

c) The magnetic material temperature shall be maintained at or below rated values for the material used. Magnetic materials should not be subject to irreversible losses.

d) The irreversible magnetic losses at operating temperatures of the magnetic drive shall be considered.

Fluids containing magnetically attracted particles should be avoided unless such particles can be effectively removed.

Special arrangements may be provided to avoid formation of ice in air gaps when pumping cold liquids.

The magnetic drive shall be designed in such a manner that start-up will not cause the magnet assemblies to decouple.

4.2.3 Canned motor pumps

Canned motors are generally cooled by circulation of pumped liquid or by the use of coolant liquid to remove heat generated by the containment liner, eddy current losses, motor electrical losses and mechanical losses. Stator winding temperatures shall be maintained at or below values established for the grade of insulation used.

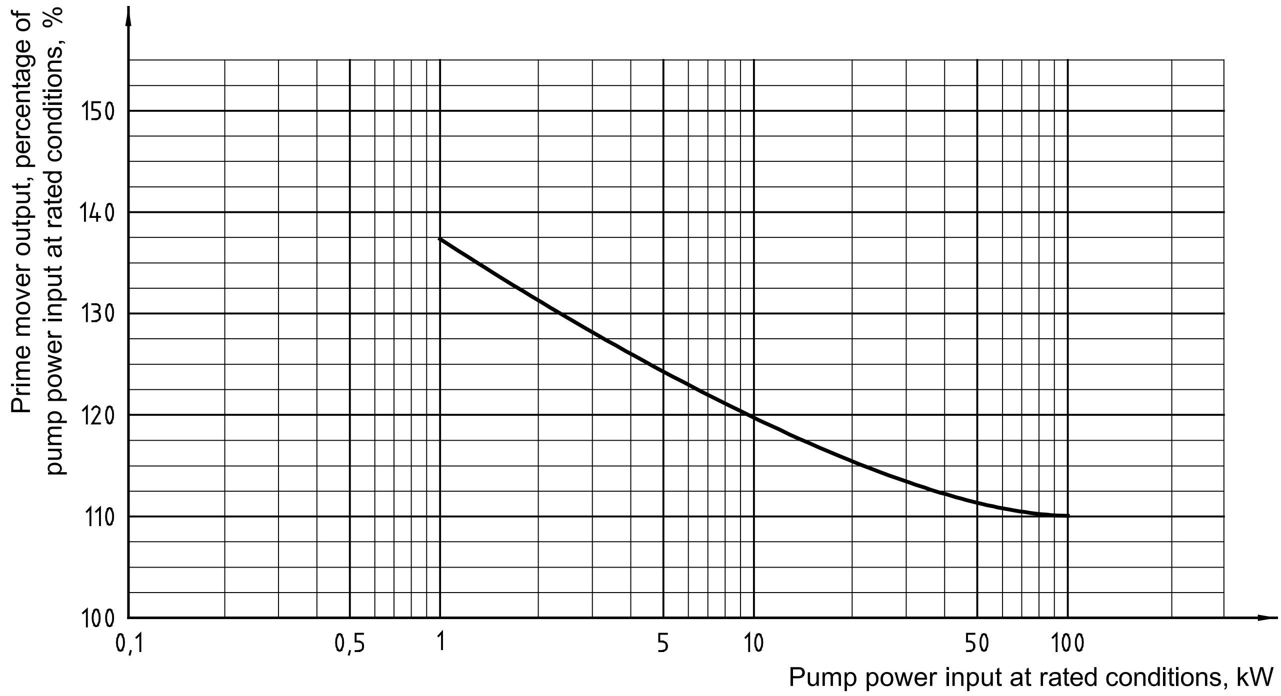


Figure 3 — Prime mover output, percentage of pump power input at rated conditions

When rating a canned motor the conditions listed below shall be taken into consideration in addition to points a) to h) listed under 4.2.1:

— power losses within the canned rotor;

— power losses in the bearings;

— power losses due to liquid circulation;

— explosion protection requirements.

Manufacturers/suppliers shall specify external cooling requirements when required.

Stand-by units may require special arrangements for flushing and/or heating to prevent the settling out of solids, or the formation of ice, or solidification or too low viscosity of the liquid to be pumped.

• The details of such arrangements should be agreed upon between the purchaser and manufacturer/supplier.

4.3 Critical speed, balancing and vibrations

4.3.1 Critical speed

The critical speed shall be calculated with liquid.

• For some pump types (e.g. vertical line shaft and horizontal multistage), the first critical speed may be below the operating speed when agreed between the purchaser and manufacturer/supplier.

Particular attention shall be paid to the critical speed when the pump is to be driven at variable speed.

