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Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries —

Part 2: Special-purpose oil systems

Industries du pétrole, de la pétrochimie et du gaz naturel — Systèmes de lubrification, systèmes d'étanchéité, systèmes d'huile de régulation et leurs auxiliaires —

Partie 2: Systèmes d'huile pour applications spéciales

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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 10438-2 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

ISO 10438 consists of the following parts, under the general title *Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries*:

— *Part 1: General requirements*

— *Part 2: Special-purpose oil systems*

— *Part 3: General-purpose oil systems*

— *Part 4: Self-acting gas seal support systems*

Introduction

ISO 10438 is based on API Std 614, 4th edn., April 1999, divided into four parts as follows:

— *Part 1: General requirements* is based on Chapter 1 of API Std 614;

— *Part 2: Special-purpose oil systems* (this part) is based on Chapter 2 of API Std 614;

— *Part 3: General-purpose oil systems* is based on Chapter 3 of API Std 614;

— *Part 4: Self-acting gas seal support systems* is based on Chapter 4 of API Std 614.

Users of this part of ISO 10438 should be aware that further or differing requirements might be needed for individual applications. This part of ISO 10438 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 part of ISO 10438 and provide details.

This part of ISO 10438 requires the purchaser to specify certain details and features.

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 or decision should be indicated on suitable data sheets; otherwise it should be stated in the quotation request (inquiry) or in the order.

Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries —

Part 2: Special-purpose oil systems

1 Scope

This part of ISO 10438 specifies requirements for oil systems supplying oil to compressors requiring seal oil, and to other machines, in special-purpose applications for use in the petroleum, petrochemical and natural gas industries as well as in other industries by agreement. It is intended to be used in conjunction with ISO 10438-1. ISO 10438 in its entirety specifies requirements for lubrication systems, oil-type shaft-sealing systems, self-acting gas seal systems, control-oil systems and other auxiliaries for general- or special-purpose applications. These systems can serve equipment such as compressors, gears, pumps and drivers.

None of the parts of ISO 10438 is applicable to internal combustion engines.

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 4572, *Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance*

ISO 10438-1:2003, *Petroleum, petrochemical and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries — Part 1: General requirements*

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

ISO 14691, *Petroleum and natural gas industries — Flexible couplings for mechanical power transmission — General purpose applications*

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

API RP 520, Parts I and II, *Sizing, selection and installation of pressure-relieving devices in refineries*

API Std 526, *Flanged steel safety relief valves*

API Std 611, *General-purpose steam turbines for petroleum, chemical, and gas industry services*

API Std 676, *Positive displacement pumps — Rotary*

API RP 686, *Machinery installation and installation design*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms, definitions and abbreviated terms given in ISO 10438-1 apply.

4 General requirements

4.1 The equipment (including auxiliaries) covered by this part of ISO 10438 shall be designed and constructed for a minimum service life of 20 years and at least 3 years of uninterrupted operation. It is recognized that this is a design criterion.

4.2 The oil system shall be suitable for special-purpose applications as defined in ISO 10438-1. The system shall be designed as a separate console, or if approved by the purchaser, it may be designed to be integral with the baseplate of the equipment it serves. The design shall allow for transfer between and shutdown of the main and spare components of the system for maintenance without interrupting the operation of the system or the equipment the system serves.

4.3 The vendor shall assume unit responsibility for all equipment and all auxiliary systems included in the scope of the order.

4.4 The materials of construction of all major components shall be clearly stated in the vendor's proposal. Materials shall be identified by reference to applicable international or national standards including the material grade.

● **4.5** The purchaser shall specify the required oil supply conditions and the heat load.

4.6 Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort of the purchaser and the vendor. The equipment furnished by the vendor shall conform to the maximum allowable sound pressure level specified by the purchaser.

● **4.7** The purchaser shall specify whether the seal-oil and lube-oil systems are to be separate or combined. If separate systems are specified, the means of preventing interchange of oil between the two systems shall be described in the vendor's proposal.

● **4.8** Where oil is supplied from a common system to two or more machines (such as a compressor, a gear and a motor), the oil's characteristics shall be specified by the purchaser on the basis of mutual agreement with all vendors supplying equipment served by the common oil system.

NOTE The usual lubricant employed in a common oil system is a hydrocarbon oil that corresponds to ISO Grade 32, in accordance with ISO 8068.

4.9 The system shall be designed to supply oil to all equipment specified.

4.10 Oil recycled for control purposes shall originate upstream of the filters.

NOTE This minimizes the potential for generation of static electricity (or a static charge) that can result when filtered oil bypasses the equipment and is recycled directly to the reservoir. This is very important especially if explosive gas might also be present in the reservoir.

4.11 The seal-oil system shall be designed to serve the full range of equipment operating conditions specified. These conditions may include but are not limited to the following:

a) settling-out pressures;

b) process relief-valve settings;

c) shop test and field run-ins;

d) startup conditions.

4.12 In addition to the above requirements, seal-oil systems shall be designed to operate safely prior to process startup or any other idling condition specified, with the system in total automatic control and with the compressor at atmospheric pressure.

- **4.13** The purchaser shall specify whether the installation is indoors (heated or unheated) or outdoors (with or without a roof) as well as the weather and environmental conditions in which the equipment will operate (including maximum and minimum temperatures and unusual humidity, dust, or corrosion conditions).

4.14 The arrangement of the equipment, including piping and auxiliaries, shall be developed jointly by the purchaser and the vendor. The arrangement shall provide adequate clearance areas and safe access for operation and maintenance.

- **4.15** If applicable, the purchaser shall specify minimum requirements for clearance around and access to components (especially clearance around and access to coolers, filters and hand valves).

- **4.16** Motors, electrical components and electrical installations shall be suitable for the area classification (class, group, and division or zone) specified by the purchaser and shall meet the requirements of the applicable part(s) of IEC 60079, as well as local codes specified and furnished by the purchaser.

4.17 Pumps, filters, strainers, coolers, traps, valves, and all other components that retain oil under pressure and are external to the reservoir shall be made of steel.

4.18 Valved vents, drains, and piping shall be furnished to permit draining, cleaning, and refilling of idle components while the equipment is in operation.

- **4.19** The purchaser shall specify when and where double-block-and-bleed valves are required for isolating a component and how they are to be arranged (see Figure A.30).

4.20 Coolers, filters, overhead oil tanks, drain traps, accumulators and other pressure vessels within the scope of the pressure design code shall conform to that code.

4.21 The oil system shall perform on the test stand and on its permanent foundation within the specified acceptance criteria. After installation, the performance of the oil system shall be the joint responsibility of the purchaser and the vendor.

4.22 The vendor shall advise the purchaser of, and both parties shall mutually agree upon, any special provisions that are necessary to ensure that an adequate supply of lube or seal oil or both is maintained in the event of complete failure of the lube- or seal-oil supply system. These provisions may include emergency pumps, accumulators, rundown tanks and special arrangements for equipment safety and protection when the equipment decelerates. Provisions shall be adequate for coast-down time, cool-off time, and block-in time as applicable; the purchaser shall specify the required block-in time. The purchaser and the vendor shall mutually agree upon the system and its components.

4.23 Block valves which interrupt the oil flow to the equipment shall not be installed in oil supply lines downstream of the filters unless the block valves are part of a component block and bypass arrangement.

4.24 Welding of piping and pressure-containing parts, as well as any dissimilar-metal welds and weld repairs, shall be performed and inspected by operators and procedures qualified in accordance with the pressure design code.

- **4.25** In addition to the requirements of 4.24, the purchaser may specify that 100 % radiography, magnetic particle inspection, or liquid penetrant inspection of welds is required (see also ISO 10438-1).

4.26 All welding other than that covered by the pressure design code or the piping systems design code, such as welding on baseplates, non-pressure ducting, lagging and control panels, shall be in accordance with a structural welding standard (e.g. AWS D1.1), unless otherwise specified.

5 Baseplates

5.1 The system shall be designed as a console, as a single or multiple package, or as another arrangement as specified by the purchaser. Each package shall have a structural steel baseplate with all system components and related valves and manifolds mounted on the baseplate. The major components (pumps, filters, coolers, and reservoir) shall be mounted directly on structural steel.

5.2 Package baseplates shall be the drain-gutter type with one or more drain connections at least DN40 (NPS 1 1/2) in size unless otherwise specified. Baseplates, mounted components, and decking shall be arranged and installed to ensure drainage and to avoid the retention of liquid.

5.3 The baseplate shall be provided with lifting lugs for at least a four-point lift. The baseplate shall be designed so that after the components and all piping mounted on it are drained of oil, the package can be lifted without permanently distorting or otherwise damaging either the baseplate or any component mounted on it.

5.4 Unless otherwise specified, non-skid metal decking covering all walk and work areas shall be provided on the top of the baseplate.

5.5 Unless otherwise specified, all baseplates shall be provided with at least one opening or hole in each bulkhead section through which grout can be poured and vented. Each opening shall have a clear area of no less than 125 cm^2 (20 in^2) and no dimension less than 100 mm (4 in), and each shall permit filling and venting of the entire cavity with grout under the baseplate without creating air pockets. Each hole in which the grout is to be poured shall be accessible, i.e. no component or piping shall be disturbed, and no tripping hazards in walk and work areas shall be created. Each hole shall also be provided with steel curbing 13 mm (1/2 in) high to prevent accumulated oil or water from entering the grout. Vent holes at least 13 mm (1/2 in) in diameter shall be provided for each bulkhead compartment.

5.6 If specified, the baseplate shall be suitable for column mounting (that is, of sufficient rigidity to be supported at specified points) without continuous grouting under structural members. The baseplate design shall be mutually agreed between the purchaser and the vendor.

5.7 When epoxy grout is specified, the vendor shall precoat all the grouting surfaces of the mounting plates with a catalysed epoxy primer applied to degreased white metal. The epoxy primer shall be compatible with epoxy grout. The vendor shall submit instructions for field preparation of the epoxy primer to the purchaser.

5.8 The bottom of the baseplate between structural members shall be open. When the baseplate is installed on a concrete foundation, accessibility for grouting under all load-carrying structural members shall be provided.

6 Oil reservoirs

6.1 General

Unless otherwise specified, reservoirs shall be separate from the equipment baseplate and shall be rigid enough to prevent sagging and vibration. Components bolted to the reservoir shall be mounted on pads; no bolt holes shall extend into the reservoir. To prevent deposit accumulations, reinforcing ribs on the walls of the reservoir shall be external.

NOTE For special features see 6.12.

6.2 Protection from dirt and water

6.2.1 Reservoirs shall be sealed to prevent dirt and water from entering. Top-surface openings shall be raised at least 25 mm (1 in) and shall have a gasket.

6.2.2 Unless otherwise approved, pumps, coolers, or filters shall not be mounted on top of the reservoir. It is possible that this will be a user consideration for off-shore or other installations where available space is limited.

6.2.3 The tops of reservoirs shall be sloped at least 1:100 (1/8 in/ft). It may not be possible to implement this requirement for reservoirs integrated with main equipment baseplate.

6.3 Oil connections and internal piping

6.3.1 All oil return flow streams shall be hydraulically located as far away from the pump suction connections as possible.

NOTE The use of the term “hydraulically located as far away” is intended to convey the concept that it is possible to direct return flow streams by internal piping or baffling to avoid disturbing the oil flow at pump inlets. This internal piping or baffling could be used in lieu of external connections physically located at such a distance from the pump suctions that they avoid disturbing the oil flow at the pump inlets.

6.3.2 All atmospheric oil return connections (including fill connections) shall be located above the maximum operating level and shall transport oil (via open-top stilling tubes or degassing trays) as shown in Figure A.24. Stilling tubes shall have bottom baffles.

6.3.3 Control back-pressure valve and return stream control valve connections shall be separate and shall discharge oil via internal piping below the pump suction-loss level as shown in Figure A.24. Pressurized oil shall not be returned to stilling tubes or degassing trays. Internal piping shall have bottom baffles.

6.3.4 Pump suction connections shall be located near the high end of the sloped reservoir bottom and at least 50 mm (2 in) above it.

6.3.5 Except as specified in 6.9, reservoir pipe connections shall be flanged.

6.4 Manways and drains

To ensure complete drainage, the bottom of each reservoir shall slope continuously, at least 1:50 (1/4 in/ft), to a low point. A flanged drain connection (with a valve and a blind flange) at least DN50 (NPS 2) in size shall be provided. Manway openings shall be provided which will permit unobstructed entry for inspection and cleaning of all interior compartments. If entry is required for cleaning and unless otherwise specified, manways shall be located on top of the reservoir and each manway shall be at least 600 mm × 600 mm or 450 mm in diameter (24 in × 24 in or 18 in in diameter). Internal manways are not acceptable.

6.5 Features and appendages

6.5.1 The oil reservoir shall have the following features and appendages:

a) the capacity to settle moisture and foreign matter adequately and to provide allowance for rundown from the entire system;

b) provisions to eliminate air and minimize migration of foreign matter to each pump suction;

c) a reflex-type, welding-pad oil level glass (with stainless steel weld pad and carbon steel cover) arranged to cover the span from at least 25 mm (1 in) above the rundown level to 50 mm (2 in) below the pump suction-loss level. The oil level glass shall be located as far away as possible from the oil return lines and be visible from the perimeter of the unit. The maximum and minimum operating levels, rundown level and suction-loss level shall be indicated on the level glass. If more than one level glass is provided, they shall be offset;

d) a fill opening at least 50 mm (2 in) in size which automatically closes (normally held shut by a spring) and is equipped with a stainless steel, fine-mesh strainer basket that has an open area equal to 200 % of the internal pipe area;

e) a blind-flanged vent connection at least 50 mm (2 in) in size;

f) a weatherproof, corrosion-resistant filter-breather cap at least 50 mm (2 in) in size (for reservoirs containing seal oil, see 6.5.2);

g) internal baffles that are not gas tight;

h) if the train is driven by a gas or steam turbine and the oil reservoir contains the seal oil, a separate connection shall be provided on the reservoir for the compressor seal-oil return line;

NOTE This line prevents pressurization of the turbine lube oil drain header if the compressor seals fail.

i) individual non-pressurized reservoir return lines shall enter the reservoir above the rundown level (see 6.6.1.1).

6.5.2 On reservoirs containing seal oil, a specially sized vent is required to handle the total flow of gas coming from the failed seal(s) through the oil drain lines. The vendor shall provide the purchaser with the vent size and the sizing criteria.

Vents routed to flare systems or vapour recovery systems shall be provided with an overpressure protection device. The sizing of this device shall be jointly developed by the purchaser and the vendor.

6.6 Capacity and configurations

NOTE Sizing criteria is covered in 6.6.3.

6.6.1 Definitions of levels

6.6.1.1 The rundown level (1 in Figure 1) is the highest level that oil in the reservoir can reach when the entire system is shut down.

6.6.1.2 The maximum operating level (2 in Figure 1) is the highest level that oil can reach during normal operation of the equipment.

6.6.1.3 The minimum operating level (3 in Figure 1) is the lowest level that oil can reach during normal operation of the equipment.

6.6.1.4 The suction-loss level (4 in Figure 1) is the level above the pump suction level (5 in Figure 1), at which the pump begins to lose prime. The pump suction level is defined by the pump suction vortex and net positive suction head requirements.

6.6.1.5 The charge capacity is the total volume below the rundown level.

6.6.1.6 The normal operating range is any level between the maximum and minimum operating levels.

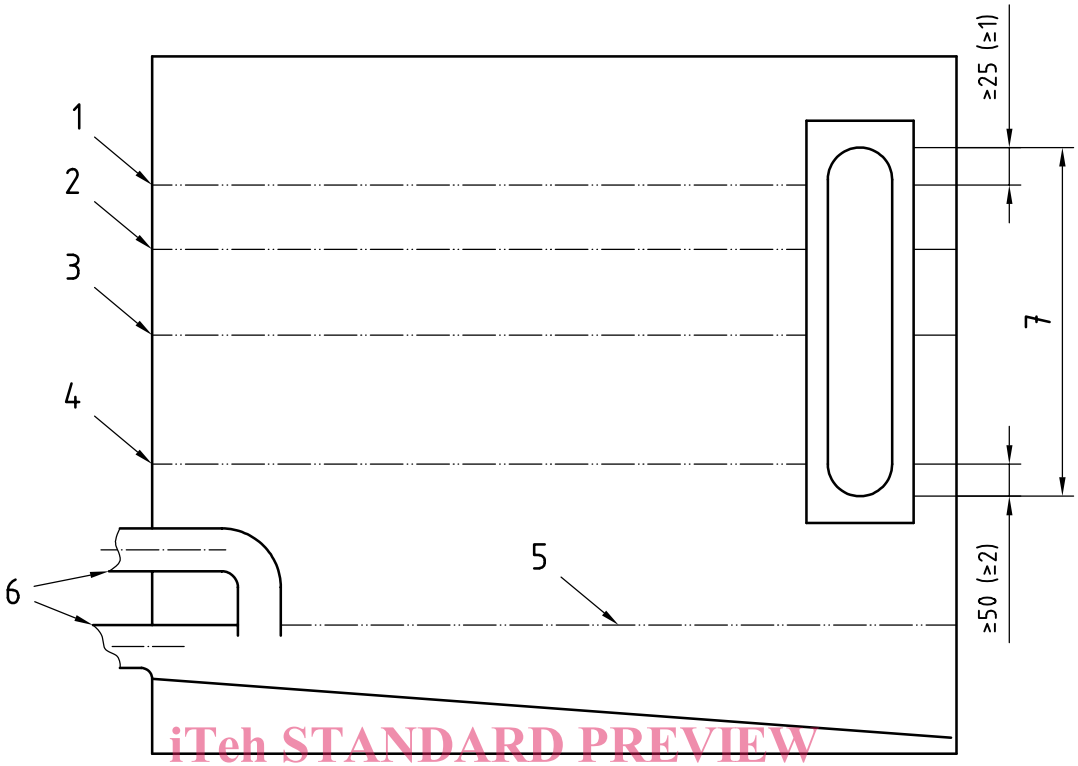
6.6.1.7 The retention capacity is the total volume below the minimum operating level.

6.6.1.8 Retention time is the time allowed for disengagement of entrained air or gas.

6.6.1.9 The rundown capacity is the volume between the rundown level and the maximum operating level.

6.6.1.10 The working capacity is the volume between the minimum operating level and the suction-loss level.

Dimensions in millimetres (inches)



Key

1 rundown level
2 maximum operating level
3 minimum operating level
4 suction-loss level
5 pump suction level
6 alternative pump suction arrangements
7 manufacturer's standard glass length

A manufacturer's standard gauge glass may be used in this arrangement with the bottom of the gauge no less than 50 mm below the minimum operating level and with any excess length being above maximum operating level.

Figure 1 — Reservoir levels and oil level glass details

6.6.2 Low level alarm

A low-level alarm shall actuate at the minimum operating level.

6.6.3 Criteria for sizing a reservoir

6.6.3.1 The working capacity between the minimum operating level (3 in Figure 1) and the suction-loss level (4 in Figure 1) shall be sufficient for at least 5 min of normal flow.

6.6.3.2 The minimum retention capacity shall be calculated based on 8 min of normal oil flow.

6.6.3.3 The rundown capacity shall allow for all of the oil contained in all of the components, such as bearings and seal housings, overhead seal tanks, rundown tanks, accumulators, control elements, and vendor-furnished piping that drain back to the reservoir. The rundown capacity shall also allow for at least an additional 10 % of these volumes for the purchaser’s interconnecting piping.

NOTE Rundown can cause some backup in the drain lines entering the reservoir.

6.6.3.4 Where sour oil is present in a seal-oil system, the capacity between the minimum and maximum operating levels shall be at least 50 mm (2 in) of reservoir height, and, based on the manufacturer’s estimated

seal-oil usage rate when the seals have worn to two times their maximum design clearance, the capacity shall be sufficient to permit at least 3 days of operation without requiring that oil be added to the reservoir.

The usage rate shall be provided by the seal manufacturer. This is of special concern when the sour oil is not returned to the reservoir.

6.6.3.5 In a lube-oil system, the capacity between the minimum and maximum operating levels shall be at least 50 mm (2 in) of reservoir height.

6.6.3.6 The free surface of the oil in the reservoir shall be a minimum of 60 cm^2 for each litre per minute (0,25 ft^2 for each gallon per minute) of normal flow.

6.7 Heating

6.7.1 Heaters shall be provided if the minimum site temperature on the data sheet is less than the minimum oil startup temperature.

Users may specify special provision for lube oil coolers to allow steam to be introduced to the water side and act as a heater prior to startup. Details of alternate arrangements such as this shall be mutually discussed.

- **6.7.2** The purchaser shall specify if heaters are to be steam or electric.

6.7.2.1 When a steam heater is specified, a removable element external to the oil reservoir shall be provided for heating the charge capacity of oil before startup in cold weather. The device shall have the capacity to heat the oil in the reservoir from the specified minimum site ambient temperature to the manufacturer's required minimum oil startup temperature within 12 h. Unless otherwise specified, the reservoir heat loss during heating shall be determined based on an uninsulated reservoir, the minimum site ambient temperature, and a 16 km/h (10 mile/h) wind. The vendor shall provide data to support this.

6.7.2.2 When an electric heater is specified, a thermostatically controlled removable electric immersion heating element shall be provided for heating the charge capacity of oil before startup in cold weather. The device shall have the capacity to heat the oil in the reservoir from the specified minimum site ambient temperature to the manufacturer's required startup temperature within 12 h. It shall have a maximum surface heat flow density of 2 W/cm^2 (15 W/in^2). Heater elements in contact with the oil shall be sheathed in austenitic stainless steel; copper or copper-bearing materials shall not contact the oil. Unless otherwise specified, the reservoir heat loss during heating shall be determined based on an uninsulated reservoir, the minimum site ambient temperature and a 16 km/h (10 mile/h) wind. The vendor shall provide data to support this.

Electric immersion heaters should be interlocked by the purchaser to be de-energized when the oil level drops below the minimum operating level.

6.7.2.3 Electric immersion heaters shall be installed in a manner that allows the heaters to be removed during operation. They shall be top-, or side-mounted and installed vertically, on an angle, or horizontally. If oil-filled tubes with vented expansion chambers are used, the oil inside the tubes shall be the same as in the reservoir and its temperature maintained at a minimum of 10 °C (18 °F) below its flash point.

6.7.2.4 In all installations, but especially if top-mounted vertical or angle heaters are used, the heater element shall be located below the pump suction loss level.

6.8 Provision for insulation

- If specified by the purchaser, reservoirs shall be fitted with insulation clips. The purchaser shall furnish and install the insulation.

6.9 Auxiliary connections

Above the rundown oil level, each reservoir shall be provided with connections that are at least DN25 (NPS 1) in size. These connections may be threaded and plugged or flanged and blanked. These two connections may

be used for such services as purge gas, makeup oil supply, and oil conditioner return. One connection shall be located to ensure an effective sweep of purge gas toward the vents.

6.10 Provision for oil conditioner

6.10.1 Unless otherwise specified, the vendor shall provide below the minimum operating level a DN25 (NPS 1) flanged, valved, and blinded connection (see Figure A.24) that will be used to connect an oil conditioner.

6.10.2 The vendor shall also provide inside the reservoir a pipe loop with a siphon breaker hole at the top which has a maximum diameter of 6 mm (1/4 in). This pipe loop shall prevent the oil level from falling more than 50 mm (NPS 2) below the minimum operating level due to the action of the conditioner.

6.11 Welds

Joints, pads, and connections shall be both internally and externally welded to eliminate cavities, potential sources of corrosion, and contamination. The reservoir's wall-to-top junctions may be welded from the outside if a full-penetration weld is used. All welds shall be continuous. Internal joints shall be made smooth by grinding or other suitable means as necessary to eliminate pockets and provide an unbroken finish.

6.12 Special features

- **6.12.1** If specified, reservoir tops shall be provided with the following:

a) an accessible ladder with extended handrails;

b) handrails around the perimeter of the reservoir top;

c) non-skid-surface decking (checker or diamond plate or hot-dipped galvanized steel grating).

6.12.2 For equipment mounted on the reservoir, the reservoir shall provide sufficient structural stiffness to properly support the equipment.

6.13 Materials

Unless otherwise specified, reservoirs and all appendages welded to reservoirs shall be fabricated from a readily weldable grade of austenitic stainless steel. Pipe connections shall be as specified in ISO 10438-1.

Carbon steel appendages such as ladders and handrails may be bolted to clips welded to the reservoir.

6.14 Grounding

Two grounding clips or pads diagonally opposed to each other (see Figure A.24) shall be welded to the reservoir. The pads shall accommodate a 13 mm (1/2 in UNC) bolt.

7 Pumps and drivers

7.1 The oil system shall include a main oil pump and a standby oil pump. The main and standby pumps shall be identical and suitable for continuous operation. The purchaser shall specify whether horizontal centrifugal or rotary pumps shall be used. Except as modified in this part of ISO 10438, pumps shall conform to ISO 13709 or API Std 676, respectively.

NOTE For the purpose of this provision, API 610 is equivalent to ISO 13709.

7.2 Unless otherwise specified, pumps shall be external to the reservoir.