
**Petroleum and natural gas industries —
Rotary-type positive-displacement
compressors —**

**Part 2:
Packaged air compressors (oil-free)**

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*Industries du pétrole et du gaz naturel — Compresseurs volumétriques de
type rotatif*

Partie 2: Compresseurs à air assemblé (sans huile)

ISO 10440-2:2001

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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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.

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 part of ISO 10440 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10440-2 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines* and Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

ISO 10440 consists of the following parts, under the general title *Petroleum and natural gas industries — Rotary-type positive-displacement compressors*: **(standards.iteh.ai)**

- *Part 1: Process compressors (oil-free)* [ISO 10440-2:2001](https://standards.iteh.ai/catalog/standards/sist/cd178d3e-3390-494c-b7bd-2636257f5214/iso-10440-2-2001)
- *Part 2: Packaged air compressors (oil-free)* <https://standards.iteh.ai/catalog/standards/sist/cd178d3e-3390-494c-b7bd-2636257f5214/iso-10440-2-2001>

Annex A forms a normative part of this part of ISO 10440.

Introduction

This part of ISO 10440 is based on the 2nd edition API 619 and upon the accumulated knowledge and experience of manufacturers and users of oil-free rotary compressors. The objective of this publication is to provide a purchase specification to facilitate the manufacture and procurement of oil-free rotary compressors for general petroleum and natural gas industry services but its use is not limited to these services.

The purpose of this part of ISO 10440 is to establish minimum requirements for design and construction so that the equipment will be suitable for the purpose for which it is required. This limitation in scope is one of charter rather than interest and concern. Energy conservation and protection of environment are matters of increasing concern and are important in all aspects of equipment design, application and operation. The manufacturers and users of equipment should aggressively pursue alternative innovative approaches which improve energy utilization and/or minimize environmental impact without sacrificing safety or reliability. Such approaches should be thoroughly investigated and purchase options should increasingly be based on the estimation of whole life costs and the environmental consequences rather than acquisition costs alone.

This part of ISO 10440 requires the purchaser to specify certain details and features.

For effective use of this part of ISO 10440 and ease of reference to the text, the use of the data sheets in annex A is recommended.

Users of this part of ISO 10440 should be aware that further or differing requirements may be needed for individual applications. This part of ISO 10440 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 applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this part of ISO 10440 and provide details.

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Petroleum and natural gas industries — Rotary-type positive-displacement compressors —

Part 2: Packaged air compressors (oil-free)

1 Scope

This part of ISO 10440 covers the minimum requirements for helical, spiral and straight-lobe, oil-free rotary compressors used for applications up to 0,20 MPa in refinery services. It is applicable to air (and other inert gas) compressors that are in continuous duty on process units.

This part of ISO 10440 is not applicable to oil injected rotary compressors.

NOTE A bullet (•) at the beginning of a clause or sub-clause indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the data sheets; otherwise it should be stated in the quotation request or in the order.

2 Normative references

[ISO 10440-2:2001](https://standards.iteh.ai/catalog/standards/sist/cd178d3e-3390-494c-b7bd-2623575214/w/iso-10440-2-2001)

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The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10440. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10440 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 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 262:1998, *ISO general-purpose metric screw threads — Selected sizes for screws, bolts and nuts*

ISO 281:1990, *Rolling bearings — Dynamic load ratings and rating life*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*

ISO 1217:1996, *Displacement compressors — Acceptance tests*

ISO 1328-2:1997, *Cylindrical gears — ISO system of accuracy — Part 2: Definitions and allowable values of deviations relevant to radial composite deviations and runout information*

ISO 1940-1:1986, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 1: Determination of permissible residual unbalance*

ISO 3506-1:1997, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 1: Bolts, screws and studs*

ISO 10440-2:2001(E)

ISO 5167-1:—¹⁾, *Measurement of fluid flow in circular cross-section conduits running full using pressure differential devices — Part 1: General*

ISO 7005-1:1992, *Metallic flanges — Part 1: Steel flanges*

ISO 9329-2:1997, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Unalloyed and alloyed steels with specified elevated temperature properties*

ISO 9329-4:1997, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 4: Austenitic stainless steels*

ISO 10441:1999, *Petroleum and natural gas industries — Flexible couplings for mechanical power transmission — Special purpose applications*

IEC 60060-1, *High-voltage test techniques — Part 1: General definitions and test requirements*

IEC 60060-2, *High voltage test techniques — Part 2: Measuring systems*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 4: Electrical fast transient/burst immunity test*

EN 55011, *Industrial, scientific and medical (ISM) radio-frequency equipment — Radio disturbance characteristics — Limits and methods of measurement*

EN 55022, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement*

ASME B31.1:1998, *Power Piping*

ASME B31.3:1999, *Process Piping*

ASME BPVC Section VIII:1998, *Rules For Construction of Pressure Vessels Division 1*

API 614:1995, *Lubrication, Shaft-Sealing, and Control-Oil Systems for Special-Purpose Application*

API 661:1992, *Air-Cooled Heat Exchangers for General Refinery Service*

API 670:1993, *Vibration, Axial-Position, and Bearing-Temperature Monitoring Systems*

API 671:1990, *Special-Purpose Couplings for Petroleum, Chemical, and Gas Industry Services*

NEMA SM23:1991, *Steam turbines for mechanical drive service*

1) To be published. (Revision of ISO 5167-1:1991)

3 Terms and definitions

For the purposes of this part of ISO 10440, the following terms and definitions apply.

3.1

rated conditions

specified conditions at which operation is expected and/or optimum efficiency is expected

3.2

maximum allowable differential pressure

highest differential pressure that can be permitted in the casing under the most severe operating conditions of minimum suction pressure and discharge pressure equal to the relief valve setting

3.3

maximum allowable working pressure

maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified temperature

3.4

rated discharge pressure

highest pressure required to meet the conditions the purchaser specifies for the intended service

3.5

maximum allowable temperature

maximum continuous temperature for which the manufacturer has designed the equipment

3.6

rated discharge temperature

predicted actual operating temperature resulting from rated conditions

3.7

rated speed

speed of the power input rotor corresponding to the requirements of the compressor rated capacity

NOTE Rated speed is expressed in revolutions per minute.

3.8

maximum allowable speed

highest speed of the power input rotor at which the manufacturer's design permits continuous operation

NOTE Maximum allowable speed is expressed in revolutions per minute.

3.9

minimum allowable speed

lowest speed of the power input rotor at which the manufacturer's design permits continuous operation for the lowest rated conditions

NOTE Minimum allowable speed is expressed in revolutions per minute.

3.10

trip speed

speed at which independent emergency overspeed devices operate to shut down a prime mover

NOTE Trip speed is expressed in revolutions per minute.

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3.11

rated capacity

volume flowrate required by the rated conditions

NOTE Rated capacity is expressed in cubic metres per hour.

3.12

rotor body

profile section on or integral with the shaft

3.13

rotor

complete rotor body and the shaft and shrunk-on sleeves (when furnished)

3.14

rotor assembly

rotating elements mounted on the rotor, excluding couplings

3.15

compressor stage

one or more rotors operating in a casing, the displacement being effected by vanes, meshing elements, or by displacement of the rotor itself

3.16

packaged compressor

compressor unit, stationary or mobile (portable), as supplied by the manufacturer, fully piped and wired, including power transmission, primer mover, filters and flow rate control

NOTE A canopy may be provided with the compressor for sound insulation and/or weather protection. Packaged compressors may also include starting equipment, intercoolers, aftercoolers, silencers, moisture separators, dryers, outlet filters, minimum pressure devices, outlet valves, check valves, etc.

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3.17

axially split casing

casing with joints that are parallel to the shaft centerline

3.18

radially split casing

casing with joints that are transverse to the shaft centerline

3.19

maximum sealing pressure

highest pressure expected at the seals during any specified static or operating conditions and during start-up or shut-down

3.20

pressure casing

composite of all stationary pressure-containing parts of the unit, including all nozzles and other attached parts

3.21

critical speed

finite speed where resonance exists

4 Basic design

4.1 General

4.1.1 The purchaser and the vendor shall agree upon the pressure equipment code to be applied (e.g. ASME Section VIII Division 1 for design, Section IX for welding, etc.). This shall be specified on the data sheet (see annex A).

4.1.2 Equipment shall be capable of running safely to the trip speed at 110 % relief valve setting, and specified maximum differential pressure.

NOTE To run safely involves factors other than differential pressure, such as maximum discharge temperature or limiting driver power.

4.1.3 Cooling water systems shall be designed for the following conditions unless otherwise specified.

— Velocity in exchanger tubes	1,5 m/s to 2,5 m/s
— Maximum allowable working pressure	> 5 bar (> 0,5 MPa)
— Test pressure	> 7,7 bar (> 0,77 MPa)
— Maximum pressure drop	1 bar (0,1 MPa)
— Maximum inlet temperature	32 °C
— Maximum outlet temperature	49 °C
— Maximum temperature rise	17 °C
— Minimum temperature rise	11 °C
— Fouling factor on water side	0,35 m ² .K/kW

Provision shall be made for complete venting and draining of the system.

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

4.1.5 All equipment shall be designed to permit rapid and economical maintenance. Major parts such as casing components and bearing housings shall be designed (shouldered or dowelled) and manufactured to ensure accurate alignment on reassembly.

4.1.6 Unless otherwise specified by the purchaser, spare parts for these compressors and auxiliaries shall meet all the requirements of the original equipment supplied.

4.1.7 Oil reservoirs and housings that enclose moving lubricated parts (such as bearings, shaft seals, highly polished parts, instruments and control elements) shall be designed to minimize contamination by moisture, dust and other foreign matter during periods of operation or idleness.

4.1.8 When special tools and fixtures are required to disassemble, assemble or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the compressor. For multi-unit installations, the requirements for quantities of special tools and fixtures shall be mutually agreed upon by the purchaser and the vendor.

4.1.9 When special tools are provided, they shall be packaged in separate, rugged boxes and marked “special tools for (tag/item number)”. Each tool shall be tagged to indicate its intended use.

4.1.10 Packaged compressors shall perform on the test stand to the specified acceptance criteria. Other guarantees should be agreed upon between the purchaser and the vendor.

- **4.1.11** Many factors (such as pipe loadings, nozzle loadings, alignment at operating conditions, piping and foundation vibrations from other equipment installed locally, supporting structure, handling during shipment and handling and assembly at site) may adversely affect site performance.

To minimize the influence of these factors, the vendor shall propose a total compressor package. Allowable loads on the interconnecting flanges are specified by the vendor.

- **4.1.12** All electrical components and installations shall be suitable for the area classification and grouping specified by the purchaser on the data sheets and be in accordance with the local codes specified.
- **4.1.13** Control of the sound level from the packaged compressors shall be presented by the vendor. The equipment furnished shall conform to the requirements and local codes as specified by the purchaser and as detailed on the data sheets.
- **4.1.14** Water and/or oil separation shall be included in the package. The vendor shall prepare contamination levels. Where needed, contamination levels shall be specified by the purchaser.
- **4.1.15** The purchaser shall specify whether the installation is indoors (heated or unheated) or outdoors (with or without a roof) and the weather or environmental conditions in which the equipment shall operate (including maximum and minimum temperatures and unusual humidity or dust problems). The unit and its auxiliaries shall be suitable for operation in these specified conditions. For the purchaser's guidance, the vendor shall list in the proposal any special protection that the purchaser is required to supply.

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4.2 Pressure casing

4.2.1 The hoop stress values used in the design of the casings shall not exceed the maximum allowable stress values in tension, as specified in the design code in **4.1.14**, at the maximum and minimum operating temperature of the materials used.

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4.2.2 The maximum allowable working pressure of the casing shall be at least equal to the specified relief valve setting.

4.2.3 Split pressure level casings shall be avoided. If the casing is split into two or more pressure levels, the vendor shall define the physical limits and the maximum allowable working pressure of each part of the casing. See 7.1 h) for proposal requirements.

4.2.4 Each axially split casing shall be sufficiently rigid to allow removal and replacement of its upper half without disturbing rotor-to-casing running clearances.

4.2.5 Casings and supports shall be designed to have sufficient strength and rigidity to limit a change of shaft alignment to 50 µm at the coupling flange caused by the worst combination of pressure, torque, allowable piping forces and moments. Supports and alignment bolts shall be rigid enough to permit the machine to be moved by the use of its lateral, axial and vertical jackscrews.

4.2.6 Axially split casings shall use a metal-to-metal joint (with a suitable joint compound) that is tightly maintained by suitable bolting. Gaskets (including string type) shall not be used on the axial joint. When gasketed joints are used between the end covers and the cylinder of radially split casings, they shall be securely maintained by confining the gaskets.

4.2.7 Jacket cooling systems shall be designed to positively prevent leakage of the process stream into the coolant. Coolant passages shall not open into casing joints.

4.2.8 Jackscrews, guide rods and casing alignment dowels shall be provided to facilitate disassembly and reassembly. When jackscrews are used as a means of parting contacting faces, one of the faces shall be relieved (counter-bored or recessed) to prevent a leaking joint or improper fit caused by marring. Guide rods shall be of sufficient length to prevent damage to the internals or casing studs by the casing during disassembly and

reassembly. Lifting lugs or eyebolts shall be provided for lifting only the top half of the casing. Methods of lifting the assembled machine shall be specified by the vendor.

4.2.9 For corrosion resistance, wear resistance and running in, overlay cladding or plating may be applied to the casing wall. The end wall may be similarly lined or have compatible end plates provided. The vendor shall include details of his procedures in the casing design proposal.

NOTE This procedure may require an overbore of the casing during manufacture prior to final machining.

4.2.10 Details of threading shall be in accordance with ISO 262.

4.2.11 Studs are preferred to cap screws.

4.2.12 A clearance shall be provided at bolting locations to permit the use of socket or box wrenches. The vendor shall supply any required special tools and fixtures.

4.2.13 Socket, slotted nut or spanner bolting shall not be used unless specifically approved by the purchaser.

4.2.14 Tapped holes in pressure parts shall be kept to a minimum. Sufficient metal in addition to the metal allowance for corrosion shall be left around and below the bottom of drilled and tapped holes in pressure sections of casings to prevent leakage.

4.2.15 Studded connections shall be furnished with studs installed. Blind stud holes should only be drilled deep enough to allow a preferred tap depth of 1,5 times the major diameter of the stud; the first 1,5 threads at both ends of each stud shall be removed.

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4.3 Casing connections

- **4.3.1** Inlet and outlet connections shall be flanged or machined and studded, oriented as specified in the data sheets, and suitable for the working pressure of the casing as defined in clause 3.

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4.3.2 All of the purchaser's connections shall be accessible for disassembly without the machine being moved.

4.3.3 No connections shall be welded to the casing.

4.3.4 When the following items are required or specified, flanged or studded boss connections not less than 20 mm pipe size shall be provided. Smaller connections may be used with the purchaser's approval.

- a) Vents.
- b) Pressure and temperature gauge connections.
- c) Liquid injection.
- d) Water cooling.
- e) Lubricating and seal oil.
- f) Flushing.
- g) Buffer gas.
- h) Casing drains.
- i) Pressure equalizing pipes.

4.3.5 All casing openings for pipe connections shall not be less than 20 mm nominal pipe size and shall be flanged or machined and studded. Where flanged or machined and studded openings are impractical, threaded openings are allowable in sizes 20 mm and 25 mm nominal pipe size. These threaded openings shall be installed as specified in 4.3.5.1 to 4.3.5.5.