INTERNATIONAL STANDARD

ISO 10440-1

Second edition
2007-08-01

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

Part 1: Process compressors

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Industries du pétrole, pétrochimique et du gaz naturel — Compresseurs volumétriques de type rotatif —
Partie 1: Compresseurs de procédé

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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 10440-1 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment,* Subcommittee SC 1, *Process compressors*.

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This second edition cancels and replaces the first edition (ISO 10440-1:2000), which has been technically revised.

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ISO 10440 consists of the following parts, under the general title *Petroleum, petrochemical and natural gas industries — Rotary-type positive-displacement compressors*:

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— *Part 1: Process compressors*

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

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Introduction

This part of ISO 10440 is based on API 619, 4th edition, December 2004, with the intent that the 5th edition of API 619 will be identical to this part of ISO 10440.

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 appropriate 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.

A bullet (•) at the beginning of a subclause or paragraph indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the datasheet(s), otherwise it should be stated in the quotation request or in the order.

In this part of ISO 10440, where practical, US Customary (USC) units are included in brackets for information. Dedicated datasheets for SI units and for USC units are provided in Annex A.

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

Part 1: Process compressors

1 Scope

This part of ISO 10440 specifies requirements for dry and oil-flooded, helical-lobe rotary compressors (see Figure 1) used for vacuum or pressure or both in petroleum, petrochemical, and gas industry services. It is intended for compressors that are in special-purpose applications.

It is not applicable to general-purpose air compressors, liquid-ring compressors, or vane-type compressors.

NOTE Standard air compressors are covered in ISO 10440-2.

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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.

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

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

ISO 945 [1)], *Cast iron — Designation of microstructure of graphite*

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

ISO 1217, *Displacement compressors — Acceptance tests*

ISO 1328-1:1995, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*

ISO 1940-1:2003, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

1) Under revision as ISO 945-1, *Designation of microstructure of cast irons — Part 1: Graphite classification by visual analysis.*

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ISO 3448:1992 , *Industrial liquid lubricants — ISO viscosity classification*

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

ISO 5753:1991, *Rolling bearings — Radial internal clearance*

ISO 6708, *Pipework components — Definition and selection of DN (nominal size)*

ISO 7005-1, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

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

ISO 8821, *Mechanical vibration — Balancing — Shaft and fitment key convention*

ISO 10437, *Petroleum, petrochemical and natural gas industries — Steam turbines — Special-purpose applications*

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

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

ISO 13691, *Petroleum and natural gas industries — High-speed special-purpose gear units*

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ISO 13706, *Petroleum, petrochemical and natural gas industries — Air-cooled heat exchangers*

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

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ISO 16812, *Petroleum, petrochemical and natural gas industries — Shell-and-tube heat exchangers*

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

ANSI/ABMA Standard 7, *Shaft and Housing Fits for Metric Radial Ball and Roller Bearings (Except Tapered Roller Bearings) Conforming to Basic Boundary Plan* [2)]

ANSI/ABMA Standard 20, *Radial Bearings of Ball, Cylindrical Roller and Spherical Roller Types — Metric Design*

API RP 500, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Division 1 and Division 2* [3)]

API 520 (all parts), *Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries*

ANSI/API 526, *Flanged Steel Pressure Relief Valves*

ANSI/API 611, *General-Purpose Steam Turbines for Petroleum, Chemical and Gas Industry Services*

ANSI/API 613, *Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services*

ANSI/API 670, *Machinery Protection Systems*

ANSI/API 671, *Special Purpose Couplings for Petroleum, Chemical, and Gas Industry Services*

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2) American Bearing Manufacturers Association, 2025 M Street, NW, Suite 800, Washington, DC 20036, USA.

3) American Petroleum Institute, 1220 L Street NW, Washington, DC 20005-4070, USA.

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API 677, *General-Purpose Gear Units for Petroleum, Chemical and Gas Industry Services*

API RP 686:1996, *Machinery Installation and Installation Design*

ASME B1.1, *Unified Inch Screw Threads, UN and UNR Thread Form* [4)]

ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch)*

ASME B16.1, *Cast Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250*

ASME B16.5, *Pipe Flanges and Flanged Fittings*

ASME B16.11, *Forged Steel Fittings, Socket-Welding and Threaded*

ASME B16.42, *Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300*

ASME B16.47, *Large Diameter Steel Flanges: NPS 26 Through NPS 60*

ASME B17.1, *Keys and Keyseats*

ASME Boiler and Pressure Vessel Code: Section V, *Nondestructive Examination*

ASME Boiler and Pressure Vessel Code: Section IX, *Welding and Brazing Qualifications*

ASTM A247, *Standard Test Method for Evaluating the Microstructure of Graphite in Iron Castings* [5)]

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ASTM A278, *Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 °F*

ASTM A320/A320M-05, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service*

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ASTM A395/A395M-99, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*

ASTM A536, *Standard Specification for Ductile Iron Castings*

ASTM E94, *Standard Guide for Radiographic Examination*

ASTM E709, *Standard Guide for Magnetic Particle Examination*

ASTM E1003, *Standard Test Method for Hydrostatic Leak Testing*

ANSI/AWS D1.1/D1.1M, *Structural Welding Code — Steel* [6)]

IEEE 841, *IEEE Standard for the Petroleum and Chemical Industry — Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors — Up to and Including 500 HP (370 kW)* [7)]

NACE MR0103, *Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments* [8)]

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4) American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, USA.

5) American Society for Testing and Materials, 100 Bar Harbor Drive, West Conshohocken, PA 19428-2959, USA.

6) American Welding Society, 550 North LeJeune Road, Miami, FL 33136, USA.

7) Institute of Electrical & Electronic Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331, USA.

8) NACE international, the corrosion society, 1440 South Creek Drive, Houston, Texas 77084-4906, USA.

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NEMA 250, *Enclosures for Electrical Equipment (1 000 Volts Maximum)* [9]

NEMA SM 23, *Steam Turbines for Mechanical Drive Service*

NFPA (Fire) 30, *Flammable and Combustible Liquids Code* [10]

NFPA (Fire) 70-05, *2005 National Electrical Code*

TEMA Standard Class C [11]

TEMA Standard Class R

3 Terms and definitions

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

NOTE See Annex B for a guide to rotary-type positive-displacement compressor nomenclature.

3.1
alarm point
preset value of a measured parameter at which an alarm is actuated to warn of a condition that requires corrective action

3.2
anchor bolts
bolts used to attach the mounting plate to the support structure (concrete foundation or steel structure)

NOTE Refer to 3.14 for definition of hold-down bolts.

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3.3
axially split
split with the principal joint parallel to the shaft centreline

3.4
baseplate
structure providing support and mounting surfaces for one or more pieces of equipment

3.5
certified point
point at which the vendor certifies that the performance is within the tolerances stated in the standard, usually the normal operating point

3.6
critical speed
shaft rotational speed at which the rotor-bearing support system is in a state of resonance

3.7
depressurization valve
blowdown valve
valve, external to the compressor, used to relieve the gas pressure within the compressor or compressor package to atmospheric or flare pressure

9) National Electrical Manufacturers Association, 1300 N. 17th Street, Suite 1847, Rosslyn, VA 22209, USA.

10) National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101, USA.

11) Tubular Exchanger Manufacturers Association, Inc., 25 North Broadway, Tarrytown, NY 10591, USA.

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3.8
dry screw compressor
helical-lobe rotary compressor that uses no liquid for sealing the rotor clearances and driving the non-coupled rotor

NOTE 1 The rotor-to-rotor relationship is maintained by timing gears on each rotor and the non-coupled rotor is driven by the coupled rotor through the timing gears.

NOTE 2 No rotor-to-rotor contact occurs in the dry screw compressor.

3.9
fail-safe
system that causes the equipment to revert to a permanently safe condition (shutdown and/or depressurized) in the event of a component failure or failure of the energy supply to the system

3.10
flooded screw compressor
helical-lobe rotary compressor with a lubricant (compatible with the process gas) injected into the rotor area after the closed thread position of the rotor

NOTE This lubricant helps seal rotor clearances and establishes an oil film between the rotors. One rotor drives the other in the absence of a timing gear.

3.11
gas/oil separator
pressure-containing device, usually a vessel, used to separate entrained oil from the process gas

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3.12
gauge board
bracket or plate used to support and display gauges, switches and other instruments

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NOTE 1 A gauge board is open and not enclosed.

NOTE 2 A gauge board is not a panel. A panel is an enclosure. Refer to 3.31 for the definition of a panel.

3.13
general-purpose application
application that is usually spared or is in non-critical service

3.14
hold-down bolts
mounting bolts
bolts holding the equipment to the mounting plate

3.15
hydrodynamic bearings
bearings that use the principles of hydrodynamic lubrication, where bearing surfaces are oriented such that relative motion forms an oil wedge or wedges to support the load without shaft-to-bearing contact

3.16
inlet volume flow
flow rate expressed in volume flow units at the conditions of pressure, temperature, compressibility and gas composition, including moisture content, at the compressor inlet flange

NOTE Inlet volume flow is a specific example of actual volume flow. Actual volume flow is the volume flow at any particular location such as interstage or compressor discharge. Actual volume flow should not be used interchangeably with inlet volume flow.

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3.17
inlet separator
device, usually a filter or vessel, used to separate entrained solid and liquid contaminants from the process gas inlet steam

3.18
maximum allowable differential pressure
highest differential pressure that can be permitted in the compressor under the most severe operating conditions of minimum suction pressure and discharge pressure equal to the relief-valve setting

3.19
maximum allowable speed
highest rotational speed of the power-input rotor at which the manufacturer's design permits continuous operation

3.20
maximum allowable temperature
maximum continuous temperature 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 maximum operating pressure

3.21
maximum allowable working pressure
MAWP
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 maximum operating temperature

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3.22
maximum continuous speed
highest rotational speed of the power-input rotor at which the machine, as built and tested, is capable of continuous operation with the specified fluid at any of the specified operating conditions

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3.23
maximum power
highest power the compressor and any shaft-driven appurtenances require for any of the specified operating conditions, including the effect of any equipment (e.g. pulsation suppression devices, process piping, intercoolers, after-coolers and separators) furnished by the compressor vendor

NOTE Deviations from the specified conditions, such as relief-valve set pressure, are excluded from maximum power.

3.24
maximum sealing pressure
highest pressure at which the seals are required to seal during any specified static or operating condition and during start-up and shutdown

3.25
minimum allowable speed
lowest rotational speed of the power-input rotor at which the manufacturer's design permits continuous operation

3.26
minimum allowable temperature
lowest temperature for which the manufacturer has designed the equipment or part thereof

3.27
mounting plate
device used to attach equipment to concrete foundations

NOTE A mounting plate can be a soleplate, a baseplate or a combination of both.

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3.28
normal operating point
point at which usual operation is expected and optimum efficiency is desired, usually the certified point

3.29
observed inspection
observed test
inspection or test where the purchaser is notified of the timing of the inspection or test and the inspection or test is performed as scheduled if the purchaser or his representative is not present

NOTE Refer to 3.58 for the definition of a witnessed test.

3.30
owner
final recipient of the equipment who may delegate another agent as the purchaser of the equipment

3.31
panel
enclosure used to mount, display and protect gauges, switches and other instruments

NOTE A panel is not a gauge board. A panel is enclosed and not open. Refer to 3.12 for the definition of a gauge board.

3.32
pocket-passing frequency
frequency at which the gas is discharged from the rotor lobes into the discharge port

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NOTE Pocket-passing frequency, expressed in hertz, is calculated by multiplying the rotor rotational speed, expressed in revolutions per minute, by the number of lobes on that rotor and dividing the product by 60.

3.33
pressure casing

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

3.34
pressure design code
recognized pressure vessel standard specified or agreed by the purchaser

3.35
purchaser
agency that issues the order and specifications to the vendor

NOTE The purchaser can be the owner of the plant in which the equipment is to be installed or the owner's appointed agent.

3.36
radially split
split with the principal joint perpendicular to the shaft centreline

3.37
rated speed
100 % speed
highest rotational speed of the power input rotor required to meet any of the specified operating conditions

3.38
relief-valve set pressure
pressure at which a relief valve starts to lift

3.39
remote
located away from the equipment or the console, typically in a control house

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3.40
required capacity
largest inlet volume required by the specified operating conditions

3.41
rotor
rotating male or female assembly, including rotor body, shaft and shrunk-on sleeves (if furnished)

NOTE See Figure 1.

3.42
rotor body
helical profile section on or integral with the shaft

3.43
rotor set
set consisting of both male and female rotors and, for dry screw compressors, including timing gears and thrust collars

3.44
seal buffer gas
clean gas supplied to the process (inboard) side of a seal

3.45
seal barrier gas
clean gas supplied to the area between the seals of a dual seal arrangement at a pressure higher than the process pressure

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3.46
separation seal gas
supply of inert gas or air fed into the region between the seal and the shaft bearing or between the bearing housing and atmosphere

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3.47
settle-out pressure
highest pressure which the compressor experiences when not running and after equilibrium has been reached

NOTE This can be a function of ambient temperature, relief-valve setting and piping-system volume.

3.48
shutdown point
preset value of a measured parameter at which automatic or manual shutdown of the system or equipment is required

3.49
slide valve
device integral to the compression chamber for varying the volumetric flow through a rotary screw compressor

NOTE See Figure B.2, item 8.

3.50
soleplate
plate grouted to the foundation, with a mounting surface for equipment or for a baseplate

3.51
special-purpose application
application for which the equipment is designed for uninterrupted continuous operation in critical service and for which there is usually no installed spare equipment

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3.52
special tool
tool which is not a commercially available catalogue item

3.53
standby
normally idle or idling piece of equipment that is capable of immediate automatic or manual start-up and continuous operation

3.54
thermal relief valve
valve for relieving pressure caused by thermal expansion of liquid within a closed volume

3.55
trip speed
rotational speed of the power-input rotor at which the independent emergency overspeed system operates to shut down a prime mover

NOTE For the purposes of this part of ISO 10440, the trip speed of alternating-current electric motors, except variable-frequency drives, is the speed corresponding to the synchronous speed of the motor at maximum supply frequency.

3.56
unit responsibility
responsibility for coordinating the technical aspects of the equipment and all auxiliary systems included in the scope of the order, including responsibility for reviewing such factors as the power requirements, speed, rotation, general arrangement, couplings, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping, conformance to specifications and testing of components

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3.57
vendor
supplier
agency that supplies the equipment

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NOTE The vendor can be the manufacturer of the equipment or the manufacturer's agent and normally is responsible for service support.

3.58
witnessed inspection
witnessed test
inspection or test where the purchaser is notified of the timing of the inspection or test and a hold is placed on the inspection or test until the purchaser or his representative is in attendance

4 General

4.1 Pressure design code

- The pressure design code shall be specified or agreed by the purchaser. Pressure components shall comply with the pressure design code and the supplemental requirements in this part of ISO 10440.

4.2 Unit responsibility

The vendor who has unit responsibility shall ensure that all subvendors comply with the requirements of this part of ISO 10440.

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