INTERNATIONAL STANDARD

ISO 13707

First edition
2000-12-01

Petroleum and natural gas industries — Reciprocating compressors

Industries du pétrole et du gaz naturel — Compresseurs alternatifs

Reference number
ISO 13707:2000(E)

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Printed in Switzerland

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

International Standard, ISO 13707, was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines* in collaboration with ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

Annexes A to Q of this International Standard are for information only.

Introduction

This International Standard is based upon the accumulated knowledge and experience of manufacturers and users of reciprocating compressors. The objective of this International Standard is to provide a purchase specification to facilitate the manufacture and procurement of reciprocating compressors for general petroleum and natural gas industry services but its use is not limited to these services.

This International Standard is based on API standard 618, 4th edition, 1995.

The purpose of this International Standard 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 utilisation and/or minimize the 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 International Standard requires the purchaser to specify certain details and features.

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.

For effective use of this International Standard and ease of reference to the text the use of the data sheets in annex A is recommended.

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

Petroleum and natural gas industries — Reciprocating compressors

1 Scope

This International Standard covers the minimum requirements for reciprocating compressors and their drivers used in the petroleum and natural gas industries with either lubricated or nonlubricated cylinders. This International Standard may be used for other services or in other industries by agreement. Compressors covered by this International Standard are moderate to low-speed and in critical services. Also included are related lubricating systems, controls, instrumentation, intercoolers, aftercoolers, pulsation suppression devices and other auxiliary equipment. Excluded are integral gas-engine driven compressors, packaged high-speed separable engine-driven reciprocating gas compressors, compressors with single-acting trunk-type (automotive-type) pistons that also serve as crossheads and either plant or instrument air compressors that discharge at gauge pressures of 9 bar or below. Also excluded are gas engine and steam engine drivers.

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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, Tolerances and Designation.*

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 281-1, *Rolling bearings — Dynamic load ratings and rating life — Part 1: Calculation methods.*

ISO 1217, *Displacement compressors — Acceptance tests.*

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

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

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surfaces cleanliness. Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.*

ISO 10436, *Petroleum and natural gas industries — General-purpose steam turbines for refinery service.*

ISO 10437, *Petroleum and natural gas industries — Special-purpose steam turbines for refinery service.*

ISO 10438-2, *Petroleum and natural gas industries — Lubrication, shaft-sealing and control-oil systems and auxiliaries — Part 2: Special-purpose oil systems.*

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

ISO 13691, *Gears — High-speed special-purpose gear units for the petroleum, chemical and gas industries.*

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

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

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

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

IEC 60079-0, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements.*

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

IEC 60848, *Preparation of function charts for control systems.*

ANSI[1] B 1.20.1, *Pipe Threads, General Purpose (Inch).*

ANSI B 16.5, *Pipe Flanges and Flanged Fittings.*

ANSI B 31.3, *Process Piping.*

API[2] RP 520/1, *Sizing, Selection and Installation of Pressure Relieving Devices in Refineries — Part 1: Sizing and selection.*

API RP 520/2, *Sizing, Selection and Installation of Pressure Relieving Devices in Refineries — Part 2: Installation.*

API Std 526, *Flanged Steel Pressure Relief Valves.*

API Std 614, *Lubrication, Shaft Sealing and Control Oil Systems And Auxiliaries For Petroleum, Chemical and Gas Industry Service.*

API Std 670, *Vibration, Axial-Position, and Bearing-Temperature Monitoring Systems.*

ASME[3], *Boiler and Pressure Vessel Code 1998.*

ASTM[4] A 106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.*

ASTM A 193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.*

ASTM A 194M, *Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both.*

ASTM A 216M, *Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.*

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1) American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

2) American Petroleum Institute, 1220 L Street, N.W., Washington, DC 20005-4070, USA.

3) American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017, U.S.A.

4) American Society for Testing and Materials, Barr Harbor Drive, West Conshohocken, PA 19428-2959, U.S.A.

ASTM A 247, *Standard Test Method for Evaluating the Microstructure of Graphite in Iron Castings.*

ASTM A 269, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.*

ASTM A 278M, *Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 °F.*

ASTM A 307, *Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.*

ASTM A 312M, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.*

ASTM A 320M, *Standard Specification for Alloy Steel Bolting Materials for Low-Temperature Service.*

ASTM A 388M, *Standard Practice for Ultrasonic Examination of Heavy Steel Forgings.*

ASTM A 395M, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.*

ASTM A 503, *Standard Specification for Ultrasonic Examination of Large Forged Crankshafts.*

ASTM A 536, *Standard Specification for Ductile Iron Castings.*

ASTM A 668, *Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.*

ASTM E 94, *Standard Guide for Radiographic Testing.*

ASTM E 125, *Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings.*

ASTM E 142, *Standard Method for Controlling Quality of Radiographic Testing.*

ASTM E 709, *Standard Guide for Magnetic Particle Examination.*

AWS[5] D1.1, Structural Welding Code — Steel.

NACE[6] MR 0175, Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.

NEMA[7] SM 23, Steam Turbines for Mechanical Drive Service.

TEMA[8], *Standards.*

3 Terms and definitions

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

3.1
acoustic simulation
process whereby the one-dimensional acoustic characteristics of fluids and the reciprocating compressor dynamic flow influence on these characteristics are modelled

5) American Welding Society, 550 N W LeJeune Road, PO Box 35104, Miami, Florida 33135, U.S.A.

6) National Association of Corrosion Engineers, PO Box 218340, Houston, Texas 77218-8340, U.S.A.

7) National Electrical Manufacturers Association, 2101 L Street, N.W. Washington, D.C. 20037, U.S.A.

8) Tubular Exchanger Manufacturers Association, 25 North Broadway, Tarrytown, New York 10591, U.S.A.

NOTE The model is mathematically based upon the governing differential equations (motion, continuity, etc.). The simulation should allow for determination of pressure/flow modulations at any point in the piping model resulting from any generalized compressor excitation (see 3.4 and 3.7).

3.2
active analysis
portion of the acoustic simulation in which the pressure pulsation amplitudes due to imposed compressor operation for the anticipated loading, speed range and state conditions are simulated (see 3.1)

3.3
alarm point
preset value of a parameter at which an alarm is actuated to warn of a condition that requires corrective action

3.4
analogue simulation
method using electrical components (inductances, capacitors, resistances and current supply devices) to achieve the acoustic simulation (see 3.1).

3.5
capacity
quantity of gas taken into the compressor at the specified inlet conditions, compressed and delivered at the specified discharge pressure

NOTE The capacity of a compessor does not include any gas that leaks out of the compressor during the compression process nor any air that leaks into a compressor used as a vacuum pump.

3.6
combined rod load
algebraic sum of gas load and inertia force on the crosshead pin

NOTE Gas load is the force resulting from differential gas pressure acting on the piston differential area. Inertia force is that force resulting from the acceleration of reciprocating mass. The inertia force with respect to the crosshead pin is the summation of the products of all reciprocating masses (piston and rod assembly, and crosshead assembly including pin) and their respective acceleration.

3.7
design
word used by the designer or manufacturer in terms such as, design power, design pressure, design temperature and design speed

NOTE Use of this word in the purchaser's specifications should be avoided.

3.8
digital simulation
method using various mathematical techniques on digital computers to achieve the acoustic simulation (see 3.1)

3.9
fail safe mode of operation for control systems
arrangement such that failure of any component or loss of energy supply will not result in unsafe or potentially unsafe situations

3.10
gauge board
unenclosed bracket or plate used to support and display gauges, switches and other instruments

3.11
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 To determine inlet volume flow, allowance must be made for pressure drop across pulsation suppression devices and for interstage liquid knockout.

3.12
local (adj.)
applies to any device mounted on or near the equipment or console

3.13
manufacturer
organisation responsible for the design and manufacture of the equipment — not necessarily the vendor

3.14
manufacturer's rated capacity
capacity used to size the compressor

3.15
maximum permissible continuous combined rod load
highest combined rod load at which none of the forces in the running gear (piston, piston rod, crosshead assembly, connecting rod, crankshaft, bearings etc.) and the compressor frame exceed the values in any component that the manufacturer's design will permit for continuous operation

3.16
maximum permissible continuous gas load
highest force that a manufacturer will permit for continuous operation on the static components (e.g., frame, distance piece, cylinder and bolting) of the compressor

3.17
maximum permissible speed
highest speed at which the manufacturer's design will permit continuous operation

3.18
maximum permissible 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 pressure

3.19
maximum permissible working gauge pressure (MPWGP)
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

3.20
minimum permissible speed
lowest speed at which the manufacturer's design will permit continuous operation

3.21
minimum permissible suction pressure (for each stage)
lowest pressure (measured at the inlet flange of the cylinder) below which the combined rod load or gas load or discharge temperature, or crankshaft torque load (whichever is governing) will exceed the maximum permitted during operation at the setpoint pressure of the discharge relief valve and other specified gas conditions for the stage

3.22
minimum permissible temperature
lowest temperature for which the manufacturer has designed the equipment (or any part to which the term is referred)

3.23
mode shape (of an acoustic pulsation resonance)
description of the pulsation amplitudes and phase angle relationship at various points in the piping system

NOTE Knowledge of the mode shape allows the analyst to understand the pulsation patterns in the piping system (see 3.1).

3.24
normal operating point
point at which usual operation is expected and optimum efficiency is desired

NOTE This point is usually the point at which the manufacturer certifies that performance is within the tolerances stated in this International Standard.

3.25
normally open and normally closed
both on-the-shelf positions and de-energized positions of devices such as automatically controlled electrical switches and valves

NOTE The normal operating position of such a device is not necessarily the same as the device's on-the-shelf position.

3.26
owner
final recipient of the equipment

NOTE The owner may delegate another body or agent as the purchaser of the equipment.

3.27
panel
enclosure used to mount, display and protect gauges, switches and other instruments

3.28
passive analysis
portion of the acoustic simulation in which a constant flow amplitude modulation over an arbitrary frequency range is imposed on the system, normally at the cylinder valve locations

NOTE The resulting transfer function defines the acoustic natural frequencies and the mode shapes over the frequency range of interest (see 3.1).

3.29
pressure design code
recognized pressure vessel standard or code specified or agreed by the purchaser (e.g. ASME, *Boiler and Pressure Vessel Code 1998*, Section VIII)

3.30
purchaser
individual or organization that issues the order and specification to the vendor

NOTE The purchaser may be the owner or the owner's agent.

3.31
rated discharge pressure
highest pressure required to meet the conditions specified by the purchaser for the intended service

3.32
rated discharge temperature
highest predicted operating temperature resulting from any specified operating condition

3.33
rated power (of the compressor)
maximum power the compressor plus any shaft-driven appurtenances require for any of the specified operating conditions

NOTE 1 The rated power includes the effect of equipment such as pulsation suppression devices, process piping, intercoolers and separators.

NOTE 2 Driver and transmission losses are not included in the rated power of the compressor. Losses incurred in outboard bearings (e.g. as used to support large flywheels) are included.

3.34
rated speed
highest speed required to meet any of the specified operating conditions

3.35
remote (adj.)
applies to any device located away from the equipment or console, typically in a control room

3.36
required capacity
rated process capacity specified by the purchaser to meet process conditions, with no-negative-tolerance (NNT) permitted

NOTE See annex B for an explanation of the term no-negative tolerance.

3.37
rod reversal
change in direction of force in the piston rod loading (tension to compression or vice versa), which results in a load reversal at the crosshead pin during each revolution

3.38
shut-down point
preset value of a parameter at which automatic or manual shut-down of the system is required

3.39
spectral frequency distribution
description of the pressure pulsation harmonic amplitudes versus frequency at a selected test point location for an active or passive acoustic analysis (see 3.1)

3.40
standard flow
flow rate expressed in volume flow units at ISO standard conditions which are an absolute pressure of 1,013 bar and a temperature of 0 °C

3.41
trip speed
speed at which the independent emergency overspeed device operates to shut down a variable speed prime mover

3.42
unit responsibility
responsibility for co-ordinating the technical aspects of the equipment and all auxiliary systems included in the scope of the order

NOTE It includes responsibility for reviewing such factors as the power requirements, speed, rotation, general arrangement, couplings, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping and testing of components.

3.43
vendor
organization that supplies the equipment

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