INTERNATIONAL STANDARD

ISO 13631

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Petroleum and natural gas industries — Packaged reciprocating gas compressors

Industries du pétrole et du gaz naturel — Unités de compresseurs alternatifs à gaz

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13631 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*.

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

Introduction

This International Standard is based on API specification 11P second edition, November 1989.

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.

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 data sheets (see annex A).

Petroleum and natural gas industries — Packaged reciprocating gas compressors

1 Scope

This International Standard gives requirements and recommendations for the design, materials, fabrication, inspection, testing and preparation for shipment of packaged skid-mounted, reciprocating, separable or integral compressors with lubricated cylinders and their prime movers, for use in the petroleum and natural gas industries for the compression of hydrocarbon gas.

It is also applicable to all necessary auxiliary equipment, such as water and gas coolers, silencers, emission control equipment, filters, separators, control panel, piping, etc., required to install an operable unit in compliance with the purchase specifications and with the intent of minimizing field construction and field-purchased equipment.

This International Standard is not applicable to the following:

— reciprocating compressors for petroleum and natural gas industries covered by ISO 13707;

— column-mounted compressors;

— non-lubricated compressors;

— compressors having trunk-type (automotive-type) pistons that also serve as crossheads;

— utility or instrument air compressors with a discharge gauge pressure of 0,9 MPa (9 bar) or less;

— compressors driven by diesel engine, gas turbine and steam turbine prime movers.

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 68-2:1998, *ISO general-purpose screw threads — Basic profile — Part 2: Inch screw threads*

ISO 185, *Grey cast iron — Classification*

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 263:1973, *ISO inch screw threads — General plan and selection for screws, bolts and nuts — Diameter range 0.06 to 6 in*

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

ISO 1813, *Belt drives — V-ribbed belts, joined V-belts and V-belts including wide section belts and hexagonal belts — Electrical conductivity of antistatic belts: Characteristics and methods of test*

ISO 4126-1:1991, *Safety valves — Part 1: General requirements*

ISO 4986:1992, *Steel castings — Magnetic particle inspection*

ISO 5864:1993, *ISO inch screw threads — Allowances and tolerances*

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

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

ISO 8504-2, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 2: Abrasive blast-cleaning*

ISO 9934-2, *Non-destructive testing — Magnetic particle testing — Part 2 Detection media*

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

ISO 13707, *Petroleum and natural gas industries — Reciprocating compressors*

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

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

IEC 60034, *Rotating electrical machines*

IEC 60079, *Electrical apparatus for explosive gas atmospheres*

IEC 60364-5, *Electrical installation of buildings — Part 5: Selection and erection of electrical equipment — Common rules*

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

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

API Std 1B[1)], *Specification for oil-field V-belt*

API RP 520 Part I, *Sizing, selection and installation of pressure relieving devices in refineries. Part I — Sizing and selection*

API RP 520 Part II, *Sizing, selection and installation of pressure relieving devices in refineries. Part II — Installation*

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

ASME[2] B 1.1 *Unified inch screw threads (UN and UNR thread form)*

ASME B 1.20.1, *Pipe threads, general purpose (inch)*

ASME VIII, ASME Boiler and pressure vessel code: 1998, Section VIII, *Rules for construction of pressure vessels*

ASTM A 320/A 320M, *Standard specification for alloy/steel bolting materials for low-temperature service*

ASTM A 503, *Standard specification for ultrasonic examination of forged crankshafts*

ASTM A 536, *Standard specification for ductile iron castings*

ASTM A 668/A 668M, *Standard specification for steel forgings, carbon and alloy, for general industrial use*

ASTM A 781/A 781M, *Standard specification for castings, steel and alloy, common requirements, for general industrial use*

EN 1561:1997 *Founding — Grey cast irons*

EN 1563:1997 *Founding — Spheroidal graphite cast irons*

EN 10213-1:1995, *Technical delivery conditions for steel castings for pressure purposes — Part 1: General*

EN 10213-2:1995, *Technical delivery conditions for steel castings for pressure purposes — Part 2: Steel grades for use at room temperature and elevated temperatures*

EN 10213-3:1995, *Technical delivery conditions for steel castings for pressure purposes — Part 3: Steel grades for use at low temperatures*

EN 10213-4:1995, *Technical delivery conditions for steel castings for pressure purposes — Part 4: Austenitic and austenitic-ferritic steel grades*

EN 10269, *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties*

NACE MR 0175[3], *Standard material requirements, Sulfide stress cracking resistant metallic materials for oilfield equipment*

NEMA Standards Publication 250-1997, *Enclosures for Electrical Equipment (10 000 Volts Maximum)*

3 Terms and definitions

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

3.1
capacity
quantity of gas taken into the compressor at the specified inlet conditions, compressed and delivered at the specified discharge pressure

NOTE 1 It is expressed in units of mass flow or standard volume flow.

NOTE 2 The capacity of a compressor 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.

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2) American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017, USA.

3) National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218-8340, USA.

3.2
combined rod load
algebraic sum of gas load and inertia force on the crosshead pin

3.2.1
gas load
force resulting from differential gas pressure acting on the piston differential area

3.2.2
inertia force
force resulting from the acceleration of reciprocating mass

NOTE 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 accelerations.

3.3
manufacturer's rated capacity
capacity of the compressor used by the manufacturer to assign its size

3.4
maximum allowable continuous combined rod load
highest combined rod load at which none of the forces in the running gear and the compressor frame exceeds the values that the compressor manufacturer's design permits for any component for continuous operation

NOTE Running gear includes the piston, piston rod, crosshead assembly, connecting rod, crankshaft, bearings, etc.

3.5
maximum allowable speed
highest speed at which the manufacturer's design permits continuous operation

3.6
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 pressure

3.7
maximum allowable working pressure
MAWP
maximum continuous gauge pressure for which the compressor manufacturer has designed the equipment (or relevant part thereof) when handling the specified fluid at the specified temperature

3.8
minimum allowable speed
lowest speed at which the manufacturer's design permits continuous operation

3.9
normal operating point
point at which usual operation is expected and optimum efficiency is desired

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

3.10
rated discharge pressure
highest pressure required to meet the conditions specified by the purchaser for the intended service

3.11
rated power
〈of the compressor〉 maximum power required of the compressor plus any shaft-driven appurtenances for any of the specified operating conditions

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

3.12
rated speed
highest speed required to meet any of the specified operating conditions

3.13
required capacity
capacity specified by the purchaser to meet process conditions, with no negative tolerance (NNT) permitted

3.14
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

3.15
standard flow
flowrate at an absolute pressure of 0,101 3 MPa (1,013 bar) and a temperature of 0 °C

NOTE It is expressed in units of volume flow.

4 Statutory requirements

The purchaser shall specify any applicable regulations. The purchaser and the vendor shall mutually determine the measures to be taken to comply with those regulations that are applicable to the equipment.

Use of the word “design” in the purchaser's specifications should be avoided.

5 General package requirements

5.1 Compressor package performance curves

- If specified, the compressor package performance curves shall cover the range of operating conditions indicated by the purchaser. Any limitations such as rod load, available driver power, additional clearance required to meet the range of operating conditions, etc., shall be marked on the performance curves.

5.2 Package arrangement

The arrangement of the package components shall be developed by the vendor to provide reasonable access for operation and maintenance.

5.3 Drawings

- The vendor shall furnish plan and elevation drawings. Pre-fabrication approval or additional drawings may be specified by the purchaser.

5.4 Sound pressure level

- Control of the sound pressure level of all equipment furnished shall be the joint effort of the purchaser and the vendor. If specified, the equipment furnished by the vendor shall not exceed the maximum sound pressure level required by the purchaser.

5.5 Electrical area classification

- Motors, electrical components and electrical installations shall be suitable for the area classification (zone) specified by the purchaser, shall meet the requirements of IEC 60079 and other standards specified by the purchaser and shall comply with all applicable local codes and regulations.

5.6 Package installation

- The purchaser shall specify the site conditions (altitude, ambient temperature, etc.), and 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 must operate (including maximum and minimum temperatures, unusual humidity or dust problems). The unit and its auxiliaries shall be suitable for operation in these specified conditions. The purchaser shall specify dimensional limitations, if any.

5.7 Torsional analysis

- The vendor shall provide a torsionally sound system and perform an analysis to demonstrate this. When specified, a torsional analysis report shall be provided, and the vendor shall be responsible to coordinate with the compressor and prime-mover manufacturers to produce such a report.

6 Compressor

6.1 General

6.1.1 Manufacturer's rated capacity

The compressor shall be sized to handle not less than the required capacity with the gas composition, suction pressures, suction temperatures, discharge pressures and site conditions specified by the purchaser. The number of stages of compression shall accommodate pressure limitations and gas additions or withdrawals as specified. The package design shall also allow for all pressure drops through the separators, pulsation suppression devices (if any), coolers and piping from the inlet flange to the outlet flange of the package.

6.1.2 Performance calculations

The vendor shall use the specified values of mass flowrate, the specified gas composition and the gas conditions to calculate average molar mass, ratio of specific heats (c_p/c_V), compressibility factors (z) and inlet volume flowrate. The compressor vendor shall indicate his values on the data sheets with the proposal and use them to calculate performance data.

6.1.3 Compressor size

- If specified, the compressor shall be furnished with cylinders which, when operating at the specified operating condition(s), shall as far as practical, load the gas engine to the limit specified in 8.2.1 or electric motor to the limit specified in 8.3.2.

Compressors driven by induction motors shall be sized at the motor operating speed.

6.1.4 Forces and couples

The vendor shall furnish values for the unbalanced primary and secondary forces and couples in the horizontal and vertical planes for the package.

6.2 Allowable speeds

- The maximum acceptable average piston speed (in metres per second) and the maximum acceptable speed (in revolutions per minute) may be specified by the purchaser where experience indicates that specified limits should not be exceeded for a given service.

6.3 Allowable discharge temperature

- Unless otherwise specified and agreed, the maximum predicted discharge temperature shall not exceed 135 °C. This limit applies to all specified operating and load conditions. If specified, the vendor shall provide the purchaser with both the predicted and adiabatic discharge temperatures.

NOTE The actual discharge temperature will vary from the adiabatic depending on such factors as the power input to a cylinder, the ratio of compression, the size of the cylinder, the surface area of the cooling passages and the velocity of the coolant.

6.4 Rod loads

6.4.1 Allowable rod loads

6.4.1.1 The combined rod load shall not exceed the manufacturer's maximum allowable continuous combined rod load for the compressor running gear at any specified operating conditions and any load step. These combined rod loads shall be calculated on the basis of the set point pressure of the discharge relief valve of each stage and the lowest specified suction pressure corresponding to each load step.

6.4.1.2 The gas loads shall not exceed the manufacturer's maximum allowable continuous gas loading for the compressor static crankcase components (cylinders, heads, distance pieces, crosshead guides, crankcase and bolting) at any specified operating load step. The gas loads shall be calculated on the basis of the set point pressure of the discharge relief valve, plus accumulation, of each stage and the lowest specified suction pressure corresponding to each load step.

6.4.2 Rod load reversal

For all specified operating load conditions, the axial component of the combined rod load shall reverse enough to ensure adequate lubrication between the crosshead pin and bushing during each complete turn of the crankshaft.

6.5 Compressor cylinders

6.5.1 General

6.5.1.1 The maximum allowable working pressure of the cylinder shall exceed the rated discharge pressure by at least 10 % or 0,17 MPa (1,7 bar), whichever is greater. The maximum allowable working pressure shall be at least equal to the specified relief valve set pressure including accumulation.

6.5.1.2 Horizontal cylinders shall have bottom discharge connections except where side or top discharge connections are accepted by the purchaser.

6.5.1.3 Cylinders shall be spaced and arranged to permit access and removal for normal maintenance of all components (including covers, packing, valves or unloaders mounted on the cylinder) without removing the cylinder, major piping or pulsation suppression devices.