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Turbine compressors for large air separation plant

大型空分装置用透平压缩机

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1 Scope

This document specifies the classification, technical requirements, test methods, inspection rules, packaging, transport and storage of turbine compressors for large air separation plants.

This document applies to the manufacture of axial compressors and centrifugal compressors for large air separation plants.

Note: the large air separation plants to which this document applies are plants with an oxygen output greater than 40 000 m3/h (standard conditions).

3 Terms and definitions

The terms and definitions given in GB/T 10606, JB/T 2977, JB/T 4113 and ISO 10439-1, together with the following, apply to this document.

3.1 compressor process section. The combination of compressor stages for which the inlet and outlet parameters, such as flow, pressure and temperature, are explicitly specified in the process scheme. Note: the interstage parameter requirements for instrument air extraction are not treated as a separate process section.

3.2 aerodynamic performance calibration. Comparison of the aerodynamic performance figures of the compressor running on site with the guaranteed design values.

3.3 main air compressor. The feed air compressor whose inlet medium is the local atmosphere.

3.4 booster compressor. The compressor whose inlet medium is high pressure air or high pressure nitrogen.

4 Symbols and abbreviations

4.1 Symbols. Av is the radial vibration displacement (peak to peak), expressed in micrometres (μm). Nmc is the maximum continuous speed, expressed in revolutions per minute (r/min).

4.2 Abbreviations. CCS: compressor control system. DCS: distributed control system. ESD: emergency shutdown device. MCC: motor control center.

5 Classification

5.1 Air separation process schemes. According to the way the oxygen is compressed, the process scheme of an air separation plant is either external compression or internal compression. The scheme and the equipment shall comply with GB/T 36227. Note 1: in the external compression scheme the low pressure oxygen produced by the air separation equipment is raised by an oxygen compressor to the pressure required. Note 2: in the internal compression scheme the liquid oxygen drawn from the main cold box is pumped by a liquid oxygen pump to the pressure the user requires; because of its high safety and reliability and its good overall economics, internal compression is widely used in the large air separation plants of the petrochemical and coal chemical industries.

5.2 Turbine compressors for air separation plant. The turbine compressors of an air separation plant (referred to below as compressors) are mainly the feed air compressor, the air booster and the nitrogen booster. The main compressor of an air separation plant is usually a single-shaft centrifugal compressor, a combined axial and centrifugal compressor or an integrally geared centrifugal compressor, and the booster is usually an integrally geared centrifugal compressor. The medium handled by the main air compressor is natural atmospheric air, containing oxygen, nitrogen, argon, moisture, carbon dioxide, dust and traces of hydrocarbons. The medium handled by the booster is air purified through the molecular sieve system, or pure nitrogen. The feed air of an air separation plant is available without limit and free of charge, so the running cost of the compressor train is essentially energy consumption; the factors that affect it are the energy consumption of the driver, the electricity consumed by the oil station, the pressure drop of the gas coolers, the pressure drop of the inlet filter and the pressure drop of the pipes and fittings.

5.3 Compressor train configuration. In the internal compression scheme, different air separation processes require different discharge pressures: the discharge pressure of the main air compressor is usually 0.55 MPa(A) to 0.8 MPa(A), and the discharge pressure of the booster falls mainly into two classes, the 5 MPa(A) class and the 7 MPa(A) class. The main combinations of compressor and driver in an internal compression air separation plant are: a) the main air compressor driven by its own motor or steam turbine and the booster driven by its own motor or steam turbine; b) the main air compressor and the booster driven by one steam turbine, also called a one drives two train, the turbine being designed with a shaft extension at each end; c) the main air compressor and the booster designed as one machine driven by a single motor or steam turbine, which is common where the booster discharge pressure is below 5 MPa(A).

6.1 General requirements

Where the technical requirements of ISO 10439-1, ISO 10439-2, ISO 10439-3 and ISO 10441 conflict with this document, this document prevails; technical requirements not covered by this document shall meet the technical requirements defined in ISO 10439-1, ISO 10439-2, ISO 10439-3 and ISO 10441. If specified, the compressor equipment, its

components, the technology used, the raw materials and the manufacturing methods shall have been proved in actual service.

The compressor shall be provided with active noise reduction measures; if specified, passive measures shall also be provided, including the supply and installation of the noise reduction equipment. Note 1: active noise reduction means reducing noise by optimising the mechanical design of the compressor, including but not limited to lowering gas velocities and increasing casing thickness. Note 2: passive noise reduction means fitting noise reduction equipment such as acoustic hoods, jackets or acoustic fencing outside the casings of the compressor, the driver and the gearbox in order to lower the environmental noise.

All gas discharged from the compressor train to the atmosphere shall comply with GB 31571. The technical specification of the compressor shall state the spare parts list for installation and for the individual machine test run.

6.2 Mechanical construction

6.2.1 Pressure casing. The maximum allowable working pressure of each pressure casing shall be not lower than the set pressure of the relief valve of the compressor process section concerned. The casing design pressure shall meet the settle-out pressure of its process section. If a horizontally split casing is used, the joint face shall be a metal-to-metal design and a machined groove with an added sealing ring shall not be used. All fasteners of casing sealing faces and of external connection flanges shall be studs; if specified, hexagon head bolts or screws may be used. Lifting eyes or lifting columns shall be provided on the upper half of a horizontally split casing for lifting and turning it over.

6.2.2 Pressure casing connections. Standard mating flanges with the associated gaskets and fasteners shall be supplied as a set with the piping. The design of the suction and discharge nozzles shall not adversely affect the performance of the volute. Recommended values shall be given for the minimum straight length of the compressor inlet and outlet process piping, and the effect on compressor performance of site conditions that do not provide that straight length shall be assessed. No pressure-carrying connection on the casing shall be threaded.

6.2.3 Stationary parts. The first stage of each compressor process section shall be fitted with adjustable inlet guide vanes. The inlet guide vane shaft of the booster shall be well sealed so as to reduce gas leakage to atmosphere. Where necessary the internal labyrinth seals shall be of abradable design. Note: the abradable material meets the design temperature of the compressor. If specified, the split face of a horizontally split diaphragm shall have a groove with an inlaid sealing strip. Note: the material and properties of the sealing strip need to meet the design temperature of the compressor or the corrosivity of the medium.