JB

MECHANICAL INDUSTRY STANDARD

OF THE PEOPLE'S REPUBLIC OF CHINA

ICS 71.100.20

J 76

Filing No.: 51510-2015

JB/T 8693-2015

Replacing JB/T 8693-1998

Large and medium scale air separation plants

大中型空气分离设备

Issued on: October 10, 2015 **Implemented on: March 01, 2016**

Issued by: Ministry of Industry and Information Technology of PRC

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Large and medium scale air separation plants

1 Scope

This standard specifies the terms and definitions, product classification and model, technical requirements, exit-factory inspection, on-site inspection, marking, packaging, transportation, storage of large and medium scale air separation plants (hereinafter referred to as air separation plants).

This standard is applicable to air separation plant, where the oxygen yield is greater than or equal to 1000 m^3/h and less than 60000 m^3/h, AND the cryogenic method is used to separate air, to produce oxygen, nitrogen, argon products.

Extra-large air separation plant can be implemented, with reference to this standard.

Note 1: Pressures, which are not specified in this standard, are gauge pressures. However, if adding "(A)", it means absolute pressure.

Note 2: The production of oxygen, nitrogen, argon in this standard is the gas volume under the standard state, that is, the gas volume under the state of 0 °C and 101.325 kPa (A), in cubic meters per hour (m^3/h).

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB 150 (all parts) Pressure vessel

GB/T 151 Heat exchanger

GB/T 2624 (all parts) Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full

GB/T 2888 Methods of noise measurement for fans blowers compressors and roots blowers

GB 3096 Environmental quality standard for noise

GB/T 3863 Industrial oxygen

HG/T 2690 Molecular sieve 13X

JB/T 4711 Coating and packing for pressure vessels transport

JB/T 4734 Aluminium welded vessels

JB/T 5902 Technical conditions for oxygen pipelines used in air separation plants

JB/T 6896 Surface clearness of air separation plant

JB/T 8058 Activated aluminum oxide for air separation equipment - Acceptance technical condition

JB/T 9077 Conventional powder insulation tanks

JB/T 11006 Air separation plant - Methods for compiling product models

JC/T 1020 Expanded perlite for thermal isolation of low temperature equipment

SH 3043 Codes for surface color and mark on equipment pipe and steel structure in petrochemical industry

TSG D0001 Pressure pipe safety technology supervision regulation for industrial pressure pipe

TSG D7002-2006 Pressure piping components type test regulation

TSG R0004 Supervision regulation on safety technology for stationary pressure vessel

3 Terms and definitions

The terms and definitions as defined in GB/T 10606, as well as the following terms and definitions apply to this document.

3.1

The equivalent product A

The sum of the flow rate of the product A per unit time AND the flow rate of other products after converted to reference product per unit time. It is obtained by selecting the product A of a certain specification, which is produced by the air separation plant, as the reference product, AND using the principle of equivalent energy consumption, to convert other products into the flow rate (mass flow or volume flow) of the reference product.

air pre-cooling and purification; air pressurization; air expansion at medium pressure; feeding the structured packing into tower; compressing the liquid oxygen and reheating it out of the cold box, which is referred to as process II;

- Internal compression process of high-pressure oxygen: 3.0 MPa < product oxygen pressure ≤ 10.0 MPa; air filtration and compression; compressed air pre-cooling and purification; air pressurization (or nitrogen cycle pressurization); air (nitrogen) expansion at medium pressure; feeding the structured packing into tower; internal compression of liquid oxygen and reheating out of the cold box, which is referred to as process III;

- All-liquid air separation process: Air filtration and compression; compressed air pre-cooling and purification, air (nitrogen) cyclic pressurization, expansion by high and low temperature turboexpander; feeding the structured packing into tower; liquid products out of the cold box, which is referred to as process IV.

This standard defines four types of common processes. For each type of process, it can be determined whether to include a full distillation hydrogen-free argon production system. For the air separation plant, whose processes are not defined in this standard (such as liquid oxygen self-pressurization process, low-purity oxygen process, pure nitrogen equipment, independent argon extraction equipment, krypton xenon extraction equipment, neon helium extraction equipment, liquefaction equipment, etc.), it may be implemented with reference to this standard.

4.2 The product model is in accordance with the requirements of JB/T 11006.

5 Technical requirements

5.1 Engineering conditions

5.1.1 General:

This standard specifies the general engineering conditions, which are required in the design of air separation plant. When the values in Table 1 ~ Table 7 do not conform to the contract technical agreement, it shall follow the contract technical agreement. If the contract technical agreement does not clearly stipulate, this standard shall prevail.

5.1.2 Raw material air conditions:

There shall be a certain safe distance, BETWEEN the air inlet of the air separation unit AND the source of harmful gases, such as hydrocarbons

5.4 Composition of air separation plant

5.4.1 General

Air separation plant usually consists of raw material air filter, raw air turbo-compressor, air pre-cooling system, air purification system, air (nitrogen) booster, booster turboexpander (refrigeration), fractionation tower system, liquid storage and vaporization system, oxygen compressor, nitrogen compressor, instrument control system, electrical control system, etc.

5.4.2 Raw air filter

The main function of the raw air filter is to remove dust and other mechanical impurities, in the raw material air. It shall meet the following requirements:

a) The processing capacity of the raw air filter shall be twice the processing air volume;

b) The efficiency and resistance of the filter shall meet the requirements of GB/T 14295;

c) The filter shall have an automatic blowback function; the filter element can be replaced online;

d) There shall be perfect preventive measures for areas, which are prone to sand and dust storms.

5.4.3 Raw air turbo-compressor

The function of the raw air turbo-compressor is to provide air to the device, to enable the fluid to flow along the process route. The machine is generally driven by an electric motor or a steam turbine. The raw air turbo-compressor shall meet the following requirements:

a) The air compressor shall be equipped with the alarm interlocking devices for vibration, shaft displacement, oil pressure, oil temperature, water pressure, bearing temperature, exhaust temperature, etc. It shall carry out simulated interlocking test before starting;

b) The air compressor shall be equipped with a complete anti-surge system;

c) The air compressor shall be equipped with a full blowdown system;

d) The air compressor shall be equipped with an inlet guide vane adjustment system.

5.4.4 Air pre-cooling system

The function of the air pre-cooling system is to cool and wash the raw air, which shall meet the following requirements:

a) The air outlet of the air-cooling tower shall be equipped with a low pressure alarm and interlock, to prevent the air from leaving the air-cooling tower with water;

b) The water used in the waterway system must be clean, to avoid foaming;

c) For areas with low temperature in Winter, the upper section of the air-cooling tower, the entire water-cooling tower, the air outlet pipeline from the air-cooling tower, the chilled water pipeline, the pure (soil) nitrogen inlet water pipeline of cooling tower, shall be designed with cold preservation measures. The air inlet pipeline of the air-cooling tower shall take anti-scalding measures. The level gauges at the bottom of air-cooling tower and water-cooling tower, the liquid level transmitters, the corresponding pressure-taking pipelines, shall be equipped with steam or electric heating and tracing measures;

d) For areas where the monthly average minimum temperature, in the past years, is below zero, the lower section of the air-cooling tower, the lower section of the water-cooling tower, the water pump should be arranged indoors.

5.4.5 Air purification system

The role of the air purification system is to remove moisture, acetylene, carbon dioxide, nitrous oxide (partial adsorption), etc. from the air. It shall meet the following requirements:

a) Activated alumina shall meet the requirements of JB/T 8058;

b) The acceptance of molecular sieve shall meet the requirements of HG/T 2690;

c) After being processed by the molecular sieve adsorber, the carbon dioxide content (volume fraction) in the air shall not exceed 1×10^{-6};

d) The adsorption time of a single molecular sieve adsorber is generally not less than 3.5 h;

e) A trace water analyzer shall be installed at the outlet of the steam heater's sewage nitrogen outlet; its dew point shall not be higher than -65 °C;

f) The inlet and outlet pipes of the molecular sieve adsorber, the heater and its pipes shall be wrapped with insulation layer, respectively.

l) The cold box of the fractionation tower shall be filled with dry nitrogen, to maintain a positive pressure (50 Pa ~ 300 Pa), during normal operation. It shall be checked frequently. The cold box shall be equipped with pressure gauges, cold box safety valves, analysis sampling points, etc., in layers.

m) The cold box's insulation pearl sand shall meet the requirements of JC/T 1020.

5.4.9 Liquid storage vaporization system

The main function of the liquid storage vaporization system is to store the liquid oxygen, liquid nitrogen, liquid argon products, which are produced by the air separation plant; provide spare oxygen, nitrogen, argon, through cryogenic liquid pumps, self-superchargers, vaporizers and other equipment. The liquid storage vaporization system shall meet the following requirements:

a) The design of cryogenic liquid storage tanks shall meet the requirements of GB/T 18442 (all parts);

b) Cryogenic liquid shall be collected and discharged to a safe area:

c) The layout of the liquid oxygen storage vaporization system shall meet the requirements of GB 50016;

d) The filling of oxygen, nitrogen, argon cylinders shall meet the requirements of GB 14194;

e) The design of the oxygen, nitrogen, argon filling station shall meet the requirements of GB 50030;

f) The liquid storage vaporization system shall be equipped with necessary safety relief devices, such as safety valves, rupture discs, etc.;

g) Necessary ventilation shall be considered, in the area of the liquid storage vaporization system, especially the area of large atmospheric storage tanks.

5.4.10 Oxygen compressor

The oxygen compressor is a machine, which is set to increase the pressure of the product oxygen, which is produced by the air separation plant. The air separation plant, which has an oxygen yield of less than 6000 m^3/h generally uses an oil-free piston compressor. The air separation plant, which has an oxygen yield of greater than or equal to 6000 m^3/h, generally uses a single-shaft centrifugal compressor.

The compressor is usually driven by an asynchronous motor or a steam turbine.

It is generally not allowed to be driven by a synchronous motor. The turbo oxygen compressor shall meet the following requirements:

a) Strictly control the temperature and flow rate of oxygen in the compression process and flow process; comply with the requirements of GB 16912;

b) The impeller, main shaft and other rotor parts must be made of stainless steel, which has a higher ignition point in pure oxygen. The materials of oxygen pipes and pipe fittings shall meet the requirements of GB 16912;

c) If carbon steel or cast iron is used for the internal parts, other than the impeller, of the oxygen compressor, the surface in contact with oxygen must be plated with copper OR adopt equivalent surface safety treatment;

d) All surfaces in contact with oxygen must be strictly cleaned and degreased, before being put into operation, meanwhile subject to strict inspections, to ensure that the runner surface is clean and free of welding slag, weld bead, flanging, sharp corners, grease; the solid particles are especially prohibited;

e) Oxygen compressors generally need to be protected by an unroofed firewall, which is made of more refractory materials;

f) The oxygen compressor must be equipped with sufficient online fire extinguishing nitrogen, which can quickly replace the oxygen volume, in the compressor and corresponding parts;

g) The oxygen compressor and related components must have reliable grounding measures, to prevent static electricity from accumulating. Meanwhile it shall be equipped with reliable lightning protection facilities;

h) The oxygen compressor must be equipped with a reliable instrument control and protection system, to perform strict online monitoring of the compressor's shaft vibration, shaft displacement, bearing and shell temperature, oxygen temperature, etc., to protect it; meanwhile to achieve the on-line monitoring and adjustment of the operating conditions of the compressor, thereby automatically realizing the anti-surge protection and safety protection interlock of the compressor;

i) Reliable isolation measures shall be provided on the inlet pipe and outlet pipe of the oxygen compressor;

j) The vicinity of the oxygen compressor shall be well ventilated, to prevent the accumulation of oxygen;

k) When repairing the oxygen compressor and related components, it shall monitor the oxygen concentration in the repair environment.

h) The standard gas cylinder room of analytical instruments should be separated from the analytical instrument room.

5.4.13 Electrical control system

The main function of the electrical control system is to ensure the safe, reliable, economical operation of the air separation plant, by optimizing the power supply and distribution plan AND the reasonable configuration of the control, protection, measurement, communication and other functions of the electrical equipment, under the condition of meeting the process requirements. The electrical control system shall meet the following requirements:

a) Electrical equipment, such as motors, shall meet the corresponding requirements of the site conditions (altitude, humid tropical zone, indoor and outdoor, etc.).

b) Electrical equipment (high and low voltage switch cabinets, transformers, frequency converters, etc.) must be safe and reliable, AND easy to operate and maintain. The settings of electrical control, protection, signal and metering devices shall comply with relevant national standards or regulations.

c) The degree of protection of electrical equipment shall meet the requirements of the on-site use conditions and relevant national regulations.

d) In order to ensure the reliability of power supply, high and low voltage power supplies should adopt dual-circuit power supply, the main wiring adopts a single busbar sectioned bus tie. If the lubricating oil system is equipped with an accident oil pump, there must be an accident power supply.

e) In order to reduce the impact on the power grid and machinery when the motor starts, when the short-circuit capacity of the bus does not meet the requirements that the bus voltage is not less than 85% (not less than 80% in special circumstances), a step-down start or soft start is required.

f) Electrical equipment enclosures and equipment that endanger safe operation, due to the presence of static electricity (such as condensing evaporators, etc.) shall be equipped with grounding terminals (grounding electrodes).

g) In order to ensure the quality of power supply, a capacitive reactive power compensation device is installed, on the high-voltage or low-voltage bus, according to the requirements and actual conditions.

5.5 Other technical requirements

5.5.1 The matched pressure vessel shall comply with relevant regulations and standards such as TSG R0004, GB 150 (all parts), GB/T 151, JB/T 4734.

5.5.2 The oxygen pipeline shall meet the requirements of GB 16912 and JB/T 5902. The design of the high-pressure oxygen valve shall meet the requirements of GB 16912.

5.5.3 An independent valve chamber or protective wall shall be set up, for the oxygen regulating valve group (the oxygen regulating valve group of the oxygen plant and station shall be located outside the main building). The fire separation distance can be determined, according to the process requirements; however, the fire separation distance from the oxygen storage tank shall not be less than 3.5 m.

5.5.4 The parts, in contact with oxygen, must be made of materials, that are relatively inert in oxygen, AND shall be completely degreased. The surface cleanliness shall meet the requirements of JB/T 6896.

5.5.5 The engineering design and installation of air separation plant shall comply with product design requirements, GB 50016, GB 50274, GB 50275, as well as other standards and relevant regulations.

5.5.6 The operators, mechanics and instrument workers of machinery and equipment must be familiar with the structure and operation of the machinery and equipment; they can only operate on their posts, after passing the training and examination.

5.5.7 The user shall formulate safety operating procedures, regular inspection and maintenance and inspection systems, spare parts management systems, according to the requirements of the production process; strictly implement them.

5.5.8 When machinery or equipment fails, it shall be reported and dealt with in time. For serious failures, feedback shall be given to the manufacturer. The manufacturer shall deal with the feedback, in a timely manner. It shall visit users regularly, to understand the use and operation of the product, so as to improve the design and improve the quality of the product.

5.5.9 The surface color and markings of the equipment, pipes, steel structure of the air separation unit, which is used in dry chemical and petrochemical operations, shall be implemented in accordance with the provisions of SH 3043.

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