Guideline No.M-06 (~~201510~~202502)

M-06

NITROGEN GENERATOR

(NITROGEN MAKING MACHINE)

Issued date: ~~20th October, 2015~~ February 1，2025

© China Classification Society

Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

Historical version and release date: M-06(201510) October 20, 2015

Main change: ~~New Release~~ Correction and add duration set to hydraulic and tightness test

CONTENTS

NITROGEN GENERATOR(NITROGEN MAKING MACHINE)

1 Application

1.1 This Guideline applies to nitrogen generators used in inert gas systems;

1.2 This Guideline applies to nitrogen generators of membrane-separation and pressure swing adsorption (PSA) types, which may be provided as a reference for other types of nitrogen generators or systems.

2 Basis for approval and inspection

2.1 The following standards are the bases for approval and inspection in this Guideline:

(1) *CCS Rules for Classification of Sea-Going Steel Ships;*

(2) Chapter 15 of *International Code for Fire Safety Systems* (FSS);

(3) Chapter II-2 of *International Convention for Safety of Life At Sea* (SOLAS).

3 Terms and definitions

3.1 For definitions of product inspection, approval, type test, sample, and unit/batch inspection, refer to Article 3.1.2, Chapter 3, Part One of CCS *Rules for Classification of Sea-going Steel Ships*.

3.2 PSA (nitrogen preparation method) — A general term that describes PSA nitrogen generation methods whereby nitrogen is separated from oxygen with the air as material through selective adsorption of oxygen and nitrogen by solid adsorbent based on PSA principle;

3.3 Membrane-separation (nitrogen preparation method) — A nitrogen generation method whereby nitrogen is separated from oxygen under certain pressure with the air as material based on different permeation rates of oxygen and nitrogen in the semi-permeable membrane.

4 Plans and documents

In addition to the *Application for Approval*, applicants are to submit the plans and documents as described below.

4.1 Plans and documents approved by CCS:

(1) Main product performance specification table, including startup time, nitrogen (oxygen) concentration, gas output, outlet pressure, etc.;

(2) A detailed list of equipment model/parameter, including supporting air compressor, pressure vessels (air reservoir, nitrogen reservoir, buffer tank, etc.), inlet air treatment equipment (air dryer or drier, oil/air separator, oil filter, etc.), electric control box, nitrogen (oxygen) concentration measurement equipment, recording units;

(3) System principle diagram and workflow chart;

(4) Schematic diagram of automatic control/alarm/safety protection system;

(5) General assembly plan;

(6) Type test program (submitted when applying for type approval by CCS).

4.2 Plans and documents for information by CCS:

(1) Instructions on product use/operation/maintenance;

(2) Samples of product nameplate, factory quality certificate, etc.

(3) A detailed list of designation and manufacturer of adsorbing material or semi-permeable membrane;

4.3 Other required information:

(1) Factory profile: Name, address, production history, capacity, technicians and inspectors, main products, affiliation, trademark, etc.;

(2) Details of the product to be approved;

(3) Main production equipment;

(4) Main testing equipment;

(5) A brief description on production technology of the product to be approved;

(6) Quality management document;

(7) Registration certificate;

(8) Qualification certificate and/or production license;

(9) Sample of product quality certificate;

(10) Quality control plan (where applicable).

5 Materials and components

5.1 Materials and components are to be controlled according to relevant requirements of the CCS Rules currently in effect;

5.2 Materials and components mainly include the associated air compressor, pressure vessels (air reservoir, nitrogen reservoir, buffer tank, etc.), inlet air treatment equipment (air dryer or drier, oil/air separator, oil filter, etc.), electric control box, nitrogen (oxygen) concentration measurement equipment, valves, etc.;

5.3 Air compressor sets, pressure vessels (to be equipped with overpressure preventers such as safety valve, fusible plug), and the corollary equipment such as electric control boxes are to have the product certificate issued by CCS;

5.4 Adsorbing materials, membrane components, air dryers, driers, filters, valves are to have the quality certificate issued by the manufacturer;

5.5 The nitrogen (oxygen) concentration measurement equipment is to be verified by the metrological verification department or within the validity period of verification before installation into the system.

6 Design and technical requirements

6.1 The marine nitrogen generator systems are to be designed in accordance with Article 4.2.3, Chapter 4, Part Six of CCS *Rules for Classification of Sea-going Steel Ships*, as well as related requirements of *International Code for FSS* and SOLAS referenced in the aforesaid article.

6.2 A nitrogen generator is to be able to generate high-purity nitrogen containing at most 5% O2 (by volume).

6.3 An automatic device is also to be provided for exhausting harmful gases to a safe position on the open deck during startup and abnormal operation.

6.4 Where a pipeline or the system component, when used, would work under the pressure exceeding the design value, a safety valve is to be provided at a proper location to prevent overpressure.

6.5 Where this nitrogen generator is the only inert gas generator onboard, at least 2 air compressors are to be provided. It is recommended that the total system capacity be shared equally by both air compressors, either of which is to have the capacity no less than 1/3 of the total at any time. Where sufficient air compressors and prime movers are provided such that the crew may minimize the faults, the provision of only one air compressor is permitted.

6.6 A gas supply treatment system is to be arranged to remove moisture, particle and oil drop from the compressed air, and ensure the required temperature.

6.7 For easy maintenance, separate facilities are to be provided between the generator and the storage device (nitrogen reservoir).

6.8 An apparatus providing continuous indication of air temperature and pressure is to be provided at the following position:

(1) Outlet of the air compressor;

(2) Inlet of the nitrogen generator.

6.9 Where the inert gas is generated, an apparatus providing continuous display and permanent record of oxygen content is to be arranged at the inert gas outlet of the nitrogen generator.

6.10 A nitrogen generator is to provide the following alarm and automatic protection functions:

(1) Where the air compressor outlet pressure is below the normal working pressure, the system is to give an alarm and shut itself down;

(2) Where the air compressor outlet air temperature is above the normal working temperature, the system is to give an alarm and shut itself down;

(3) Where the gas supply treatment system fails to provide the gas quality meeting the system requirements (e.g. failure shutdown of air dryer or drier, high condensed water level of automatic drain pipe of oil-water separating equipment), the system is to give an alarm and shut itself down;

(4) Where there is a fault on the electric heater or other equipment (if any) which would significantly influence the gas quality ultimately provided by the system, the system is to give an alarm and shut itself down;

(5) Where the nitrogen generator outlet gas cannot reach the required standard (oxygen content ≤ 5% or nitrogen content ≥ 95% or higher at the request of user), the system is to give an alarm and shut itself down;

(6) Where there is a fault on the power supply of equipment at the gas outlet of the nitrogen generator system that provides measurement, continuous display and permanent record of oxygen content, the system is to give an alarm and automatically switch the gas outlet to the "Discharge into the atmosphere" state;

* In the above Paragraphs (1)-(6), the alarm is to include the alarm display on the local control equipment and the output of remote alarm signal;

* In the above Paragraphs (1)-(5), the system shutdown is to include automatic stop of equipment and closure of nitrogen outlet, as well as automatic discharge of residual gas to a safe position on the open deck;

7 Selection of typical samples

A prototype selected for approval is to be representative or inclusive of the product or line of products to be approved in terms of the characteristic, feature and quality, and is generally to be the one with maximum gas supply flow in each series.

8 Type test

8.1 Test items

(1) In general, test items are to include:

① Hydraulic test of pipeline (not for connecting lines fitted on board);

② Tightness test of pipeline (not for connecting lines fitted on board);

③ Startup test;

④ Test of safety protection and alarm functions;

⑤ Performance test.

~~(1)~~ (2) All applicable test items described in the above Paragraph (1) are to be fulfilled for the first approval.

8.2 Test requirements

(1) Test site

The manufacturer must have the equipment and capability for type test/factory test and the approval test is to be carried out at the manufacturer.

(2) Measuring instrument

The measuring instrument is to have the metrological calibration certificate and is to be within the period of validity, with accuracy of no less than that as specified in Table 8.2:

Test instrument accuracy **Table 8.2**

Item	Accuracy
Pressure gauge	± 1.5
Flow meter	± 1.5
Thermometer	± 0.5 °C, division ≤ 0.5 °C
Barometer	± 66.6 Pa
Oxygen analyzer	Minimum division: 0.1% O_2
Nitrogen analyzer	Minimum division: ≤ 0.2% N_2

*Note: An instrument that accompanies the equipment may be used for the test, provided it is proven to meet the above requirements and has passed the verification.

(3) Conversion of measured flow

① Where a rotor flow meter is used, the oxygen and nitrogen flows of the dry product are to be corrected for the density in a manner as described in the *Instructions of Rotor Flow Meter*.

② The oxygen and nitrogen flows of the dry product are to be corrected by using Eq. (1):

$$Q = Q1\sqrt{\frac{pT_1}{p_1T}} \quad \text{..... (1)}$$

Where: Q — corrected dry gas flow under the design condition, in m^3/h;

Q_1 — measured gas flow, in m^3 /h;

p_1 — actual pressure of the gas before the flow meter, in MPa (absolute pressure);

p — atmospheric pressure, with p = 0.098 MPa (absolute pressure);

T_1 — actual temperature of the gas before the flow meter, in K;

T — atmospheric temperature under the design condition, with T = 273.15 K.

③ Where the atmospheric condition disagrees with the design condition, the gas flow is to be converted by using Eq. (2):

$$Q_0 = Q\frac{(p_0 - \varphi_0 p_{S0})T_2}{(p_2 - \varphi_2 p_{S2})T_0} \quad \text{..... (2)}$$

Where: Q_0 — gas flow under the design condition, in m^3/h (standard condition);

p_0 — atmospheric pressure under the design condition, in MPa (absolute pressure);

p_2 — atmospheric pressure under the actual condition, in MPa (absolute pressure);

ϕ_0 — relative humidity under the design condition, in %;

ϕ_2 — relative humidity under the actual condition, in %;

p_{s0} — saturated water vapor pressure in the atmosphere under the design condition, in MPa (absolute pressure);

p_{s2} — saturated water vapor pressure in the atmosphere under the actual condition, in MPa (absolute pressure);

T_0 — atmospheric temperature under the design condition, in K;

T_2 — atmospheric temperature under the actual condition, in K.

8.3 Test method

(1) Hydraulic test of pipeline

Any system connecting pipeline provided by the nitrogen generator manufacturer is to be subject to the hydraulic test under 1.5 × maximum operating pressure on completion of manufacturing. This test pressure is to be retained for a minimum period of 5 min.

(2) Tightness test of connecting pipeline

Any system connecting pipeline provided by the nitrogen generator manufacturer is to be subjected to the tightness test under 1.25 ×operating pressure after system connection. This test pressure is to be retained for a minimum period of 5 min.

(3) Startup test

With the nitrogen generator set to the “Auto” mode and started, now the generated gas is to be automatically discharged into the atmosphere until the quality reaches the requirements (oxygen content ≤ 5% or nitrogen content ≥ 95%, or higher at the request of user), in which case, the system is to be switched to the “Supply gas to rear device (e.g. nitrogen reservoir)” state.

Record the time elapsed from the pressing of start button to the beginning of gas supply, which will not exceed the startup time given in the performance parameter table provided by the manufacturer.

(4) Test of safety protection and alarm functions

① Where the air compressor outlet pressure is below the normal working pressure, the system is to give an alarm and shut itself down;

② Where the air compressor outlet air temperature is above the normal working temperature, the system is to give an alarm and shut itself down;

③ Where the gas supply treatment system fails to provide the gas quality meeting the system requirements (e.g. failure breakdown of air dryer or drier, high condensed water level of automatic drain pipe of oil-water separating equipment), the system is to give an alarm and shut itself down;

④ Where there is a fault on the electric heater or other equipment (if any) which would significantly influence the gas quality ultimately provided by the system, the system is to give an alarm and shut itself down;

⑤ Where the nitrogen generator outlet gas cannot reach the required standard (oxygen content ≤ 5% or nitrogen content ≥ 95% or higher at the request of user), the system is to give an alarm and shut itself down;

⑥ Where there is a fault on the power supply of equipment at the gas outlet of the nitrogen generator system that provides measurement, continuous display and permanent record of oxygen content, the system is to give an alarm and automatically switch the gas outlet to the "Discharge into the atmosphere" state;

* In the above Paragraphs (1)-(6), the alarm is to include the alarm display on the local control equipment and the output of remote alarm signal which may be simulated by external connection of an indicator lamp;

* In the above Paragraphs (1)-(5), the system shutdown is to include automatic stop of equipment and closure of nitrogen outlet, as well as automatic discharge of residual gas to a safe position on the open deck;

(5) Performance test

① The test is to be performed with the equipment in automatic operation without interruption and failure shutdown;

② Test duration: 24 h for type test;

③ Where the nitrogen generator system features two or more air compressors, automatic switching is allowed between the active and the standby air compressors within the time specified in the aforesaid Article B;

④ Composition of the outlet gas is to always meet the requirements (oxygen content ≤ 5% or nitrogen content ≥ 95% or higher at the request of user) throughout the test;

⑤ The flow and oxygen (or nitrogen) content are to be measured once per hour during the test;

⑥ All measuring, displaying and recording equipment are to be kept in normal working condition during the test;

⑦ Where the oxygen (or nitrogen) content recording equipment at the nitrogen outlet is not covered in the scope of supply of the nitrogen generator manufacturer, the electric signal from the signal output interface reserved for the recording equipment is to be measured each time when the oxygen (or nitrogen) content is measured, which is to have a computational relationship with the measured oxygen (or nitrogen) content that conforms to the design document of the manufacturer.

9 Unit/batch inspection

The application for CCS product inspection is permitted only for those products which have passed the manufacturer's inspection/test and proven to be deliverable.

9.1 For unit/batch inspection of products obtaining the type B approval by CCS, the following requirements are to be complied with for inspection items:

(1) The inspection plan ratified at the time of approval is to be complied with but inclusive of, at a minimum, the visual inspection and the test items stipulated in ~~6.8.1~~8.1(1);

(2) For unit/batch inspection after approval, the duration of performance test is to be 2 h;

(3) The above test may be carried out independently by the manufacturer, with a complete test report to be submitted to the Surveyor for approval;

(4) Where the manufacturer has completed all the test items for outgoing products and may provide all test data during the on-site inspection by the Surveyor, the Surveyor may randomly take at least 10% (or 1 unit) from a batch of nitrogen generators per model/specification for re-test of “startup test”, “test of safety production and alarm functions” and “performance test”;

(5) In each application for unit/batch inspection, the quality proof documents and product certificate (if required) of main parts of the batch are to be provided at the same time to the Surveyor for approval.

9.2 Unit/batch inspection of manufactured products not approved by CCS;

(1) The inspection content is to include plan approval and type test;

(2) Plan approval

The manufacturer is to prepare and submit plans/documents as specified in 4.1 and 4.2 of this Guideline to the CCS for approval/information.

(3) Type test

At least one of nitrogen generators for product inspection is to be randomly taken per model to the type test for all items specified in Article 8 of this Guideline;

(4) Nitrogen generators not selected are to be inspected and tested at least according to Article 9.1 of this Guideline.