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Continuous analysers for oxides of nitrogen in ambient air

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law:

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Continuous analysers for oxides of nitrogen in ambient air

1 Scope This Japanese Industrial Standard specifies automatic analysers for measuring continuously concentrations of nitrogen oxides in ambient air (hereafter referred to as "analysers") especially based on absorptimetry or chemiluminescence method.

Remarks: The normative references to this Standard are listed in Attached Table 1.

2 Common matters The common matters shall be according to **JIS K 0055** and **JIS K 0095**.

3 Definitions For the main terms used in this Standard, the following definitions apply, and the rest of the terms are as given in **JIS K 0211**, **JIS K 0212** and **JIS Z 8103**.

- (1) **equivalent solution** A reference solution prepared to obtain the equivalent value in place of calibration gas, and is any following type.
 - (a) equivalent solution for zero adjustment
 - (b) equivalent solution for span adjustment
 - (c) equivalent solution for mid-point
- (2) **zero drift** Indication drifting in a certain period relating to the minimum scale value of analyser.
- (3) **span drift** Indication drifting in a certain period corresponding to the scale span of analyser.
- (4) **zero gas** A gas used for calibrating the minimum graduation of analyser.
- (5) **span gas** A gas used for calibrating the maximum graduation of analyser.
- (6) **regulated flow rate** A flow rate of sample ambient air, calibration gas and the like, specified for the analyser.
- (7) **absorbent solution** A solution of Saltzman reagent, that colors on absorbing nitrogen dioxide.
- (8) **converter** An apparatus that converts nitrogen dioxide into nitrogen monoxide.
- (9) **ozone source gas** Oxygen or a gas containing oxygen for generating ozone.
- (10) **flow-path changeover system** A system in which flow-paths of one passing through the converter and another not passing are connected to a reaction tank via switch valve, and samples from the respective flow-paths are flown alternately into the reaction tank combined with a detector. It is also called "one-cell one-tube system".
- (11) **light-path changeover system** A system in which the respective chemiluminescences in both flow-paths of one passing through the converter and another not passing are led alternately into one detector with a chopper. It is also called "two-cell one-tube system".

- (12) **two-flow-path two-light-path system** A system in which flow-paths of one passing through the converter and another not passing are connected to detector combined reaction tanks respectively. It is also called "two-cell two-tube system".

Informative reference: The safety control of hi-pressure gas shall be according to Hi-pressure Gas Safety Law (1st April, 1997) and Guidance for hi-pressure gas control at continuous monitoring ambient air (Atmospheric Measurement Safety Committee, Environment Agency, Oct. 1973).

4 Classification of analyser Analysers shall be classified by the principle, and the measuring ranges (hereafter referred to as "ranges") as given in Table 1. Each range of the analyser shall be determined suitably between the upper and lower limits shown in Table 1.

Table 1 Classification and range of analyser

Type of analyser	Range volppm ⁽¹⁾	Remarks
Absorptiometry	0 to 0.1–0 to 1.0	The recording results draw a saw teeth shape, which each top point, as the maximum value will appear at the air passing end of each measuring cycle, shows the mean value per 1 h of concentration of nitrogen oxides in the sample air.
Chemiluminescence method	0 to 0.1–0 to 10	The instantaneous values of concentration of nitrogen oxides in the sample air will be indicated and recorded continuously.

Note ⁽¹⁾ The ranges divided suitably by the objects are prepared between this total range.

5 Rated voltage and frequency The rated voltage of analysers shall be single-phase AC 100 V, and the frequency shall be for 50 Hz only, 60 Hz only, or common to 50 Hz and 60 Hz.

6 Performance Analysers, when tested by the methods of clause 8, shall conform to the performances given in Tables 2 and 3.

Table 2 Performance of absorptiometry type

Item	Performance	Test method
Repeatability	±2 % of maximum scale value	8.4.1 (1) (a)
Zero drift	±2 % of maximum scale value	8.4.1 (1) (b)
Span drift	±2 % of maximum scale value	8.4.1 (1) (c)
Indication error	±4 % of maximum scale value	8.4.1 (1) (d)
Stability of sample air flow rate	±7 % of regulated flowrate	8.4.1 (3) (b)
Stability of collecting absorbent solution	±4 % of regulated volume	8.4.1 (3) (c)

Table 2 (concluded)

Item	Performance	Test method
Indication stability to voltage variation	± 1 % of maximum scale value	8.4.1 (1) (e)
Stability of sample air flow rate to voltage variation	± 4 % of regulated flow rate	8.4.1 (3) (a)
Nitrogen dioxide collecting rate	97 % min.	8.4.1 (2) (a)
Nitrogen monoxide oxidizing rate	60 % min.	8.4.1 (2) (b)
Withstanding voltage	Not to cause abnormalities	8.4.1 (3) (d)
Insulation resistance	2 M Ω min.	8.4.1 (3) (e)

Table 3 Performance of chemiluminescence method type

Item	Performance	Test method
Repeatability	± 2 % of maximum scale value	8.4.2 (1)
Zero drift	± 2 % of maximum scale value	8.4.2 (2)
Span drift	± 4 % of maximum scale value	8.4.2 (3)
Indication error	± 4 % of maximum scale value	8.4.2 (4)
Response time	4 min max.	8.4.2 (5)
Effect of interfering substance	5 % of maximum scale value max.	8.4.2 (8)
Stability to voltage variation	± 2 % of maximum scale value	8.4.2 (10)
Converter efficiency	95 % min.	8.4.2 (6)
Ammonia conversion limit of converter	5 % max.	8.4.2 (7)
Stability to ambient temperature variation	5 °C max.	8.4.2 (9)
Withstanding voltage	Not to cause abnormalities	8.4.2 (11)
Insulation resistance	2 M Ω max.	8.4.2 (12)

7 Construction

7.1 General Analysers shall be constructed to conform to the following provisions:

- (1) The shape to be correct, the assembly and the finishing of each part to be well-done, and to be durable.
- (2) To be free from concern of dangers on normal operation, to work safely and smoothly.
- (3) Every part shall not be so constructed as cause easily mechanical or electrical defect or dangerous state.
- (4) To be constructed so that the analyser will not be affected by dew drop and the like.

- (5) The parts contacted with such heating devices as lighting source, heater and the like shall be constructed to prevent deformation and functional defect by the temperature.
- (6) To be constructed to allow easy work for maintenance or inspection without danger.

7.2 Analyser

7.2.1 Absorptiometry system A system to measure simultaneously and continuously the nitrogen monoxide and nitrogen dioxide contained in the sample ambient air by the principle of absorptiometry using an absorbent solution (of Saltzman reagent).

Passing the sample air at a certain flow rate for a definite time through a definite volume of absorbent solution (mixed solution of *N*-1-naphthyl ethylene diamine dichlorate, sulfanilic acid and glacial acetic acid) to be absorbed nitrogen dioxide, and measuring the absorbance of the absorbent solution, the concentration of nitrogen dioxide in the sample air shall be determined continuously. As nitrogen monoxide does not react to the absorbent solution, it shall be measured, after transforming into nitrogen dioxide with an oxidizing agent (solution of potassium permanganate acidified by sulphuric acid), in a similar way as for nitrogen dioxide.

The absorptiometry type analyser shall be constituted of a filter, flowmeter, nitrogen dioxide absorber, oxidizing bottle, nitrogen monoxide absorber, sample air suction pump, absorbent solution tank, absorbance measuring instrument, amplifier programmer, indicating recorder, etc., as shown in Fig. 1. The nitrogen dioxide absorber, oxidizing bottle and nitrogen monoxide absorber shall be arranged in series, and the temperatures of those absorbing parts shall be kept at 20 °C or above. The principal piping from the sample air inlet to the nitrogen monoxide absorber through which the sample air passes shall be made of such materials, which absorb and resolve less nitrogen oxides, as polytetrafluoroethylene or glass.

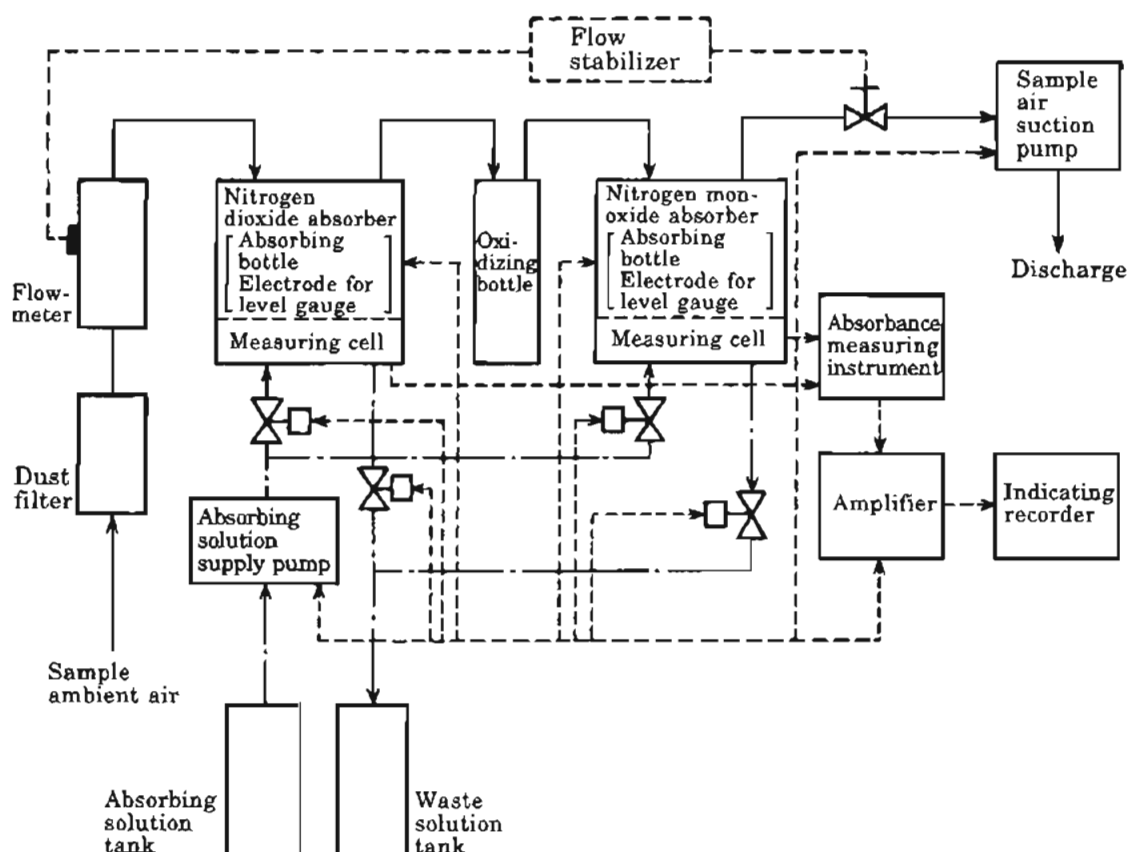


Fig. 1 Constitution of nitrogen oxides analyser of absorptiometry system (an example)

- (1) **Sample air inlet** Part to be connected with the sample air inlet tube, which allow to be connected with an inlet tube of 6 mm to 8 mm in inner diameter.
- (2) **Dust filter** Device to remove the dust contained in the sample air, which is made of such material absorbable less nitrogen oxides as polytetrafluoroethylene.
- (3) **Flowmeter** As the variation of the sampling air flow rate will cause measurement error, a flowmeter is required to adjust and confirm the flow rate. The flowmeter for this system shall be graduated for a design temperature of 20 °C and a design pressure of 101.3125 kPa, provided with the maximum scale 1.2 times to 2 times the regulated flow rate, and accurated to conform to the specifications of clause 3 (Measuring principle) of JIS Z 8761.
- (4) **Sample air suction pump** A pump used for flowing the sample air, which is located generally behind the absorbing bottle. The pump shall have an enough suction force to retain the regulated flow rate even through the air-passing resistance is increased due to a clogging of the dust filter. The material quality of the parts to be connected with gases shall not be so that corroded by the absorbent solution or acetic acid evaporated from the solution.
- (5) **Nitrogen dioxide absorber** To be constituted of an absorbing bottle, electrode for level gauge and measuring cell, etc., as shown in Fig. 2, and to conform to the following provisions. For collection of nitrogen dioxide, after holding the absorbent solution with the level gauge, introduce the sample air in bubbling state into the absorbing bottle to gather the nitrogen dioxide contained in the air into the absorbent solution.

- (a) **Absorbing bottle** A bottle in which a definite quantity of absorbent solution is held to absorb nitrogen dioxide and colour, through the sample air passing.
- (b) **Electrode for level gauge** To function as a detector for taking the absorbent solution by a regulated quantity.
- (c) **Measuring cell** A cell for measuring the absorbance of absorbent solution, which is constructed either integrated with or independent of the absorbing bottle.
- (6) **Oxidizing bottle** Part for oxidizing the nitrogen monoxide in the sample air into nitrogen dioxide, which is a glass bottle holding 1 l of oxidizing agent as shown in Fig. 3.
- (7) **Nitrogen monoxide absorber** Part for gathering the nitrogen dioxide oxidized in the oxidizing bottle, of which the construction and the performance are similar to the nitrogen dioxide absorber.
- (8) **Absorbent solution tank** To be made of a material not corroded by the absorbent solution, and not affect the solution quality.
- (9) **Absorbent solution supply pump** Device to supply the absorbent solution stored in the tank to the nitrogen dioxide absorber and the nitrogen monoxide absorber within a specified time, of which the material quality shall not be corroded by the absorbent solution and not change the solution in quality.
- (10) **Absorbance measuring instrument** An instrument for measuring the absorbance of absorbent solution coloured by nitrogen dioxide with a light near 545 nm in wavelength, which is constituted of a light source, measuring wavelength filter, photoelectric element, etc.
 - (a) **Light source** To use a tungsten lamp or such a source irradiating selectively a light of near 545 nm in wavelength as a semiconductor element.
 - (b) **Measuring wavelength filter** A filter, utilized absorption of specific wavelength band or interference on multilayer film, for main wavelength of near 545 nm, which is required for such light source irradiating wide wavelength band as a tungsten lamp.
 - (c) **Photoelectric element** To use such that capable of stable, photoelectric conversion of light of 545 nm in wavelength as a photoelectric tube and semiconductor photometric conversion element.
- (11) **Amplifier programmer** To have such functions as to convert the photoelectrically converted signal into an electric-signal of necessary level for indication recording, and as to send signal to each component and automatically repeat the following operations according to the specified programme. The measuring cycle shall be 1 h, and the air-passing time shall not be less than 54 min.
 - (a) Taking and discharge of absorbent solution
 - (b) Beginning and stopping of sample air passing
 - (c) Beginning and stopping of absorbance measurement
 - (d) Automatic zero adjustment
 - (e) Automatic switch range
 - (f) Others

(12) **Accessory device** Analyzers may be appended to the following device.

- (a) **Flow rate stabilizer** Device stabilizing the sample air flow rate of which the performance shall be capable of keeping stability of the sample air flow rate at within $\pm 3\%$ through 10 days.

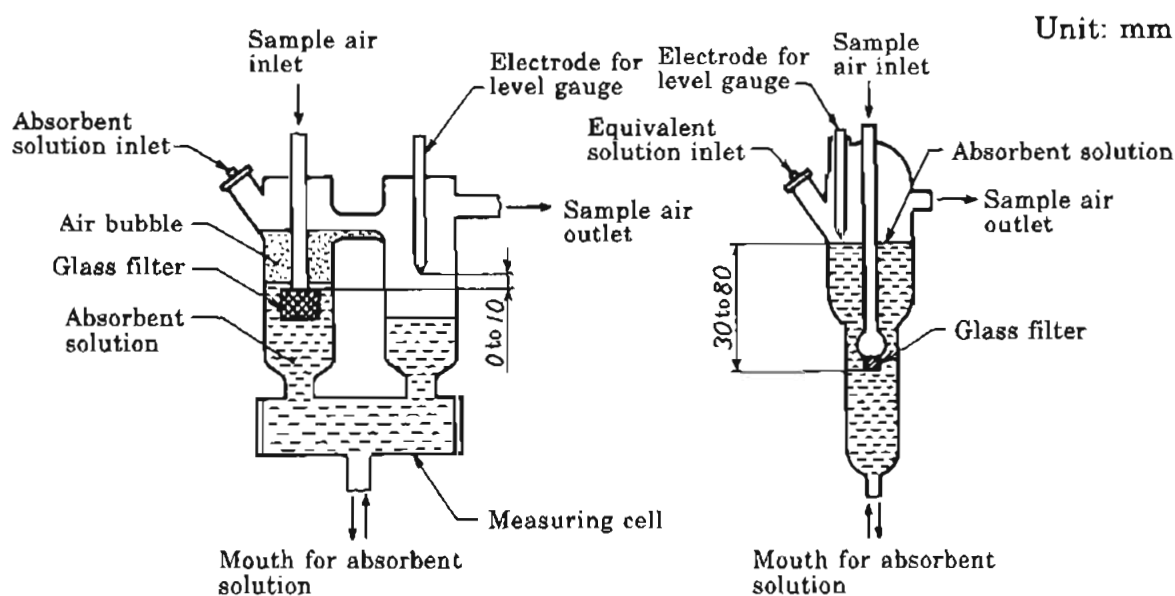


Fig. 2 Nitrogen dioxide absorber (an example)

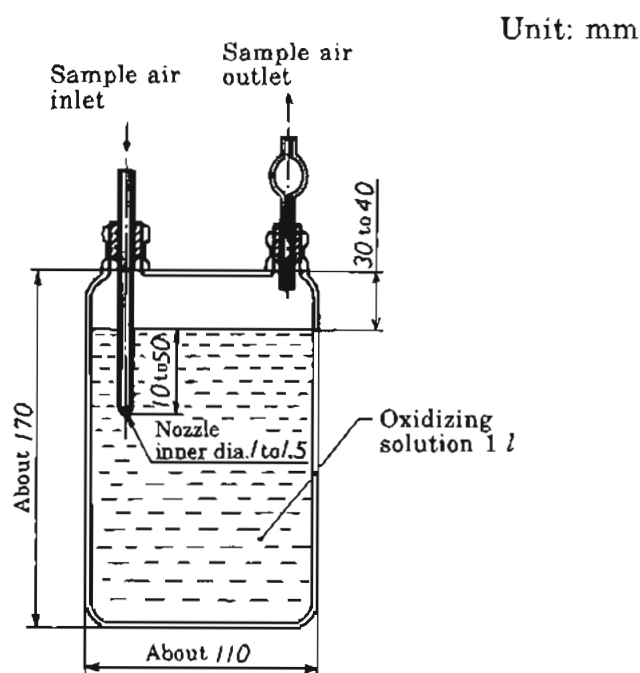


Fig. 3 Oxidizing bottle