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(JRMA/JSA)

**Rubber, vulcanized or
thermoplastic—Determination of
ozone resistance—Part 2:
Determination of the ozone
concentration**

ICS 83.060

Reference number : JIS K 6259-2 : 2015 (E)

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by The Japan Rubber Manufacturers Association (JRMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

JIS K 6259 series consists of the following 2 parts under the general title “*Rubber, vulcanized or thermoplastic—Determination of ozone resistance*”:

Part 1: Static and dynamic strain testing

Part 2: Determination of the ozone concentration

Rubber, vulcanized or thermoplastic— Determination of ozone resistance— Part 2: Determination of the ozone concentration

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **ISO 1431-3** published in 2000 with some modifications of the technical contents.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JB.

1 Scope

This Standard specifies the methods for the determination of ozone concentration in test chamber.

Moreover, this Standard is applied to three types of method such as the ultraviolet absorption method (Measuring method A), the instrumental method (Measuring method B) and the wet chemical method (Measuring method C). However, the ultraviolet absorption method is the reference method for the calibration of ozone concentration and used for the calibration of the instrumental method and the wet chemical method.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 1431-3:2000 *Rubber, vulcanized or thermoplastic—Resistance to ozone cracking—Part 3: Reference and alternative methods for determining the ozone concentration in laboratory test chambers* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21-1**.

WARNING Persons using this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 6259-1 *Rubber, vulcanized or thermoplastic—Determination of ozone resistance—Part 1: Static and dynamic strain testing*

NOTE : Corresponding international Standard: ISO 1431-1 *Rubber, vulcanized or thermoplastic—Resistance to ozone cracking—Part 1: Static and dynamic strain testing (MOD)*

JIS K 8001 *General rule for test methods of reagents*

JIS K 8637 *Sodium thiosulfate pentahydrate (Reagent)*

JIS K 8913 *Potassium iodide (Reagent)*

JIS K 9007 *Potassium dihydrogen phosphate (Reagent)*

JIS K 9019 *Disodium hydrogenphosphate dodecahydrate (Reagent)*

3 Principle

An ozone/air mixture is sampled from an ozone exposure chamber and the ozone concentration is determined by the ultraviolet absorption method, instrumental or wet chemical methods. The instrumental or wet chemical methods shall be calibrated against the ultraviolet absorption method.

Classification and method for ozone concentration measuring method are shown in Table 1.

Table 1 Classification and method for ozone concentration measuring method

Measuring method	Title	Method
Ultraviolet absorption method (Measuring method A)	—	Method using ultraviolet absorption photometer
Instrumental method (Measuring method B)	Measuring method B1	Electrochemical method
	Measuring method B2	Chemiluminescence
Wet chemical method (Measuring method C)	Measuring method C1	Iodine method
	Measuring method C2	Modified iodine method
	Measuring method C3	Chronopotentiometry

4 Ozone concentration measurement device

The ozone concentration measurement device shall be one of the following types.

Any of these apparatus shall be calibrated against the ultraviolet absorption method.

- Ultraviolet absorption photometer** The ultraviolet absorption photometer shall be in accordance with **6.1**. The ultraviolet absorption photometer shall be capable of measuring the ozone concentration specified in **JIS K 6259-1**.
- Apparatus for electrochemical method** The apparatus used for the electrochemical method shall be in accordance with **B.1**.
- Apparatus for chemiluminescence** The apparatus used for the chemiluminescence method shall be in accordance with **B.2**.
- Apparatus for wet chemical method** The apparatus used for the wet chemical method shall be in accordance with Annex C.

5 Calibration

The calibration of the ultraviolet absorption photometer shall be in accordance with Annex JA.

For the calibration of the apparatus used for the electrochemical method, chemiluminescence and wet chemical method, the ozone generator of **JA.1.1.1 b)** in Annex JA shall be used. The calibration apparatus of ultraviolet absorption ozone concentration and the apparatus to be calibrated are connected to the ozone generator and the calibration shall be carried out.

6 Measuring method

6.1 Measuring method A (Ultraviolet absorption method)

The ultraviolet absorption method shall be as follows.

- a) **Principle** Generate the ultraviolet radiation centred on 253.7 nm by a low pressure mercury discharge lamp and radiate it to the ultraviolet absorption cell through which the air containing ozone passes, to measure the ozone concentration. The ultraviolet radiation which passes through the absorption cell is measured by a photo detector and converted to an electrical signal. Absorption of the ultraviolet radiation by the air containing the ozone within the absorption cell is a measure of the ozone concentration.

The Beer-Lambert law on light absorption is used to relate the measured ultraviolet transmittance to the path length of the absorption cell, the ozone absorption coefficient at 253.7 nm and the ozone concentration. Formula (1) gives this relationship.

$$A = \frac{I}{I_0} = \exp(-aCd) \dots\dots\dots (1)$$

where, A : ultraviolet transmittance
 I : ultraviolet transmittance of air containing ozone
 I_0 : ultraviolet transmittance of air containing no ozone
 a : ozone absorption coefficient at 253.7 nm ($\text{m}^2/\mu\text{g}$)
 ($a = 1.44 \times 10^{-5} \text{ m}^2/\mu\text{g}$)
 C : mass concentration of ozone at the temperature and pressure of air in the ultraviolet absorption cell ($\mu\text{g}/\text{m}^3$)
 d : optical pass length (m)

- b) **Apparatus** For the apparatus, the automatic ozone concentration measuring and controlling apparatus composed of the ultraviolet absorption cell, low pressure mercury discharge lamp, compensatory photo detector, zero gas filter, sampling pump, air flow controller, flow meter, temperature indicator, pressure gauge and the like shall be used. An example is shown in Figure 1.
- c) **Operation method** The operation method shall be as follows.

- 1) Pass the air containing ozone through the dust filter by sampling pump from the ozone test chamber, then pass it through the ultraviolet absorption cell.
- 2) Read out the ozone concentration (ppb) on the digital display or recorder.

NOTE : For the ozone concentration in the unit of ppb, there is the relation in which the volume rate 1.0×10^{-9} at 101.3 kPa is $2.141 \mu\text{g}/\text{m}^3$ at 0°C , $1.995 \mu\text{g}/\text{m}^3$ at 20°C and $1.962 \mu\text{g}/\text{m}^3$ at 25°C . The ozone concentration (ppb) at the temperature and pressure of the air containing ozone in absorption cell is automatically calculated by operation circuit, adjusted to the specified ozone concentration and, at the same time, is indicated on digital display or recorder.

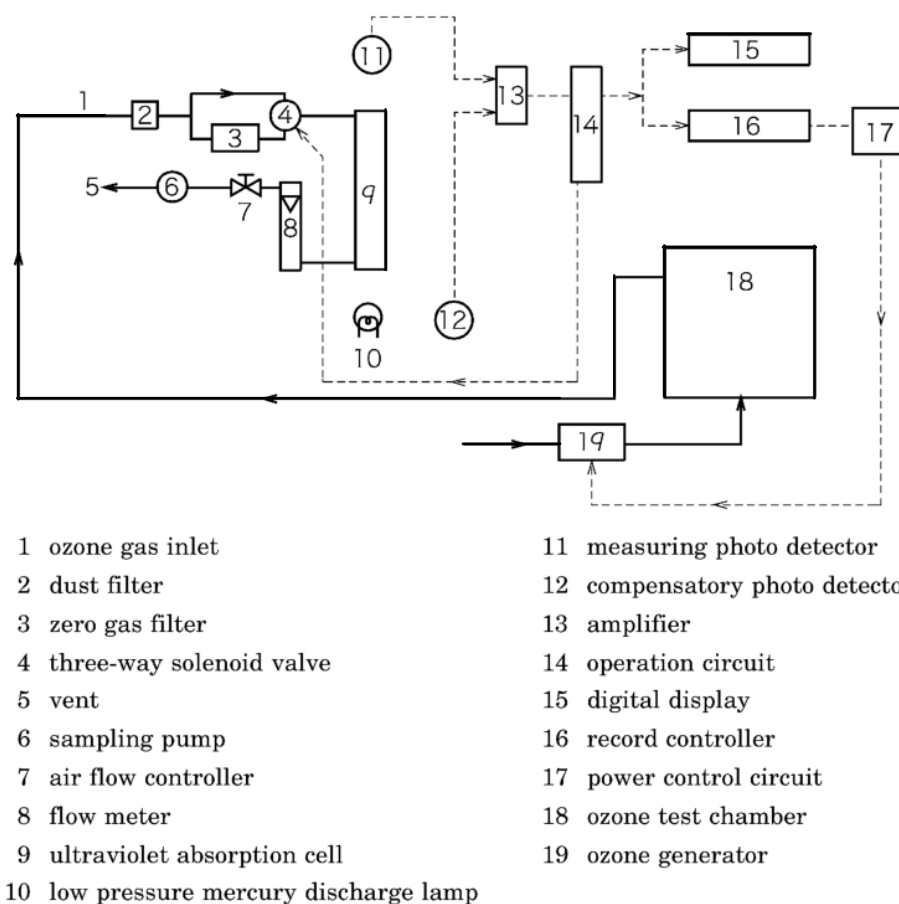


Figure 1 Example of ozone concentration measuring and controlling apparatus for ultraviolet absorption method

6.2 Measuring method B (Instrumental method)

The measuring method B1 (Electrochemical method) and the measuring method B2 (Chemiluminescence) shall be in accordance with Annex B. The instrumental method shall be in accordance with the manufacturer's instructions, attention being paid in particular to initial setting up, zero adjustment and maintaining and checking the instrument.

6.3 Measuring method C (Wet chemical method)

The measuring method C1 (Iodine method), the measuring method C2 (Modified iodine method) and the measuring method C3 (Chronopotentiometry) shall be in accordance with Annex C.

7 Expression of results

Generally, the ozone concentration ($\varphi_{0,3}$) is expressed in ppb or pphm. However, the ozone concentration may also be expressed in mg/m^3 or in mPa. The ozone concentration expressed in mg/m^3 depends on both pressure and temperature (see Annex A).

The formulae for the conversion of unit shall be the following (2) and (3).

$$C = 5.78 \times 10^{-3} \times \frac{P}{T} \times \varphi_{0,3} \dots\dots\dots (2)$$

where, C : ozone concentration corrected by atmospheric pressure (mg/m^3)

$\varphi_{0,3}$: ozone concentration (ppb)

P : atmospheric pressure (hPa)

T : absolute temperature (K)

Expressed by the partial pressure of ozone,

$$p_{0,3} = 10^{-2} P \varphi_{0,3} \dots\dots\dots (3)$$

where, $p_{0,3}$: partial pressure of ozone (mPa)

P : atmospheric pressure (hPa)

$\varphi_{0,3}$: ozone concentration (ppb)

8 Test report

The test report shall contain the following information.

- a) Reference to this Standard (**JIS K 6259-2**)
- b) Apparatus used
- c) Measurement interval (if measurement was not continuous)
- d) Ozone concentration or range of concentrations measured (ppb, pphm, mg/m^3 or mPa), pressure of air containing ozone, if necessary by a calibration factor
- e) Date of the test

Annex A (informative)

The relation between the partial pressure of ozone and concentration

The rate of reaction of ozone with vulcanized or thermoplastic rubber, i.e. the cracking rate, is a function of the rate of collision of the ozone molecules with the rubber surface. And it is therefore a function of the number of ozone molecules present, all other factors being constant.

The perfect-gas equation and Dalton's law permit the partial pressure of ozone (p_{O_3}) to be calculated as a function of the number of moles of ozone (n_{O_3}) in volume (V) of the ozone/air mixture, measured at temperature (T). The relation is shown in following formula (A.1).

$$p_{O_3} = \frac{n_{O_3}RT}{V} \dots\dots\dots (A.1)$$

where, p_{O_3} : partial pressure of ozone (mPa)

n_{O_3} : number of moles of ozone (mol)

T : temperature (K)

V : volume of test chamber (m³)

R : gas constant ($R=8.314 \text{ Pa} \cdot \text{m}^3 \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$)

NOTE : Under standard conditions of temperature (273 K) and pressure (1 013 hPa),
1 ppm = 0.101 mPa.

It can be demonstrated that, for the same ozone content, by volume, of the ozonized air, measured at the same temperature but at different atmospheric pressures, the partial pressure of ozone and the number of moles of ozone vary in the same ratio as the atmospheric pressure.

The results of an interlaboratory test programme conducted in North America prove the effect of ambient pressure on the cracking rate at a constant volumetric ozone content.

Therefore, the expression of the ozone concentration in laboratory test chambers on a volume per volume basis is inappropriate where differences in atmospheric pressure are likely to exist.