

JAPANESE  
INDUSTRIAL  
STANDARD

Translated and Published by  
Japanese Standards Association

---

JIS B 9929 : 2006

(JACA/JSA)

**Standard for measuring methods of  
airborne ion density**

---

ICS 13.040.35:17.060

Reference number : JIS B 9929 : 2006 (E)

PROTECTED BY COPYRIGHT

## 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 of establishing a Japanese Industrial Standard based on a non-national standard (JACA No. 39) from Japan Air Cleaning Association (JACA)/Japanese Standards Association (JSA), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 2006-11-20

Date of Public Notice in Official Gazette: 2006-11-20

Investigated by: Japanese Industrial Standards Committee

Standards Board

Technical Committee on Industrial Machinery

---

JIS B 9929 : 2006, First English edition published in 2007-03

Translated and published by: Japanese Standards Association  
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

---

In the event of any doubts arising as to the contents,  
the original JIS is to be the final authority.

© JSA 2007

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

## Contents

|                       |                                                                                                              | Page |
|-----------------------|--------------------------------------------------------------------------------------------------------------|------|
| 1                     | Scope .....                                                                                                  | 1    |
| 2                     | Normative reference .....                                                                                    | 1    |
| 3                     | Terms and definitions .....                                                                                  | 1    |
| 4                     | Types and classification of measuring methods of airborne ion .....                                          | 2    |
| 4.1                   | Measuring method and classification of airborne ion density .....                                            | 2    |
| 4.2                   | Measuring method and classification relating to the evaluation of amount generated by the ion generator..... | 2    |
| 5                     | Measuring method of airborne ion.....                                                                        | 3    |
| 5.1                   | Measuring method of airborne ion density .....                                                               | 3    |
| 5.2                   | Measuring method relating to evaluation of the generated amount by the ion generator .....                   | 5    |
| 6                     | Preparation of report .....                                                                                  | 9    |
| Annex 1 (informative) | Airborne ion density measuring device .....                                                                  | 12   |
| Annex 2 (informative) | Method for evaluation of the removal effect of electricity f an ionizer with the charged plate monitor ..... | 19   |
| Annex 3 (informative) | Method for generation of airborne ion.....                                                                   | 21   |
| Annex 4 (informative) | A relationship between life span of ions and aerosol concentration.....                                      | 23   |
| Annex 5 (informative) | A laminar flow test method within a condenser at a time of designing .....                                   | 25   |

## Standard for measuring methods of airborne ion density

**1 Scope** This Japanese Industrial Standard specifies measuring methods of airborne ion density and the amount of ion generated with an ion generator.

In addition, the device for measuring airborne ion density is described in Annex 1 (informative).

**2 Normative reference** The following standard contains provisions which, through reference in this text, constitute provisions of this Standard. The most recent edition of the standard (including amendments) indicated below shall be applied.

JIS B 9920 *Classification of air cleanliness for cleanrooms*

**3 Terms and definitions** For the purposes of this Standard, the following definitions apply:

- a) **coaxial dual cylindrical ion density measuring device** a device with both ends of a coaxial dual cylindrical air condenser opened to aerate a sample air, which can apply voltage on either one electrode on the inner or outer part of the cylinder and collect voltage on the other electrode

It is also referred to as Gerdien condenser type ion density measuring device.

- b) **parallel flat plate ion density measuring device** a device with both ends of a flat plate air condenser opened to aerate a sample air, which can apply voltage on one electrode and collect voltage on the other electrode
- c) **laminar flow** an air flow containing no temporally and spatially irregular fluctuation, where each part of fluids moves parallel to the axis of cylinder or the flat plate and Poiseuille flow is realized
- d) **uniform environmental conditions** environment conditions without irregular fluctuations of factors specifying environment, such as temperature, relative humidity, atmospheric pressure and aerosol concentration

The others are referred to as non-uniform environment.

- e) **blowing out flow volume** the amount of air flow blowing out to the external environment from the measuring part of the test apparatus for evaluation of ion generated amount to be used, which depends on the capacity of air blasting part of the test apparatus for evaluation of ion generated amount
- f) **airborne ion density** number density of marginal mobility or over of positive and negative ions to be measured, which is expressed in /m<sup>3</sup>
- g) **ion generator** an apparatus for continuous generation of ions in the air, which has the various generating methods such as a method by using electric discharge or a method by using radiation (see Annex 3)

- h) **mobility of ion** the moving rate of ions in a unit electric field, whose amount is expressed with  $k$  and is expressed in  $\text{m}^2/(\text{V} \cdot \text{s})$

If the electric field is expressed with  $E$  ( $\text{V}/\text{m}$ ) and the average mobility in the field is expressed with  $v$  ( $\text{m}/\text{s}$ ), then the mobility is expressed with  $k = v / E$ .

- i) **marginal mobility** a minimum mobility capable of being measured with the ion density measuring device, which generally means the mobility when the ions flowing into one inlet surface reaches to the posterior end of the other collector electrode

#### 4 Types and classification of measuring methods of airborne ion

**4.1 Measuring method and classification of airborne ion density** This method is used for establishment and evaluation of ion density in the space to be tested through measuring the airborne ion density in the space. It is the method to choose the appropriate number of measuring points in the space to be tested and evaluate the airborne ion density in the space to be tested with average values of each measuring point.

In addition, the evaluation of airborne ion density shall be classified into the following classes based on the ion density measured according to the measuring method of airborne ion density as specified in 5.1.

|                     |                                                                                          |
|---------------------|------------------------------------------------------------------------------------------|
| Ion density class 1 | $10^1 \times 10^6 / \text{m}^3$ or over to and excluding $10^2 \times 10^6 / \text{m}^3$ |
| Ion density class 2 | $10^2 \times 10^6 / \text{m}^3$ or over to and excluding $10^3 \times 10^6 / \text{m}^3$ |
| Ion density class 3 | $10^3 \times 10^6 / \text{m}^3$ or over to and excluding $10^4 \times 10^6 / \text{m}^3$ |
| Ion density class 4 | $10^4 \times 10^6 / \text{m}^3$ or over to and excluding $10^5 \times 10^6 / \text{m}^3$ |
| Ion density class 5 | $10^5 \times 10^6 / \text{m}^3$ or over to and excluding $10^6 \times 10^6 / \text{m}^3$ |
| Ion density class 6 | $10^6 \times 10^6 / \text{m}^3$ or over                                                  |

**4.2 Measuring method and classification relating to the evaluation of amount generated by the ion generator** This is the method to find total amount of the positive and negative ions generated by the ion generator, and establish and evaluate the total generated amount.

In addition, the evaluation of ion generated amount is classified into the following classes based on the ion density measured according to the measuring method relating to evaluation of the amount of ion generated by the ion generator as specified in 5.2.

|                              |                                                                                                                            |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Ion generated amount class 1 | $10^1 \times 10^6 / (\text{m}^3 \cdot \text{s})$ or over to and excluding $10^2 \times 10^6 / (\text{m}^3 \cdot \text{s})$ |
| Ion generated amount class 2 | $10^2 \times 10^6 / (\text{m}^3 \cdot \text{s})$ or over to and excluding $10^3 \times 10^6 / (\text{m}^3 \cdot \text{s})$ |
| Ion generated amount class 3 | $10^3 \times 10^6 / (\text{m}^3 \cdot \text{s})$ or over to and excluding $10^4 \times 10^6 / (\text{m}^3 \cdot \text{s})$ |
| Ion generated amount class 4 | $10^4 \times 10^6 / (\text{m}^3 \cdot \text{s})$ or over to and excluding $10^5 \times 10^6 / (\text{m}^3 \cdot \text{s})$ |
| Ion generated amount class 5 | $10^5 \times 10^6 / (\text{m}^3 \cdot \text{s})$ or over to and excluding $10^6 \times 10^6 / (\text{m}^3 \cdot \text{s})$ |
| Ion generated amount class 6 | $10^6 \times 10^6 / (\text{m}^3 \cdot \text{s})$ or over                                                                   |

However, any air flow amount blowing out (m<sup>3</sup>/s) from the measuring part at the time of evaluation shall be described when the generator is evaluated according to the units mentioned above.

## 5 Measuring method of airborne ion

### 5.1 Measuring method of airborne ion density

**5.1.1 Setup of the measuring points and height** Setup of measuring points and height shall be as follows.

- a) **Setup of the measuring points** The measurement shall be carried out at the same point whether under uniform environmental conditions or under non-uniform ones. In the case of the measuring points within a limited space (sample air inlet), calculate minimum values for the measuring points according to an equation (1) and measure the airborne ion density in the centre of the floor surface divided by the measuring points.

$$MP = \sqrt{A} \dots\dots\dots(1)$$

where, *MP* : minimum value for the measured points, provided that fractional figure shall be omitted

*A* : total floor area of the space to be tested (m<sup>2</sup>)(<sup>1</sup>)

Note(<sup>1</sup>) : This means the area of the space without partitions. In the case of the space with partitions, it shall be separately treated as a new space to be tested.

However, when the measuring points exceed 20, some points may be suitably omitted.

NOTE : When the ion generator is attached to the side wall in the space to be tested and the generated ions are transported with a constant flow rate, a vertical sectional area to the wind shall be replaced for the total floor area *A*.

- b) **Height for measurement** The height for measurement points (sample air inlet) shall be of the working area within 0.6 m to 1.5 m above the floor surface of environmental space to be tested.

**5.1.2 Preparation for measurement (confirmation of ground and setup of marginal mobility, etc.)** The preparation for measurement shall be as follows.

- a) **Confirmation of ground** Confirm ground of the ion density measuring device not so as to generate an induction electric current at a collective electrode of the coaxial dual cylindrical or the parallel flat plate ion density measuring device due to the changes of an external electric field before the start of measurement.
- b) **Setup of an ion saturated density curve and the marginal mobility** The marginal mobility shall be set up based on the ion saturated density curve. (See Annex 1 for the setup method of the marginal mobility based on the ion saturated density curve.)

- c) **Confirmation of the laminar flow** As for the sample collecting flow volume to be set up, sample air flow volume of the inside of the coaxial dual cylindrical or the parallel flat plate condenser shall be confirmed to be within the confirmed laminar flow at the time of designing in accordance with calculation of Reynolds' number or by measurement (see Annex 5).

**5.1.3 Measurement** The measurement shall be carried out using the airborne ion density measuring device. (See Annex 1 for the airborne ion density measuring device).

- a) **Uniform environmental conditions** Under uniform environmental conditions, if temporal fluctuation in the airborne ion density is minor, the measurement immediately after preheating time of the measuring device may be performed.
- b) **Non-uniform environmental conditions** Under non-uniform environmental conditions, the measurement shall be carried out in consideration of temporal and spatial representativeness.
- c) **Sample collecting flows volume and number of measurements** As for measurement at measurement points to be set up, the total sample collecting flow volume should be  $0.5 \text{ m}^3$  or over and the number of measurement (number of sampling) should be five times or over.
- d) **Measurement of airborne ion density** The positive and negative airborne ion densities  $N$  (/m<sup>3</sup>) shall be established according to an equation (2) with electric current measured according to a fall of potential method.

$$N = \frac{1}{1.6 \times 10^{-19}} \cdot \frac{I}{\Phi}, \text{ provided that } I = \frac{V}{R} \dots\dots\dots(2)$$

where,  $I$ : an electric current value (A) flowing into a potential meter through a high resistance from an ion collecting condenser

$V$ : indicated voltage by the potential meter (V)

$R$ : input high resistance value ( $\Omega$ )

$\Phi$ : sample collecting flow volume (m<sup>3</sup>/s)

Elementary charge volume :  $1.6 \times 10^{-19}$  (C)

In the case of calculating inflow electric current value based on the potential measurement according to a charge storage method, the calculation shall be in accordance with an equation (3).

$$N = \frac{1}{1.6 \times 10^{-19}} \cdot \frac{I}{\Phi}, \text{ provided that } I = \frac{CV}{t} \dots\dots\dots(3)$$

where,  $C$ : electrostatic capacity intrinsic to the electrometer (F)

$t$ : interval of measuring time (s)

- e) **Calculation of average ion density at all measurement points** The average positive and negative ion densities  $\overline{N}_i$  (/m<sup>3</sup>) at measurement point  $i$  shall be calculated in accordance with an equation (4).

$$\overline{N}_i = \frac{1}{n} \sum_{j=1}^{j=n} N_{i,j} \dots\dots\dots(4)$$

where,  $N_{i,j}$ : ion density for  $j$ th measurement at measurement point  $i$  (/m<sup>3</sup>)

$n$ : number of measurement at measurement point  $i$

Average positive and negative ion densities  $\overline{N}$  (/m<sup>3</sup>) for all spaces to be tested shall be in accordance with an equation (5).

$$\overline{N} = \frac{1}{Z} \sum_{i=1}^{i=Z} \overline{N}_i \dots\dots\dots(5)$$

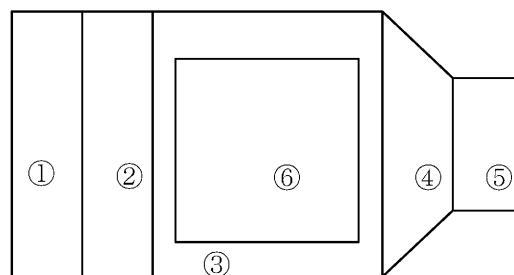
where,  $Z$ : number of measuring points for the space to be tested

**5.1.4 Evaluation of airborne ion density** The average evaluation of airborne ion density shall be performed according to the total average ion density values using airborne ion density partitions. The temporal and spatial condition evaluations of airborne ion densities shall be performed for items of total average density values, maximum density values and minimum density values.

**5.1.5 Method for indication of measured results of airborne ion density** Preparation of a report for the measured results of airborne ion density shall be in accordance with clause 6.

## 5.2 Measuring method relating to evaluation of the generated amount by the ion generator

**5.2.1 Configuration of the measuring apparatus for evaluation** The measuring apparatus consists of an air blower part, an air filter part, a setup site of the ion generator, a contracted flow mixing part and a measuring part as shown in figure 1.



- ① air blower, ② air filter, ③ setup site of the ion generator,  
④ contracted flow mixing part, ⑤ measuring part, ⑥ opening with an air-tight door

**Figure 1** An example of configuration of a measuring apparatus for evaluation of the ion generated amount

**5.2.2 Construction of measuring apparatus** The construction of measuring apparatus shall be as follows.

- a) **General construction** The inner surface of the test apparatus shall be flat, difficult to be charged and have small surface resistance capable to be grounded, and made from materials which are no self-generation of ion, and the construction shall be designed so as not to cause any influence on the ion measurement.
- b) **Air blower part** The air blower part shall have an air blowing construction capable to supply sufficiently over the blowing out flow volume for the sample collecting flow volume at the measuring part, and shall have a construction capable to adjust the flow volume as specified in 5.2.3 e).
- c) **Air filter part** The air filter part is a part to clarify air supplied to the set place of ion generator and HEPA or ULPA shall be used for the setup filter. The air cleanliness of the measuring part shall be within the cleanliness of at least cleanliness class 5 as specified in JIS B 9920 regardless of the air quality at the upper stream of the filter.
- d) **Setup site of the ion generator** The dimensions of setup site of the ion generator shall be sufficiently large to be operated under the same conditions as the ion generator is actually used. In addition, an air-tight door shall be prepared to set up the ion generator within the apparatus.
- e) **Contracted flow mixing part** The part shall be constructed so as to sufficiently mix the positive and negative ions generated by the ion generator and clean air to give uniform positive and negative ion densities in the air at the measuring part.
- f) **Measuring part** The part, which is a site for measuring ion density and blowing out flow volume, shall have such dimensions that measurement as specified in 5.2.4 can be properly carried out. The measuring part shall be opened to the outside.

**5.2.3 Preparation of measurement** The preparation of measurement shall be as follows.

- a) **Test environmental conditions within the test apparatus** As for test environmental conditions within the test apparatus, as shown in table 1, it shall be confirmed that the cleanliness before operation of the ion generator satisfies the cleanliness of class 5 or better. In addition, the test environmental conditions of temperature and humidity shall be confirmed to be within the designations by respective manufacturer of the ion generator and the ion density measuring device.

**Table 1 Test environmental conditions**

| Item                 | Test environmental conditions                                    |
|----------------------|------------------------------------------------------------------|
| Temperature          | 5 °C to 35 °C (or within a range designated by the manufacturer) |
| Relative humidity    | 40 % to 80 % (or within a range designated by the manufacturer)  |
| Atmospheric pressure | 1 013.25 hPa ± 5 %                                               |
| Cleanliness of air   | At least class 5 as specified in JIS B 9920                      |
| Power source voltage | Rating voltage ± 10 % (V)                                        |

- b) **Measurement and setup of blowing out flow volume** The blowing out flow volume of the measuring part of the test apparatus shall be generally adjusted so that the average flow rate measured at the centre of the measuring part becomes the same as the average flow rate when the air is flowing into the coaxial dual cylindrical or parallel flat plate ion density measuring device (aspiration at a constant velocity). The measuring part shall be externally opened and the flow volume supplied by the test apparatus shall be adjusted so as to sufficiently exceed the sample collecting flow volume and be allowed to be blocked from the influence of external environment of the test apparatus.
- c) **Confirmation of ground** Grounding of the test apparatus and the ion density measuring device shall be confirmed before the commencement of test, in order that the generated positive and negative ions are not influenced by an electric field, etc. under the test conditions.
- d) **Setup of ion saturated density curve and marginal mobility** A method of setting up the marginal mobility from the ion saturated density curve shall be in accordance with the same method as that specified in 5.1.2 b) (see Annex 1 for the method of setting up the marginal mobility from the ion saturated density curve).
- e) **Confirmation of sample collecting flow volume** When the sample collecting flow volume is changed, the blowing out flow volume of the test apparatus shall be simultaneously adjusted to confirm constant rate aspiration. However, in the case where the constant rate aspiration is difficult to be carried out, the flow volume shall be adjusted in a range of  $\pm 20 \%$  (see Annex 1 for the confirmation of the sample collecting flow volume).

**5.2.4 Measurement** The measurement shall be carried out by using the airborne ion density measuring device in accordance with the following procedures (see Annex 1 for the airborne ion density measuring device).

- a) **Measurement of background ion density within the test apparatus** In the case of obtaining average positive and negative background ion densities  $\overline{N}_0$  (/m<sup>3</sup>) through measuring the electric current in accordance with a fall of electric potential method, carry out the measurement in a similar manner with that as specified in 5.1.3 d) and calculate according to an equation (6).

$$\overline{N}_0 = \frac{1}{1.6 \times 10^{-19}} \cdot \frac{1}{n} \sum_{j=1}^{j=n} \left( \frac{I_{0,j}}{\Phi} \right), \text{ provided that } I_{0,j} = \frac{V_{0,j}}{R} \dots\dots\dots (6)$$

where,  $I_{0,j}$  : a  $j$  th electric current value flowing into a potentiometer through a high resistance from an ion collecting condenser (A)

$n$  : total measured number (times)

$V_{0,j}$  : indicated voltage with the electrometer (V)

$R$  : input high resistance value ( $\Omega$ )