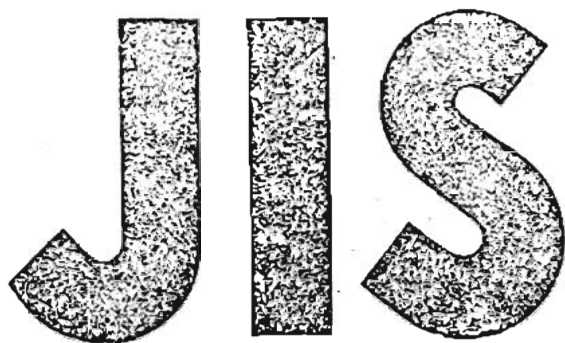


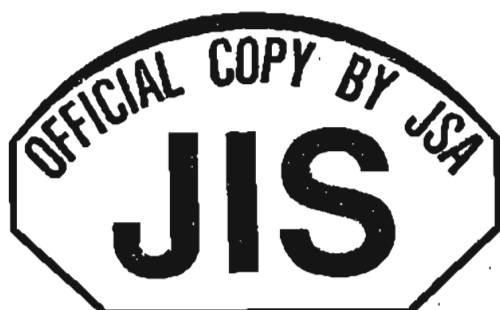


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JAPANESE INDUSTRIAL STANDARD

Test Methods of Air Compressors for
Railway Rolling Stock

JIS E 5002-1976



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Test Methods of Air Compressors for E 5002-1976
Railway Rolling Stock (Reaffirmed: 1979)

1. Scope

This Japanese Industrial Standard specifies the performance test methods of reciprocating and rotary air compressors, hereinafter referred to as the "compressors", to be used for railway rolling stock.

Remark: In this standard, units and numerical values given in { } are in accordance with the International System of Units (SI), and are given for reference.

2. Definitions

For the purpose of this standard, the following definitions apply:

- (1) standard suction condition A suction condition when a compressor takes in moist air at a temperature of 20°C, an absolute pressure of 760 mmHg {101.3 kPa} and a relative humidity of 65 %.
However, mass of 1 m³ of air at the standard suction condition is assumed as 1.20 kg.
- (2) discharged air volume A value of the discharged air volume converted into a volume at suction condition (an atmospheric pressure of P_a and a suction air temperature of t_1).

Applicable Standards:

JIS B 8341-Testing Methods for Displacement Compressors

JIS C 1502-Sound Level Meters

JIS Z 8731-Methods for Measurement of Sound Level

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- (3) pneumatic pressure The pressure that is exerted by air. Static pressure is measured at a hole bored in vertical to the wall surface which is in parallel with the current.

3. Test Items

The test items of compressors shall be the oil-leakage test of piston, temperature rise test, volumetric efficiency test, air-leakage test, unloader test and noise level test.

4. Test Apparatus and Measuring Instruments

4.1 Test Apparatus The test apparatus shall generally be as given in Attached Fig. 1 for the test using nozzle, orifice or quarter circular nozzle, as given in Attached Fig. 2 for the charged air method and as given in Attached Fig. 3 for the air leakage test and unloader test.

4.2 Connecting Pipes Bend, contraction and others which will cause pressure loss shall be avoided as far as possible in the connecting pneumatic pipes, and the length of pipe connecting the delivery port of compressor and the air tank shall be so selected that no resonance of air column can occur. The length of connecting pipe that will not cause resonance is expressed by the formulae (1) to (1').

$$L_{P1} \leq 10 \frac{c}{N} - \frac{V_P}{A} \quad \dots\dots\dots (1)$$

(When the length is selected shorter than the length which causes the primary resonance)

$$L_{P2} = (20 \text{ to } 40) \frac{c}{N} - \frac{V_P}{A} \quad \dots\dots\dots (1')$$

(When the length is selected between the lengths which cause the primary and secondary resonances)

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$$L_{P2} = (50 \text{ to } 70) \frac{c}{N} - \frac{V_P}{A} \dots\dots\dots (1'')$$

(When the length is selected between the lengths which cause the secondary and tertiary resonances).

where L_{P1} , L_{P2} and L_{P3} : length of the connecting tube which will not cause resonance (m) ;

c : velocity of sound in the tube (m/s)

N : No. of discharge per min

V_P : volume from the delivery valve in compressor to the delivery port of compressor whereon the connecting pipe is attached (m³)

A : cross-sectional area of the tube (m²)

An arbitrary length of pneumatic pipe may, however, be selected, if it is possible to prevent resonance over the entire range of the pneumatic pipe by attaching a resonance preventing device with small resistance loss.

4.3 Air Tank for Loading The volume of air tank for loading (see Attached Figs. 1 and 2) shall have a volume calculated from the formula (2).

$$V_r \geq \frac{200V_a}{R_a} \dots\dots\dots (2)$$

where V_r : volume of air tank for loading (m³)

V_a : stroke volume of piston of the last stage (m³)

R_a : pressure ratio of the last stage

$$= \frac{\text{absolute discharge pressure of the last stage}}{\text{absolute suction pressure of the last stage}}$$

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4.4 Pneumatic Pipe for Air Capacity Measurement The pneumatic pipe for air capacity measurement shall be a straight pipe of circular section with smooth inside surface, and its length shall be not less than 12 times the inside diameter D . The length may be shortened to $7D$, provided that a buffer plate of diameter $0.6D$ is concentrically installed with the pneumatic pipe at a point of $1D$ from inlet opening (see Attached Fig. 1).

4.5 Measuring Instruments of Air Capacity In the measurement of air capacity, nozzle, orifice, quarter circular nozzle or air tank for measurement shall be used.

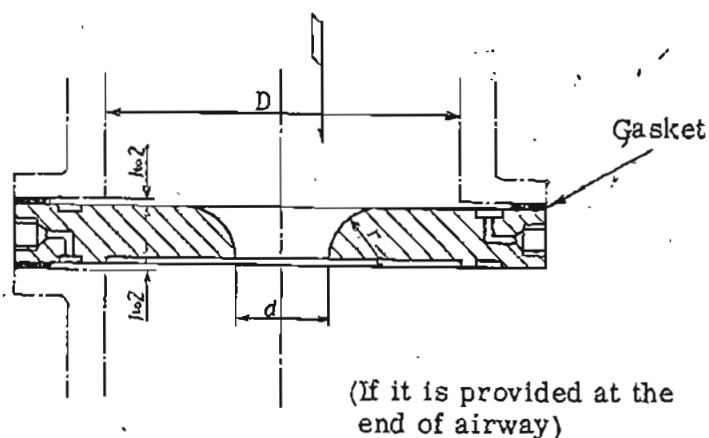
- (1) Nozzle The nozzle to be used for the measurement of air capacity shall be in accordance with JIS B 8341.
- (2) Orifice The orifice to be used for the measurement of air capacity shall be in accordance with JIS B 8341.
- (3) Quarter Circular Nozzle The quarter circular nozzle to be used for the measurement of air capacity shall be a circular hole provided concentric with the pneumatic pipe for measuring air capacity, and the shape and dimensions shall conform to Fig. 1, and the relation between the areal ratio of contraction $\beta^2 = (d/D)^2$ and the proportion of radius (r/d) shall conform to Table (given in 5.2.2).

The inside surface of the quarter circular nozzle shall be finished sufficiently smooth, and the tolerances on its inside diameter d shall be $\pm 0.001 d$.

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Fig. 1. Quarter Circular Nozzle

Unit: mm



- (4) Air Tank for Measurement The air tank for measurement shall have a volume of requiring 3 minutes or more to increase the pressure from the atmospheric pressure to the specified pressure (see Attached Fig. 2).

4.6 Size of Nozzle or Orifice The size of nozzle or orifice shall be so selected that the measured pressure difference becomes not less than 50 mmAq {490 Pa}.

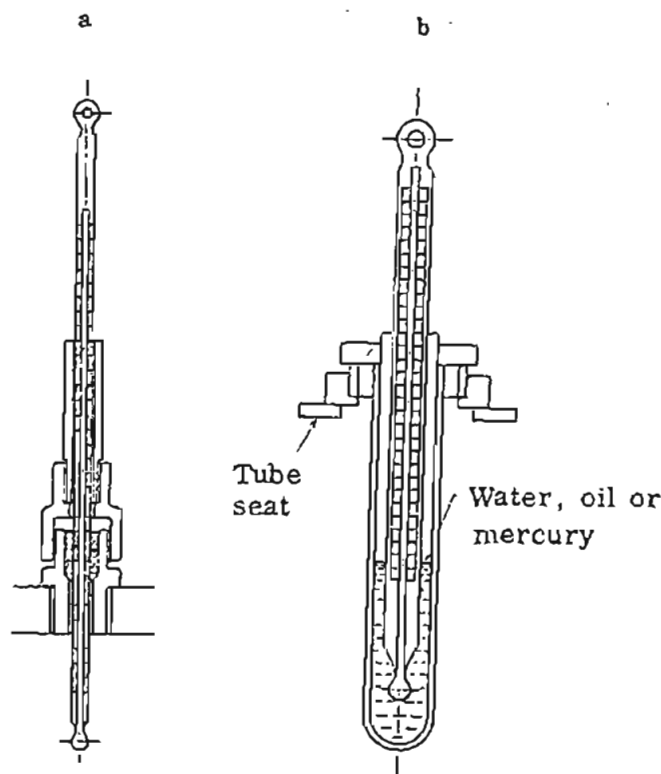
4.7 U Type Liquid Column Manometer In measuring the pressure difference between those just in front and rear of the nozzle or orifice, U type liquid column manometer shall generally be used, and water shall be used for the liquid. Specific gravity of water is assumed as 1.0 at a temperature of 0 to 40°C.

Inside diameter of the glass tubes of U type liquid column manometer shall be 6 to 12 mm, and the left and right tubes shall be nearly equal and even.

4.8 Pressure Gauge In measuring the discharge pressure, a Bourdon tube pressure gauge calibrated in advance shall be used. The gauge should, preferably, have a maximum scale value of 1.5 times to 2 times the specified pressure.

4.9 Measuring Instrument of Temperature For temperature measurement, a mercury thermometer, alcohol thermometer, electric resistance thermometer or thermocouple shall be used. In measuring the temperature of air current, the end point of thermometer or the thermojunction of thermocouple shall be directly protruded into the air current [see Fig. 2(a)]. If the thermometer is likely to be damaged, a protecting tube containing water, oil or mercury may be used [see Fig. 2 (b)]. The inside diameter of the protecting tube shall be approximately 2 times the outside diameter of the thermometer.

Fig. 2. Methods of Mounting Thermometer



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4.10 Measuring Instruments of Atmospheric Pressure and Humidity

For the measurement of atmospheric pressure, a Fortin barometer or aneroid barometer calibrated in advance shall be used, and for measuring the humidity, a psychrometer shall be used.

4.11 Tachometer In measuring the speed of revolution, a direct reading tachometer, revolution counter, electric tachometer, etc. which have been calibrated in advance and selected to suit with the type of compressor shall be used. The maximum scale value of direct reading tachometer and electric tachometer shall be not more than 3 times the speed of revolution to be measured.

4.12 Noise Level Meter The instrument to be used for measurement of the noise level shall be in accordance with JIS C 1502.

5. Measuring Methods

5.1 Measurements of Compressor Performances The measurements of compressor performances shall be carried out on the rated load pressure and rated speed of revolution.

5.2 Measurement of Air Capacity

5.2.1 Measurement by Nozzle or Orifice If Reynolds number in the pneumatic pipe for measuring air capacity lies within the applicable range of Fig. 3, measurement shall follow the measuring method using nozzle or orifice specified in JIS B 8341.

The Reynolds number R_D is calculated from the formula (3).

$$R_D = \frac{v_n D}{\nu} \dots\dots\dots (3)$$