

JIS

JAPANESE INDUSTRIAL STANDARD

Testing Methods for Air Preheaters

JIS B 8411—1989

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by

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

1. Scope

This Japanese Industrial Standard specifies the method to test the performance of air preheater, whose heating surface is composed of metal, of an exhaust heat recovery equipment to be used for the industrial combustion equipment using solid, liquid and gas fuels.

Furthermore, the subject of this Standard shall be those meeting the following conditions.

- (1) The air preheater shall be of a heat exchange type.
- (2) The heat source fluid shall be composed of only the component of exhaust gas produced when burning fuel and be free from mixture of dust and corrosive component from the outside.

- Remarks
1. The inlet temperature of air preheaters is about 300 to 1500°C usually because the heat source fluid is the combustion exhaust gas from the industrial combustion equipment.
 2. The air being a heat receiving fluid is used for combustion air usually, so the largest inlet pressure of air preheater is about 20 kPa {2000 mmAq}.
 3. The regenerative heating type (rotating regeneration type, change-over type and the like) is outside the application of this Standard even if the heating surface is composed of metal.
 4. The units and numerical values given in { } in this Standard are based on the traditional units and are appended for informative reference.

2. Definitions

For the purposes of this Standard, the following definitions apply:

- (1) input quantity of heat Quantity of heat held in the exhaust gas at the inlet of exhaust gas of air preheater. The unit is given by kJ/h (kcal/h).
- (2) quantity of heat at outlet of exhaust gas Quantity of heat held in the exhaust gas at the outlet part of exhaust gas of air preheater. The unit is given by kJ/h {kcal/h}.

Applicable Standards: See page 18.

- (3) quantity of receiving heat at air side Quantity of heat obtained in the air under the test condition. The unit is given by kJ/h {kcal/h}.
- (4) pressure loss of exhaust gas side Difference of static pressure between outlet and inlet at the exhaust gas side of air preheater measured under a test condition. The unit is given by Pa {mmAq}.
- (5) pressure loss at air side Difference of static pressure between outlet and inlet at the air side of air preheater measured under a test condition. The unit is given by Pa {mmAq}.

3. Test Items

The test shall be conducted on the following items:

- (1) Heat exchange performance (given by the heat efficiency of air preheater.)
- (2) Pressure loss at the exhaust gas side
- (3) Pressure loss at the air side
- (4) Exhaust gas analysis

4. Test Method

The air preheater intended for a test shall be checked previously at each part and be confirmed that it is free from abnormality.

Furthermore, it shall be confirmed that the piping for air and the flue for exhaust gas and the like are free from abnormality, too.

The test shall be conducted after the industrial combustion equipment has changed into running operation and become a thermally stable condition and be in accordance with the result of test of not less than one hour, as a rule.

Furthermore, the items to be measured shall be as follows:

- (1) Temperature of outlet exhaust gas of combustion equipment (t_5)
- (2) Temperature of inlet exhaust gas of air preheater (t_1)
- (3) Temperature of outlet exhaust gas of air preheater (t_2)
- (4) Temperature of inlet air of air preheater (t_3)
- (5) Temperature of outlet air of air preheater (t_4)
- (6) Temperature of inlet air of combustion equipment (t_6)
- (7) Exhaust gas pressure (static pressure) at inlet of air preheater (p_1)
- (8) Exhaust gas pressure (static pressure) at outlet of air preheater (p_2)

- (9) Air pressure (static pressure) at inlet of air preheater (p_3)
- (10) Air pressure (static pressure) at outlet of air preheater (p_4)
- (11) Flow rate of fuel (F)
- (12) Flow rate of air (V_a)
- (13) Flow rate of combustion exhaust gas (V_f)
- (14) Component of exhaust gas at outlet of combustion equipment
- (15) Component of exhaust gas at inlet of air preheater
- (16) Component of exhaust gas at outlet of air preheater
- (17) Temperature of the open air (t_o)

5. Measuring Method

5.1 Fuel

5.1.1 Measurement of Flow Rate of Fuel The measurement of flow rate of fuel shall be as follows:

- (1) The liquid fuel shall be measured by a volumetric flowmeter to be converted into mass by multiplying by density.
- (2) The gas liquid shall be measured by a flowmeter of volume type or of orifice type to convert into volume m^3 of standard condition of $0^\circ C$ and 1013 mbar {760 mmHg}.

5.1.2 Measuring Method of Sample The sampling of fuel to be used, test, analysis and measurement of heating value shall be in accordance with the following Japanese Industrial Standards as a rule or the certificate of successful sample shall be used in place of it.

JIS K 2249	JIS K 2251	JIS K 2270	JIS K 2272	JIS K 2275
JIS K 2279	JIS K 2301	JIS K 2541.		

5.2 Air for Combustion

5.2.1 Measurement of Air Flow Rate The air flow rate shall be measured at the inlet or outlet of air preheater by the use of an orifice flowmeter, Pitot tube and the like. Where the measurement is impossible, the flow rate shall be calculated from fuel and composition of combustion exhaust gas. (See JIS B 8330).

5.2.2 Measurement of Air Temperature The air temperature shall be measured at the inlet of air preheater, the outlet of air preheater and the input air pipe of combustion equipment (combustion machine part). The measuring position shall be selected at the center of section of duct as a rule or at the position where the stream not less than 300 mm apart from the inside of enclosing wall of passage of air has been rectified uniformly.

Furthermore, when ensuring the accuracy, a suction thermometer or a thermocouple as thin as possible shall be used and an appropriate comparative calibration shall be conducted together with taking care not to produce measuring error. (See JIS Z 8704, JIS Z 8705 and JIS Z 8710).

5.2.3 Temperature of Open Air The temperature of the open air shall be the average temperature of open air at the testing time.

5.3 Combustion Exhaust Gas

5.3.1 Measurement of Flow Rate of Combustion Exhaust Gas The measurement of flow rate of combustion exhaust gas shall be in accordance with the measurement of 5.2.1, as appropriate.

5.3.2 Measurement of Temperature of Combustion Exhaust Gas The temperature of combustion exhaust gas shall be measured at the outlet of combustion equipment, inlet of air preheater and outlet of air preheater. The measuring position shall be in accordance with the measurement of 5.2.2, as appropriate.

5.3.3 Sampling and Analysis of Combustion Exhaust Gas The sampling position of combustion exhaust gas shall be the temperature measuring places of the outlet of combustion equipment, the inlet of air preheater and the outlet of air preheater.

The component of combustion exhaust gas shall be analyzed by the use of Orsat analyzer, Hempel's gas analyzer or gas chromatograph as a rule. When using an electric analyzer or a mechanical analyzer, the correction shall be carried out suitably by Orsat analyzer, Hempel's gas analyzer, gas chromatograph or standard gas (see JIS K 0095).

5.4 Pressure Measurement

5.4.1 Measurement of Air Pressure The air pressure shall be measured at the inlet and outlet of air preheater by the use of U tube or other liquid column meter. The measurement shall be carried out also at the outlet of blower, burner air box and the like, as required.

The measurement shall be carried out at the position substantially uniformly rectified.

The water or alcohol having a specific gravity measured preliminarily shall be used for the liquid of a liquid level manometer.

Other pressure gauge capable of calibrating by comparing with the other liquid column gauge manometer may be used.

When measuring the static pressure, a static pressure pipe or a static pressure hole (¹) of 2 to 6 mm in diameter, bored at right angles to the pipe wall, shall be used, and the inside and the circumferential face shall be finished to be sufficiently smooth.

Note (¹) When measuring the static pressure by the use of the static pressure hole, bore the static pressure holes at two places of left and right of the pipe wall, measure each static pressure separately and obtain the average value. Where the difference between the average values of left and right is remarkable, the cause to bring about errors shall be ascertained or other static pressure hole shall be bored to compare (see JIS B 8330).

5.4.2 Pressure Measurement of Combustion Exhaust Gas The pressure of combustion exhaust gas shall be measured at the inlet and the outlet of air preheater in accordance with 5.4.1, as appropriate.

5.5 Interval of Measuring Time The taking of combustion sample, flow rate of air and exhaust gas, and measurement of pressure and temperature shall be conducted every 15 to 30 minutes respectively excepting the case where the measurement is conducted continuously by the use of a measuring instrument of recording type.

6. Calculation Method

6.1 General The input calorific value and outlet calorific value of exhaust gas are calculated from the test results, and the received calorific value of air is calculated, too. The thermal efficiency and external heat loss of air preheater shall be calculated from this calculated value.

Furthermore, the pressure loss of exhaust gas side and air side shall be calculated from the result of pressure test. The calculation methods are given in 6.2 to 6.12.

6.2 Composition of Fuel The composition of fuel to be used for calculation shall be the composition of fuel at the using time and be found as given below:

- (1) Cases of Solid Fuel Find the whole moisture content (on the using time basis), industrial chemical analysis component (equilibrated humidity base) and elementary analysis component (anhydrous basis) in accordance with JIS M 8801, JIS M 8810, JIS M 8811, JIS M 8812 and JIS M 8813 and calculate the percentage of content (mass %) at the using time basis by the conversion of the basis.

When taking the whole moisture (on the using time basis) as w %, the moisture by the industrial chemical analysis (equilibrated humidity base) as w_1 %, the ash content as a_1 % and the carbon, hydrogen, combustible sulfur, and nitrogen in accordance with the elementary analysis (anhydrous base) as c_0 %, h_0 %, s_0 % and n_0 % respectively, the percentage of content (mass %) of carbon, hydrogen, combustible sulfur, nitrogen, ash and oxygen, c %, h %, s %, n %, a % and o % respectively, at the solid fuel using time basis shall be given by the following formulae respectively.

$$\begin{aligned} c &= \frac{100-w}{100} c_0 \%, & h &= \frac{100-w}{100} h_0 \%, \\ s &= \frac{100-w}{100} s_0 \%, & n &= \frac{100-w}{100} n_0 \%, \\ a &= \frac{100-w}{100-w_1} a_1 \%, & o &= 100 - (c + h + s + n + a + w) \% \end{aligned}$$