

JIS

JAPANESE INDUSTRIAL STANDARD

**Heat balancing of kiln and
furnace for lime**

JIS R 0305—1991

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JAPANESE INDUSTRIAL STANDARD

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Heat balancing of kiln and furnace for lime

R 0305-1991

1. Scope

This Japanese Industrial Standard specifies the heat balancing of kiln and furnace used for calcination of limestone.

Remarks 1. Applicable Standards to this Standard are shown in Attached Table 1.

2. In this Standard the units and numerical values shown in { } are in accordance with traditional units and appended for informative reference.

2. Reference

2.1 The heat balancing shall be carried out by the operation actual results of continuous 24 h min. in normal operation of kiln and furnace.

2.2 The heat balancing shall be carried out concerning 1 t calcined quick lime, hereinafter referred to as the "lime".

2.3 The reference temperature of heat balancing shall be the outside air temperature.

2.4 As to the heating value of fuel, the lower heating value⁽¹⁾ at the time of using shall be used.

Note ⁽¹⁾ The conversion from higher heating value to lower heating value shall be in accordance with the method given in Annex 1.

3. Record and measuring items relating to equipment

3.1 Record relating to equipment The record relating to equipment shall be as follows:

- (1) Name and location of workshop
- (2) Type, name, number, etc. of kiln or furnace
- (3) Use⁽²⁾ of lime
- (4) Inside diameter and total length (height) ⁽³⁾ of kiln or furnace
- (5) Sectional area and effective volume of kiln or furnace
- (6) Constitutional form of wall of kiln
- (7) Class (name) of using fuel⁽⁴⁾
- (8) Form and equipment of draft⁽⁵⁾
- (9) Equipment for charge of raw material and discharge of lime

(10) Class, type, capacity, etc. of auxiliaries⁽⁶⁾

(11) History⁽⁷⁾

Notes ⁽²⁾ For example, lime of industrial use such as steel making use, chemical industry use, flue-gas desulfurization use, etc., agricultural use, construction use, etc.

⁽³⁾ Outside diameter, inside diameter (inside diameter of calcination zone part) and effective length (it gives the height in which raw stone or lime is filled and preheating zone, calcination zone, and cooling zone can provided. It generally corresponds to the height from the upper end of discharge port to the lower end of kiln top exhaust port).

⁽⁴⁾ Liquid, gas and solid fuel.

⁽⁵⁾ The uses, type, capacity, pressure, electric power and rotation number of blower and exhauster.

⁽⁶⁾ The auxiliaries are waste-gas treating equipment, boiler, oil heater, etc.

⁽⁷⁾ The date of erection and remodeling, and the outline of remodeling.

3.2 Measuring items The measuring items shall be as follows:

- (1) Term of measurement (date and time), name of measuring duty person.
- (2) Weather, atmospheric pressure, wind velocity, and temperature and humidity of outside air.
- (3) The using amount, composition and grain size range of limestone.
- (4) The class⁽⁸⁾, brand, grain size range, composition at using time, heating value, temperature and using amount of fuel.
- (5) The temperature, pressure and amount of combustion air.
- (6) The temperature of lime and the amount of residual CO₂.
- (7) The temperature and volume of exhaust gas and the composition, air ratio and volume of dry exhaust gas.
- (8) The composition and volume of collected dust.
- (9) The temperature and area of outside wall of kiln or furnace.

Note ⁽⁸⁾ Classes (names) of respective fuels of liquid, gas and solid.

4. Measuring methods

4.1 Using amount, composition and grain size range of limestone

The measurement for the using amount, composition and grain size range of limestone shall be as follows:

- (1) The using amount is to be actually measured.
- (2) The composition is to be in accordance with JIS M 8850.
- (3) As to the grain size range, in the case where limestone is crushed with a crusher and screened, the upper and lower limits of sieve opening are to be recorded according to specifications of JIS Z 8801, as appropriate.

4.2 Grain size range, composition in use, heating value and using amount of solid fuel The measurement of grain size range, composition in use, heating value and using amount of solid fuel shall be as follows:

- (1) As to the grain size range, in the case where the solid fuel is crushed with a crusher and screened, the upper and lower limits of sieve opening are recorded according to specifications of JIS Z 8801, as appropriate.
- (2) The composition and heating value are measured according to the following Japanese Industrial Standards on the basis of the using time.
 - (a) JIS K 2249
 - (b) JIS K 2251
 - (c) JIS K 2270
 - (d) JIS K 2272
 - (e) JIS K 2275
 - (f) JIS K 2279
 - (g) JIS K 2283
 - (h) JIS K 2301
 - (i) JIS K 2541
 - (j) JIS M 8810
 - (k) JIS M 8811
 - (l) JIS M 8812
 - (m) JIS M 8813
 - (n) JIS M 8814

- (3) The using amount is to be measured according to the following methods:

- (a) As to the using amount of fuel oil, measure the volume with a volumetric flowmeter and convert to mass by its specific gravity.

Further, the specific gravity of fuel oil is in accordance with JIS K 2249.

- (b) Actually measure the using amount of gas or perform mass precise calculation.
- (c) Express the using amounts of coal and cokes by the mass under the condition when charging into a kiln or furnace.

4.3 Temperature of lime and amount of indecomposed substance

The measurement of temperature of lime and the amount of indecomposed substance shall be as follows:

- (1) As to the temperature of lime, actually measure the temperature just after discharging from the kiln or furnace.
- (2) As to the amount of indecomposed substance, cool the lime after measurement of (1) to ordinary temperature, and perform the quantitative determination of carbon dioxide specified in 6.11 of JIS R 9011.

4.4 Temperature, composition and amount of exhaust gas The measurement of the temperature, composition and amount of exhaust gas shall be as follows:

- (1) Actually measure the temperature of exhaust gas with taking cares to the following points so as not to generate the error in measurement results.
- (a) The influence of leaking air (when the upper part of kiln is at negative pressure and the like, special cautions are required)
- (b) Difference due to measuring position
- (c) Difference due to measuring time (in the case of intermittent operation, cares are specially required)
- (2) Carry out the analysis of exhaust gas according to JIS K 2301.
- Further, for the analyzer, Orsat-apparatus may be used. In the case of exhaust gas analysis sample, also cares are to be taken according to the preceding item, as appropriate and the temperature and the composition should preferably be measured at the same position.
- (3) Obtain the amount of dry exhaust gas according to the following formula (nitrogen calculation).

$$V_e = \frac{[(A_o \times m_f) - (m_c \times 8.89)] \times 79}{(N_2) - [(O_2) - 0.5(CO)] \times 3.76}$$

where, V_e : dry exhaust gas amount per 1 kg lime (m^3_{N})
 A_o : theoretical air amount per 1 kg or 1 m^3_{N} fuel (m^3_{N})⁽⁹⁾
 m_f : fuel use amount per 1 kg lime (kg or m^3_{N})
 m_c : unburnt carbon amount in combustion residue per 1 kg lime (kg)
 (N_2) : volume percentage of N_2 amount in exhaust gas (%)
 (O_2) : volume percentage of O_2 amount in exhaust gas (%)
 (CO) : volume percentage of CO amount in exhaust gas (%)

Note (9) The theoretical air amount is calculated according to the method given in Annex 2.

Remarks: m^3_{N} indicates the unit of volume in standard condition 0 °C, 110.3 kPa {760 mmHg} of gas.

4.5 Temperature of each part of outside wall of kiln or furnace
 The temperature of each part of outside wall of kiln or furnace and the area corresponding each temperature shall be actually measured.

For the convenience of calculation, the temperature and area should preferably be measured by partitioning into several parts, for example preheating, calcining, cooling zones, etc. according to each temperature, each direction of wall, etc.

4.6 Pressure, capacity, etc. in using time of draft equipment As to the pressure, capacity, etc. in using time of draft equipment, actual results in using time shall be recorded relating to the items described in 3.1 (8), 6. (1) and 6. (2).

5. Heat balancing items and calculation methods

The heat balancing shall be carried out concerning the items of left column of Table 1 according to respective methods of right column of the same table. Though this calculation shall be carried out concerning per 1 kg lime for convenience, these shall be expressed as per 1 t lime by multiplying this numerical value by 10^3 when expressing.

Further, though this calculation is given concerning the case where solid fuel is used, calculations, in cases where other fuels are used, shall be carried out in accordance therewith, as appropriate.

Table 1

Item		Calculation method
1. Heat input	(1) Heat of combustion of fuel Q_a (kJ{kal})	$Q_a = m_f \times H_i$ where, m_f : fuel using amount per 1 kg lime (kg) H_i : low heating value at using time of fuel (kJ/kg {kcal/kg})
	(2) Sensible heat of fuel Q_b (kJ{kal})	$Q_b = m_f \times C_f \times (t_f - t)$ where, m_f : fuel using amount per 1 kg lime (kg) C_f : specific heat of fuel (kJ/kg°C {kcal/kg°C}) t_f : temperature of fuel (°C) t : temperature of outside air (°C)
	(3) Enthalpy of atomized steam Q_c (kJ{kal})	$Q_c = M_s \times i_s$ where, M_s : using amount of superheated steam per 1 kg lime (kg) i_s : enthalpy of superheated steam (kJ/kg {kcal/kg}) Remarks: i_s is obtained according to Attached Table 2.