METI-ASEAN PROMEEC Seminar
<Comments for EE&C in Iron & Steel Factory>

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Comments for EE&C

1. Regulations for Reheating Furnace in Japan

1) Standard/Target Air Ratios for Industrial Furnaces by the Law

2) Heat Recovery Rates for Industrial Furnaces by the Law

3) Furnace Wall Outer Surface Temperatures for Industrial Furnace

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1) Standard/Target Air Ratios for Industrial Furnaces by the Law

Furnace Category	Gas fuel		Liquid fuel	
	Coetaneous	Intermittent	Continuous	Intermittent
Standard/Target				
Melting furnace (F.) for metal Casting	1.25 1.05~1.20	1.35 1.05~1.25	1.30 1.05~1.25	1.40 1.05~1.30
Continuous steel billet/ bloom heating F. (CSHF)	1.20 1.05~1.15	— —	1.25 1.05-1.20	— —
Metal Heating F. other than CSHF	1.25 1.05~1.20	1.35 1.05~1.30	1.25 1.05~1.20	1.35 1.05~1.30

Note: The standard/Target values of air ratio mentioned in the table above define those to be obtained measurements at the exhaust port of kiln or furnace when fired at a level of load around the related after inspection and repair.

2) Heat Recovery Rates for Industrial Furnaces by the Law

Waste Heat Recovery Rates, Standard/Target for Furnaces

Exhaust gas temperature (ºC) at F'ce ~ Recu.	Capacity category	Waste heat recovery rates		(Reference for target)	
		Standard (%)	Target (%)	Waste gas temperature (ºC)	Preheat air temperature (ºC)
< 500	A & B	25	35	275	190
500 ≤ ~ < 600	A & B	25	35	235	230
600 ≤ ~ < 700	A	35	40	365	305
	B	30	35	400	270
	C	25	30	435	230
700 ≤ ~ < 800	A	35	40	420	350
	B	30	35	460	310
	C	25	30	505	265
800 ≤ ~ < 900	A	40	45	435	440
	B	30	40	480	395
	C	25	35	525	345
900 ≤ ~ <1,000	A	45	55	385	595
	B	35	45	485	490
	C	30	40	535	440
1,000 ≤	A	45	55	-	-
	B	35	45	-	-
	C	30	40	-	-

Notes: A: Rating capacity of from 84GJ/h (= 20Gcal/h)

B: Rating capacity of from 21GJ/h (= 5Gcal/h) to under 84GJ/h (= 20Gcal/h)

C: Rating capacity of from 840MJ/h (= 200Mcal/h) to under 21GJ/h (= 5Gcal/h)

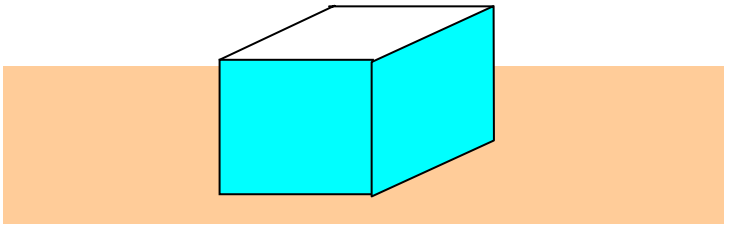
3) Furnace Wall Outer Surface Temperatures for Industrial Furnace

Standard / Target for Furnace Outer Wall Surface Temperature by the Law

Furnace temperature (ºC)	Standard / Target furnace external wall temp. (ºC)		
	Roof	Side wall	Bottom facing air
1,300 ≤	140/120	120/110	180/160
1,100 ≤ ~ <1,300	125/110	110/100	145/135
900 ≤ ~ <1,100	110/100	95/90	120/110
< 900	90/80	80/70	100/90

Note: The standard/target values of furnace wall outer surface temperature mentioned in the able above defined the average temperature of furnace wall outer surface (except specific parts) during its normal, steady operation at an outside air temperature of 20ºC.

4) Calculation of heat dissipation



Side area: As1, As2. As3. As4
Top area: At

Calculation formulas:
The heat dissipation is thought of as the radiation and natural convection because of the inside of a factory building.

a. Radiation heat

Calculation formula of heat radiation:

$$Qr = 5.67 \times \varepsilon \times \left\{ A \times \left(\frac{T1}{100} \right)^4 - \left(\frac{T2}{100} \right)^4 \right\} \quad (W)$$

(For each surface, and total of Qr = QR)

Where,

- **A: Surface area (m^2)**
- **ε : Emissivity of melting material = 0.3 (Aluminum painted)**
- **T1: Furnace surface temperature (K)**
- **T2: Ambient temperature (K)**

b. Convection heat

Calculation formula:

Side surface (Vertical wall):

$$Qs = 2.56 \times (T1 - T2)^{1.25} \times As \quad (W)$$

(For each surface, and total of Qs = QS)

Top surface:

$$Qt = 3.26 \times (T1 - T2)^{1.25} \times At \quad (W)$$

c. Total heat dissipation

$$Q = QR + Qs + Qt \ (W)$$

Where,

As: Side Surface area (m^2)

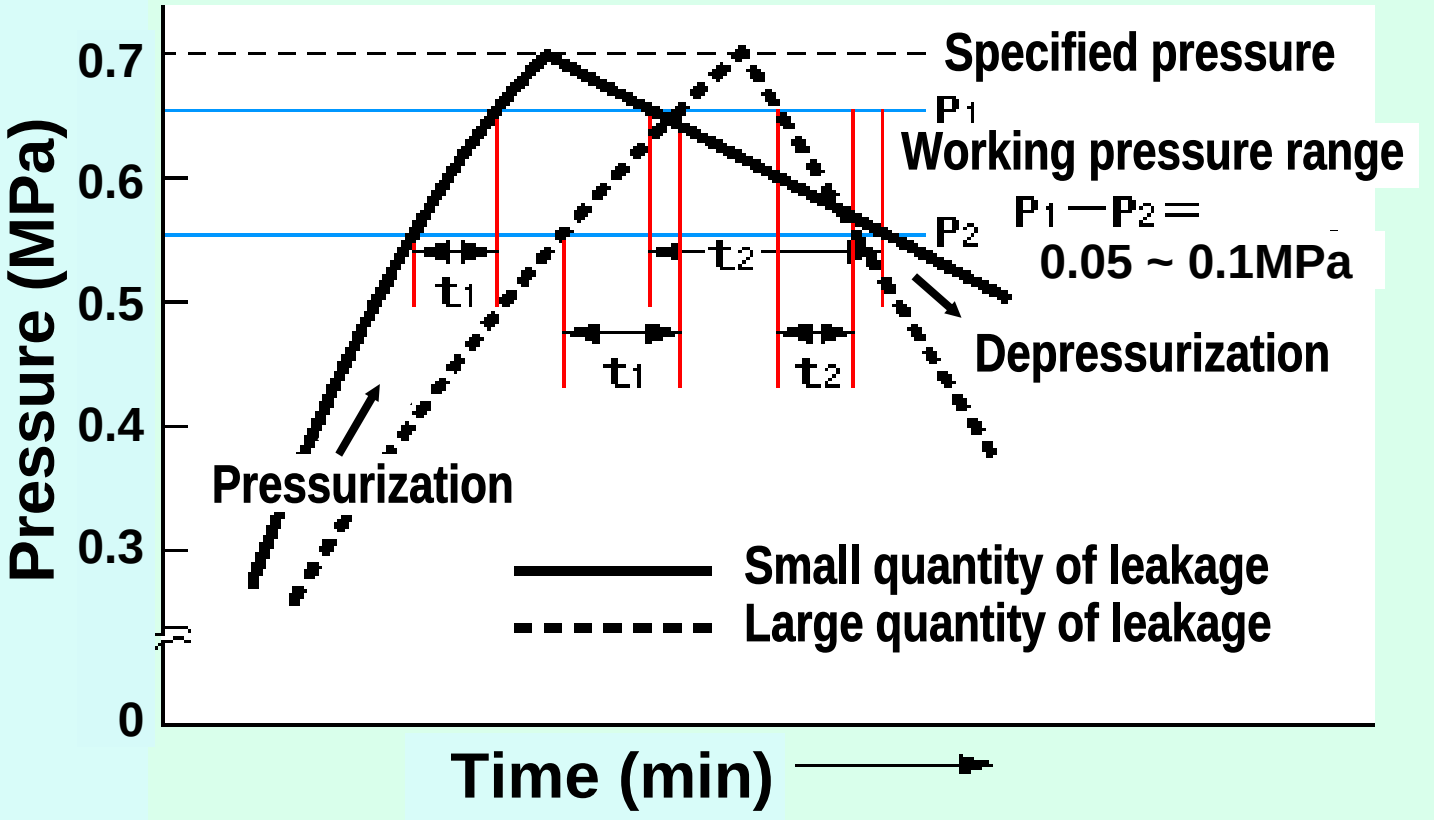
At: Top surface area (m^2)

d. Estimation of insulation effect

Calculation:

By using the data of previous temp., after temp. by improvement, operation time per year, oil calorific value, efficiency and oil price, etc.

5) Checking Method of Air Leakage (1/2)



Pressure Change in Compressed Air System

Checking Method of Air Leakage (2/2)

$$Q = \frac{(P_1 - P_2) \times V}{t_2 \times P_O}$$

$$Q_{max} - Q = \frac{(P_1 - P_2) \times V}{t_1 \times P_O}$$

$$\varepsilon = \frac{t_1}{t_1 + t_2} \times 100$$

$$Le = W_m \times H \times \varepsilon / 100 \text{ (kWh)}$$

$$W_m = \sqrt{3} \times \text{Voltage (V)} \times \text{Current (A)} \times \phi / 1000$$

Q: Leak volume (m^3/min)
V: Air system volume (m^3)
P_O: Atmospheric pressure (MPa. Abs.)
P_1, P_2: Working pressure (MPa)
t_1, t_2: (min)
ε : Leakage ratio (%)
Q_{max}: Compressor discharge volume (m^3/min)
Le: Loss power by leakage (kWh)
W_m: Average input motor power (kW)

Q_{max}: Compressor discharge volume (m^3/min)
Le: Loss power by leakage (kWh)
H: Operation time (h)
ϕ : Power factor

6) Necessary Air Tank Volume

The necessary air tank volume is calculated as follows.
This tank can cover the fluctuating air consumption volume, and keep the air pressure in tank in some range.

$$V = \frac{0.1013 \times (Q2 - Q1)}{P - PL} \times \frac{t}{60} \quad (m^3)$$

Where,

- **V: Tank volume (m^3)**
- **Q1: Air supply volume from compressor ($m^3{}_N$/min)**
- **Q2: Air consumption volume ($m^3{}_N$/min)**
- **P: Maximum pressure in tank (MPa)**
- **PL: Minimum allowable pressure (MPa)**
- **t: Time from Pressure P to PL (sec)**