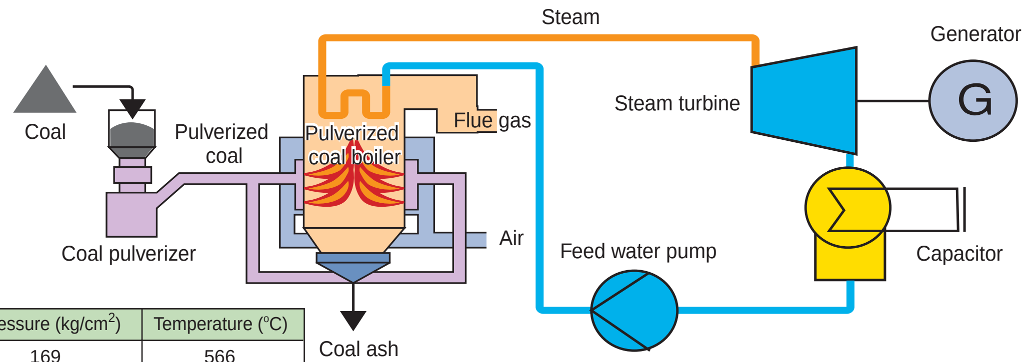
2A1. High Efficiency Pulverized Coal-fired Power Generation Technology (Ultra Super Critical Steam Condition)

Technology Overview

1. Pulverized coal-fired power generation system

The pulverized coal-fired power generation system (Fig. 1) is widely used as an established, highly reliable technology. In 2000, 600/610°C USC (Ultra Super Critical Steam Condition) systems were installed at J-POWER's Tachibanawan Thermal Power Station's No. 1 and No. 2 plants (1050 MW each). J-POWER's Isogo New Unit No. 1, which was put into service in 2002, uses the same system with full variable pressure operation at the main steam temperature of 600℃ and the reheat steam temperature of 610℃. Further challenges will be to use more types of coal, increase generation efficiency, improve environmental measures and enhance load operability.



Steam conditions	Pressure (kg/cm^2)	Temperature (°C)
Subcritical	169	566
Supercritical	246	538
Ultra-supercritical	325	596

Fig. 1 Pulverized coal-fired power generation system (Rankine cycle)

2. Efficiency increase

Increasing the thermal efficiency of power generation plants is an important issue not only to decrease the power generation costs from an economic standpoint, but also for suppressing CO_2 emissions. In particular, steam temperatures at coal-fired power plants, which are currently the most prevalent among large thermal power plants, have increased. Figure 2 shows the trend of steam condition in recent years.

In 1989, Chubu Electric Power Co., Inc.'s Kawagoe No. 1 plant (700 MW) adopted the steam condition of 316 kg/cm^{2}g (31.0 MPa) x 566°C/566°C. In 1993, Chubu's Hekinan No. 3 plant (700 MW) adopted the steam condition of 246 kg/cm^{2}g (24.1 MPa) x 538°C/593°C, marking the highest reheated steam temperature in Japan. Subsequently, The Chugoku Electric Power Co., Inc.'s Misumi No. 1 plant (1000 MW) and Tohoku Electric Power Co., Inc.'s Haramachi No. 2 plant (1000 MW) adopted the steam condition of 24.5 MPa x 600°C/600°C in 1998. Furthermore, J-POWER's Tachibanawan No. 1 and No. 2 plants (1050 MW) adopted the steam condition of 25.0 MPa x 600°C/610°C in 2000. Figure 3 shows an example of the relationship between the steam condition and the efficiency of a supercritical pressure plant.

Responding to the trend of increasing steam temperatures, power companies, steel manufacturers, and boiler manufacturers are promoting the development and practical application of high-strength materials with superior high-temperature corrosion resistance, steam-oxidation resistance, and workability.

High-temperature materials for use at 650°C have already been introduced into practical application, with work proceeding to develop materials for use at 700°C.

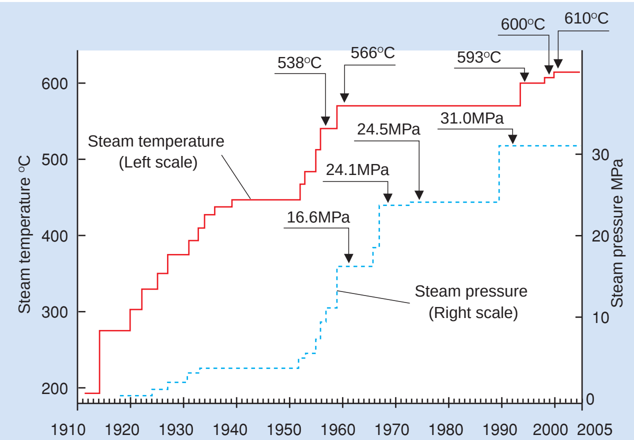


Fig. 2 Changes in steam condition over time

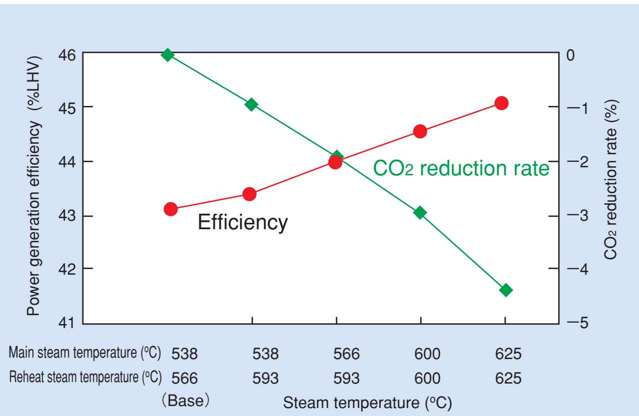


Fig. 3 Power generation efficiency and CO_2 reduction rate for various steam conditions

3. Combustion technology

Various combustion techniques have been developed and put into practical application in response to the need to satisfy Japan's strict environmental regulations, and to achieve high-efficiency combustion. The NOx emission level and the dust generated during the combustion of coal in Japan is at the world's lowest level, even at boiler exit. The ultimate emission level owes to the flue gas treatment administered at the downstream side of the boiler. Since NOx and dust emissions are very closely related, low NOx combustion technology is addressed here. Low NOx combustion technology is roughly classified according to the suppression of NOx generation at the burner and the intrafurnace denitration, using all the zones in the furnace.

(1) Low NOx pulverized coal burner

The latest burners have both improved ignitability and intraflame denitration, although the structure varies by boiler manufacturer. These burners basically use the separation of dense and lean pulverized coal streams and a multilayer charge of combustion air. Figures 4 to 7 show the burner structures of several Japanese manufacturers.

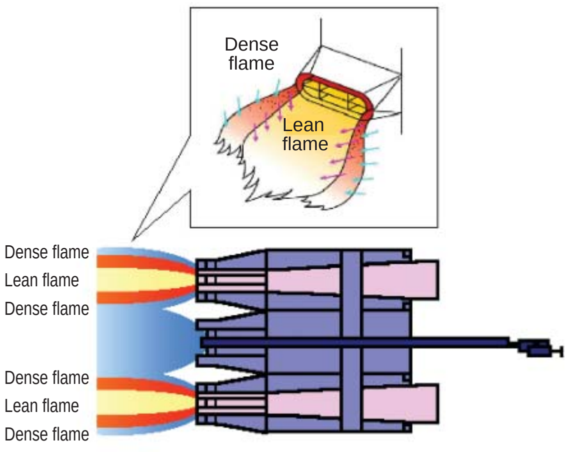


Fig. 4 Pulverized coal-fired A-PM burner: Mitsubishi Heavy Industries, Ltd.

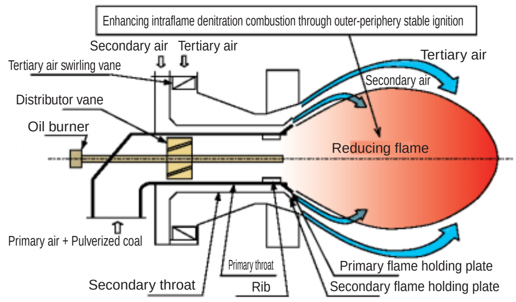


Fig. 5 CC-type pulverized coal-fired burner: Kawasaki Heavy Industries, Ltd.

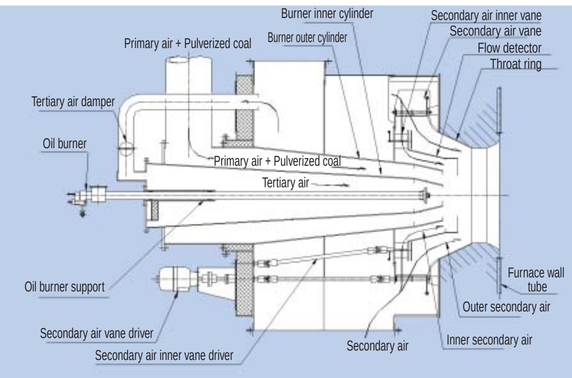


Fig. 6 DF inner vane pulverized coal-fired burner: Ishikawajima-Harima Heavy Industries Co., Ltd.

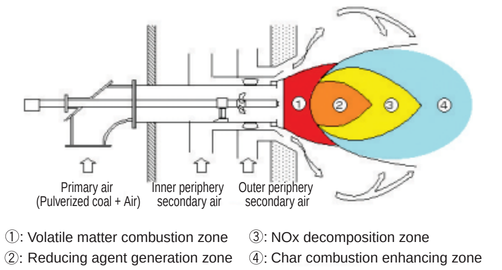


Fig. 7 Pulverized coal-fired NR burner: Babcock-Hitachi K.K.

(2) Intrafurnace denitration

Intrafurnace denitration is conducted by reducing the NOx generated in the main burner zone, using the residual hydrocarbons or the hydrocarbons generated from a small amount of fuel oil fed from the top of the main burner. The intrafurnace denitration is performed in two stages. Figure 8 is a conceptual drawing of intrafurnace denitration.

In the first stage, hydrocarbons reduce NOx levels. In the second stage, the unburned matter is completely combusted by the additionally injected air.

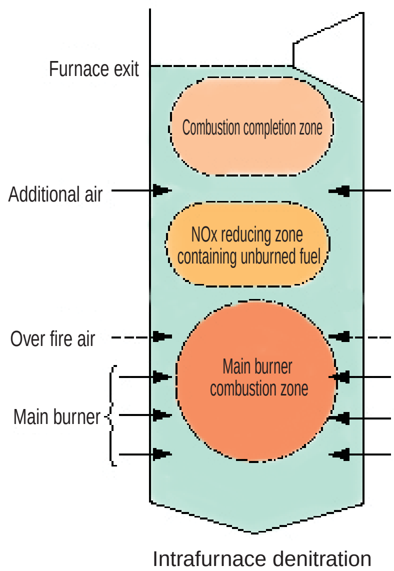


Fig. 8 Conceptual drawing of intrafurnace denitration