Supporting Information for

Combustion and NO_x emission characteristics with respect to staged-air damper opening in a 600-MW_e down-fired pulverized-coal furnace under deep-air-staging conditions

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Table Caption

TABLE S1 Coal characteristics and major operation parameters in industrial-size experiments.

Note:

Detailed explanation about the representative locations of ports 1–4 in all observation ports for coal combustion data acquisitions

Along the furnace depth direction shown in Figure 1, the low-speed fuel-rich coal/air flow is ejected vertically through the central part of the arch zone, whereas the high-speed inner and outer secondary air are vertically supplied into the near front and rear wall zone. Both the fuel-rich coal/air flow and two layers of secondary air are direct flows. Because of (i) the extrusion behavior from the high-temperature gas in the central part of the furnace and (ii) secondary air carrying the fuel-rich coal/air flow to penetrate, the downward fuel-rich coal/air flow actually inclines towards the secondary-air jets and thus penetrates in the near front and rear wall zone. From the front and rear walls to the furnace center (Figure 1), the first line of two ports are so close to the front and rear walls to be filled with the low-temperature secondary air, whereas the third line of three ports are close to the furnace center to be filled with the high-temperature recirculating gas. Consequently, in the three lines of ports below any furnace arch, only the smooth curve through in turn the selected ports 1–4 is the optimal choice to signify the downward flame travel as the coal combustion proceeds. Again, because the direct burners and down-fired combustion technology equipped in the furnace, no apparent swirl flow appears in the zone below arches where the primary coal combustion process proceeds. Therefore, the coal combustion data acquired through ports 1–4 are representative to uncover the effect of the staged-air damper opening on gas temperatures and species concentrations in the furnace.

Additional explanation about methods used to estimate quenching rates of the capture gas

samples in the water-cooling probe

Here, the value of 10^6 K/sec is the estimated quenching rate of chemical reactions in the captured gas samples, not the cooling rate of the high-pressure cooling water used to cool the high-temperature gas from approximately 1500 °C to room temperature. Generally, when gas temperatures fall to about 500 °C, it is though that chemical reactions have been quenched in the captured gas samples. Under the conditions with much larger flux and higher velocity of the high-pressure cooling water (60 L/min and about 0.7 m/s) than those of the sampled gas in the probe (1 L/min and about 0.2 m/s), the high-temperature gas samples were cooled sharply and the quenching times were estimated to rank at a millisecond order of magnitude. Accordingly, the estimated quenching rates were approximately 10^6 K/sec.

TABLE S1

proximate analysis, wt.% (as received)					
volatile matter	ash	moisture	fixed carbon	net heating value (MJ/kg)	
7.26	28.71	7.76	56.27	21.25	
ultimate analysis, wt.% (as received)					
carbon	hydrogen	sulfur	nitrogen	oxygen	
56.38	2.02	3.34	0.78	1.01	
quantity			10%	20%	30%	50%
flow rate of main steam (ton/h)			1790	1803	1795	1798
pressure of the main steam (MPa)			23.85	23.88	23.47	23.95
total rate of primary air (kg/s)			114.0	118.3	116.7	115.3
temperature of primary air (°C)			105	105	98	103
total rate of secondary air (kg/s)			567	572	568.1	563.2
temperature of secondary air (°C)			357	356	348	358
coal feed rate (ton/h)			259.3	261.9	258.7	264.1
pulverized-coal fineness (R_{90}, %)			8.3	7.6	8.1	7.9
negative pressure fluctuation in the furnace (Pa)			–60 to +20	–38 to +50	–100 to +15	–80 to +20
O_2 in flue gas (%)			3.2	3.3	3.0	3.2