Coal Preparation, Coking, and Slaking in China and Japan

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Abstract—In China and Japan, measures have been developed to maintain constant coke quality and hence permit economical and stable blast-furnace operation with the injection of coal-dust fuel; and to reduce the cost of the coke, despite the continuing shortage of high-quality coking coal. These approaches include the construction of large-capacity coke batteries, with minimal environmental impact; ramming of the coal batch before it is loaded in the furnace; drying and heating of the batch; and improvements in dry slaking of the coke.

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In the past decade, China has become a world leader in coke, hot-metal, and steel production (Figs. 1 and 2); Japan has fallen to second place. At present, the development of ferrous metallurgy in China is premised on a transition from leadership in output to leadership in technology. The structure of blast-furnace production in China has changed as a result of the construction of large new blast furnaces...
(4000–5000 m³ or more) and the elimination of small furnaces. All the blast furnaces at integrated plants in China and all the blast furnaces in Japan operate with the injection of coal-dust fuel and use coke with hot strength $CSR = 60–72\%$ and iron-ore batch consisting of high-basicity sinter (1.7–2.5), pellets, and ore [1, 2]. In both countries, high-quality coking coal is unavailable or in short supply, and efforts are underway to reduce the cost of the coke produced, while maintaining sufficient coke quality to ensure economical and stable blast-furnace operation, with the injection of coal-dust fuel. These factors shape the development of coal preparation, coke-battery construction, and coking and slaking technology. In particular, attention focuses on the construction of large-capacity coke batteries, with minimal environmental impact; ramming of the coal batch before it is loaded in the furnace; drying and heating of the batch in top-loading batteries; and dry slaking of the coke. New coke batteries are mainly under construction in China. In Japan, where ferrous metallurgy has been under development since the 1960s, most coke batteries are more than 30–40 years old.

CONSTRUCTION OF LARGE COKE BATTERIES

Large coke batteries with enlarged furnace chambers—so as to ensure maximum fuel combustion and minimal emission of CO and nitrogen oxide with the exhaust gases—offer the following benefits [4].

(1) Briefer loading and discharge operations and hence shorter atmospheric emissions. (The time required for loading and discharge is a third as much in batteries with a chamber height of 7.63 m than for a height of 4.3 m.)

(2) Reduced leakage through sealing defects at the doors, columns, and charge holes and less frequent opening of the doors each day.

(3) Increased thermal efficiency on account of the reduced specific surface of the battery, the use of better regenerator designs, and automatic control systems for the heating. (Heating expenditures are reduced by 3–4%.)

(4) Increased productivity. (The coke yield per coking chamber increases with the height: 13.4 t for 4.3 m; 21.4 t for 6 m; 35.8 t for 7 m; and 43.8 t for 7.63 m.)

(5) Increased packing density of the coal batch. (The batch density in the coking chambers increases with the height: 0.75 t/m³ for 4.3 m; 0.76 t/m³ for 6 m; and 0.82 t/m³ for 7.63 m). This boosts coke quality and reduces the demand for high-quality coal.

In 2000, the maximum height of Chinese coke batteries was 6 m. In 2005, Anshan Coking and Refractory Engineering and Consulting Corporation (ACRE) developed the JNX70-2 battery, with furnace chambers of width 450 mm and height 6.98 m. The furnace, with steam heating channels and recirculation, is heated by coke-oven gas and blast-furnace gas, with single-stage combustion. By mid-2009, eleven such coke batteries had gone into operation, and seven more were under construction.

In 2006, at the Yan Kuang plant, the first coke battery with a furnace-chamber height of 7.63 m went into operation. By 2009, nine such coke batteries had gone into operation, and six more were under construction [4].

In 2008, the total increase in China’s coke-production capacity was 30.35 million t; of this total, 71.4% corresponded to rammed-batch batteries with a chamber height of 5.5 m and top-loading batteries.