3A1. Formed Coke Process (FCP)

Research and development: Japan Coal Energy Center; and Japan Iron and Steel Federation
Period: 1978-1986 (9 years)

Technology Overview

1. Overview

The formed coke process (FCP) utilizes noncaking coal as the main raw material. Next, a binder is used to allow the coal to be shaped, and then it is carbonized in formed shapes in a vertical furnace to obtain coke.

2. Features

A series of steps are employed in FCP, including raw material processing, shaping, carbonizing the formed coal, and cooling the carbonized coke. In particular, the carbonizing and cooling steps are conducted in a vertical furnace within an enclosed system, providing many superior features in terms of work environment, work productivity, ease of system starts and stops. Relative to conventional chamber ovens, FCP systems are compact, meaning less installation space is required.

3. Results of study

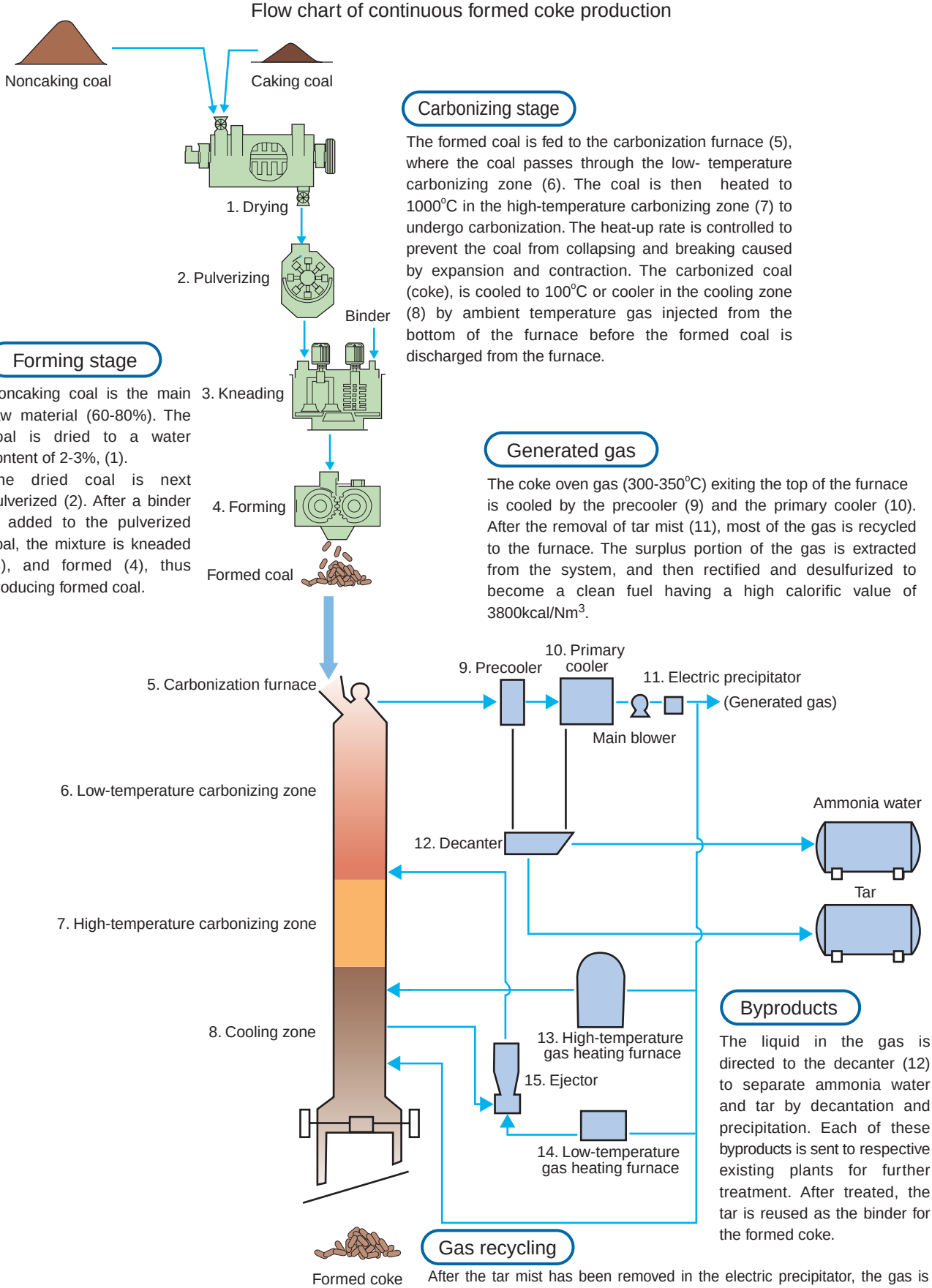
1. Production of formed coke from 100% noncaking coal
The pilot plant was normally operated with a blend of 70% noncaking coal and 30% caking coal; however, 100% noncaking coal operation was also attained.
2. Establishing stable operating technology and engineering technology
The pilot plant was operated for an extended period at the facility capacity of 200 tons/day. Production of 300 tons/day, or 1.5 times the designed capacity, was also achieved. Regarding the unit requirement of heat, 320 Mcal/t-formed coal was achieved.
3. Extended period of operation and continuous use of 20% formed coke in large blast furnace
In a large blast furnace, a long and continuous operating test was carried out for 74 days with standard 20% formed coke and a maximum blend of 30% formed coke to confirm that the formed coke can be used in a similar way as chamber oven coke.

4. Research and development progress

Table 1 Research and development progress

Fiscal year	1978	1979	1980	1981	1982	1983	1984	1985	1986
Core									
Pilot plant test				Construction			Test operation		

Flow chart of continuous formed coke production



Carbonizing stage

The formed coal is fed to the carbonization furnace (5), where the coal passes through the low- temperature carbonizing zone (6). The coal is then heated to 1000°C in the high-temperature carbonizing zone (7) to undergo carbonization. The heat-up rate is controlled to prevent the coal from collapsing and breaking caused by expansion and contraction. The carbonized coal (coke), is cooled to 100°C or cooler in the cooling zone (8) by ambient temperature gas injected from the bottom of the furnace before the formed coal is discharged from the furnace.

Forming stage

Noncaking coal is the main raw material (60-80%). The coal is dried to a water content of 2-3%, (1).
The dried coal is next pulverized (2). After a binder is added to the pulverized coal, the mixture is kneaded (3), and formed (4), thus producing formed coal.

Generated gas

The coke oven gas (300-350°C) exiting the top of the furnace is cooled by the precooler (9) and the primary cooler (10). After the removal of tar mist (11), most of the gas is recycled to the furnace. The surplus portion of the gas is extracted from the system, and then rectified and desulfurized to become a clean fuel having a high calorific value of 3800kcal/Nm^3.

Byproducts

The liquid in the gas is directed to the decanter (12) to separate ammonia water and tar by decantation and precipitation. Each of these byproducts is sent to respective existing plants for further treatment. After treated, the tar is reused as the binder for the formed coke.

Gas recycling

After the tar mist has been removed in the electric precipitator, the gas is heated to approximately 1000°C in the high-temperature gas heating furnace (13). It is then injected into the high-temperature carbonizing zone (7). The gas, heated to 450°C in the low-temperature gas heating furnace (14) drives the ejector (15). The ejector (15) draws in the high-temperature gas that was used to cool the coke. Next, the gas is fed to the low-temperature carbonizing zone (6) at a temperature of approximately 600°C.