3A5. Coke Dry Quenching Technology (CDQ)

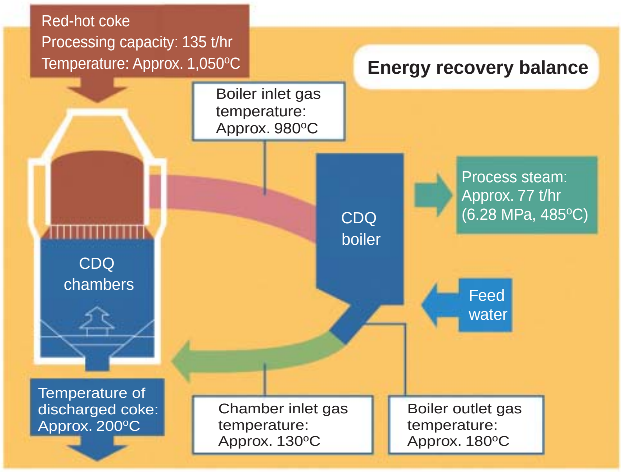
Outline of technology

1. Overview

Overview of CDQ (Coke Dry Quenching) system

The coke oven consists of plate-like carbonization chambers alternately arranged in a sandwich form to achieve higher thermal efficiency in carbonization.

Raw material placed in the carbonization chambers is heated to a temperature between approximately 1100 and 1350°C through the combustion of blast furnace gas in the combustion chambers, which are located on both sides of the carbonization chambers beyond the refractory brick. The heated raw material is not exposed to air for approximately 12 to 14 hours to allow carbonization to proceed. In this process, the fixed carbon contained in the raw material fuses and solidifies to become red-hot coke in the lower section of the carbonization chambers. The volatile component in the raw material vaporizes and decomposes, becoming gas. After escaping from the coke surface, the gas is collected through a pipe located in the upper section of the carbonization chambers. When carbonization is complete, the red-hot coke (approximately 1,050°C) is discharged from the coke oven and then carried to the top of the chambers. The coke is then fed to the chambers and while it descends through the chamber, is cooled with circulating gas blown from the bottom of the chamber. After it has cooled to approximately 200°C, the coke is ejected from the bottom, while the circulating gas that has been heated to 800°C or higher generates high-temperature and high-pressure steam in the boiler. The gas is purified by a dust collector and then sent back to the chambers for recycling. The generated steam is used as process steam or for power generation.



Sample CDQ operating data

Capacity	56t/hr
Coke charge temperature	1000-1050°C
Coke output temperature	200°C
Gas inlet temperature	170°C
Gas outlet temperature	800-850°C
Steam generation	25t/hr
Steam pressure	40kgf/cm^2
Steam temperature	440°C
Total gas volume	84,000Nm^3/hr

Comparison of CDQ coke quality

	Wet quenching	Dry quenching
Water content (%)	2-5	0.1-0.3
Ash content (%)	11.35	11.39
Volatile components (%)	0.50	0.41
Average particle size (mm)	65	55
Powder rate (after cut) (-15 mm%)	10	13
Porosity (%)	49	48
DI^{150}_{15} (%)	83.5	85.5
DI^{150}_{15} (%)	12.9	17.9
Coke strength after small reaction (%)	50	52

Composition of circulating gas

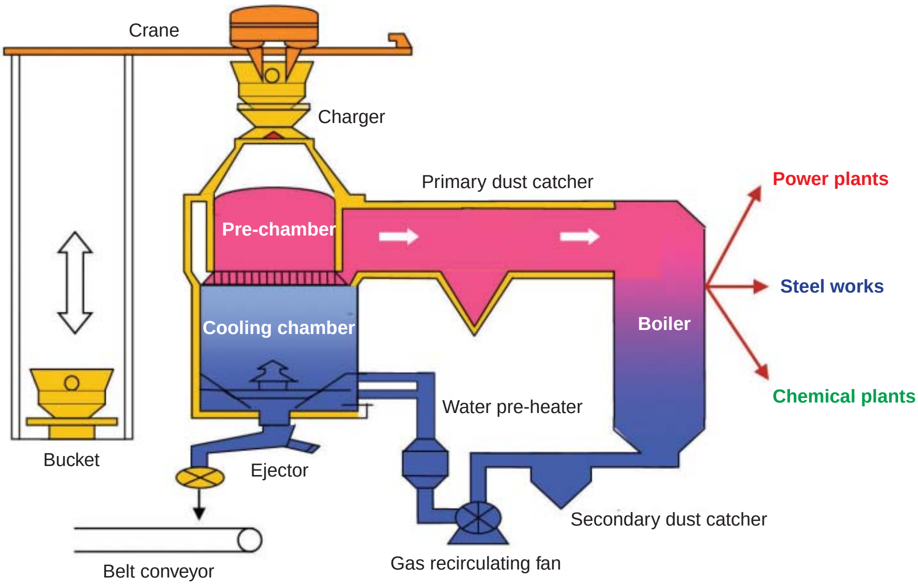
Gas	CO_2	CO	H_2	N_2
Concentration (%)	10-15	8-10	2-3	70-75

CDQ plants

Company	Works	Target furnaces	Coke processing capacity (t/hr) (units)	Plants			Put into service
				Steam (t/hr)	Pressure (kg/cm^2)	Temperature (°C)	
Nippon Steel	Oita	No. 1, 2	190 (1)	112.0	95	520	Oct. 1988
	Oita	No. 3, 4	180 (1)	92.5	93	520	Aug. 1985
	Yahata	No. 4, 5	175 (1)	120.0	75	495	Feb. 1987
	Nagoya	No. 1, 2	106 (1)	65.0	117	525	Sept. 1985
	Nagoya	No. 3	96 (1)	65.0	117	525	Jul. 1995
	Nagoya	No. 4	129 (1)	71.4	117	525	Feb. 1982
Nippon Steel Chemical	Kimizu	No. 1, 2, 3	110 (3)	60.0	95	520	Oct. 1982, Aug. 1983
	Kimizu	No. 4, 5	170 (1)	108.0	95	520	Jan. 1988
Hokkai Steel	Muroran	No. 5, 6	108 (1)	56.5	64	490	Jul. 1981
JFE Steel	East Japan	No. 5	100 (1)	50.0	52.5	436	Apr. 1981
	(Chiba)	No. 6, 7	56 (3)	30.0	25.0	228	Jan. 1977
	East Japan	No. 1	70 (5)	39.0	20	280	Sept. 1976
	(Keihin)	No. 2	70 (3)	39.0	20	280	Jul. 1979
	West Japan	No. 3, 4	100 (2)	64.9	99.0	330	Aug. to Sep. 1983
	(Kurashiki)	No. 5, 6	130 (1)	85.0	99.0	330	Jan. 1986
	West Japan	No. 4	125 (1)	69.0	105	540	Apr. 1986
	(Fukuyama)	No. 5	200 (1)	116.5	85	520	Feb. 1990
		No. 3	185 (1)	111.7	86	523	Jan. 1997
Sumitomo Metal Industries	Kagoshima	No. 1ABCD	195 (1)	100.0	105.0	545	Mar. 1986
		No. 2AB	150 (1)	65.0	105.0	545	Jan. 1984
		No. 2CD	130 (1)	65.0	105.0	545	Nov. 1981
	Wakayama	No. 6	100 (1)	60.0	102	540	Apr. 1994
Kansai Coke and Chemicals	Kakogawa	No. 1, 2	140 (1)	84.0	112.0	556	Jun. 1987
		No. 3, 4	150 (1)	98.0	112.0	556	Oct. 1998
Nakayama Steel Works	Funamachi	No. 2	58 (1)	31.0	65	490	May 1991

2. Features of CDQ system

Conventional system	The red-hot coke extruded from the coke oven is cooled by spraying it with water. The water used for cooling is vaporized and released into the atmosphere. An issue with this conventional system is the energy loss when the thermal energy of the red-hot coke is converted into heat that is vaporized and released unused. Another drawback is that the conventional system also produces airborne coke dust.
CDQ system	In the CDQ system, the red-hot coke is cooled by gas circulating in an enclosed system, thereby preventing the release of airborne coke dust. The thermal energy of the red-hot coke, which is lost in the conventional system, is collected and reused as steam in the CDQ system. This technology uses less fossil fuel and results in lower CO_2 emissions, thereby contributing to the prevention of global warming.



CDQ process flow

3. Dissemination of coke dry quenching (CDQ) systems

CDQ systems have been installed in many steel works and coke ovens in Japan as energy-efficient, environmentally-friendly technology.
Through NEDO model projects, the effectiveness of CDQ has also been recognized in China. The Chinese government specified CDQ technology as one of the targets in the Tenth 5-year plan in 2000.
Steel works in Hanfang, Beijing, Chengde and Hangzhou have already introduced Japanese CDQ systems.

Reduction of CO_2 emissions (expected energy conservation: heat collected from generated steam = 604.3 Tcal/year)

Scenario	CO_2 emissions ($t\text{-}CO_2$/year)
CO_2 emissions from CDQ project	1,771,569
Baseline CO_2 emissions	1,908,311
Expected reduction of CO_2 emissions	136,742

4. Future prospects

The Asian region is expected to continue increasing its production of crude steel. Efforts to introduce CDQ are being made in China and India. CDQ is an established technology that can help Japan to achieve its Kyoto Protocol target via the use of CDM projects.