3A4. Super Coke Oven for Productivity and Environment Enhancement toward the 21st Century (SCOPE21)

Research and development: Japan Coal Energy Center; and Japan Iron and Steel Federation
Project type: Coal Production and Utilization Technology Promotion Grant
Period: 1994-2003 (10 years)

Technology Overview

1. Background and process overview

The existing coke production process, which rapidly heats the coal at 350°C (low temperature carbonization), as opposed to the old method employing a 1200°C coke furnace, has many problems. These include the unavoidable coal grade limitation necessitating the use of mainly strong caking coke owing to the limitation of coke strength, significant energy consumption due to the characteristics of the process, as well as environmental issues. Coke ovens in Japan have reached their average lifespan of approximately 30 years, and are entering a replacement phase. Given this requirement to replace the ovens, there is a need to develop an innovative, next-generation coke production technology that has the flexibility to handle coal resources, that is energy efficient, that has excellent environmental characteristics, and that is also highly productive. Responding to these needs, a team developed a new coke process.

The SCOPE21 process aims to develop an innovative process responding to the needs of the 21st century in terms of the effective use of coal resources, improvements in productivity, and advancement of environmental and energy technologies. As shown in the Figure 1, the existing coke production process is divided into three stages along the process flow, namely 1) rapid heating of coal, 2) rapid carbonization, and 3) medium-to-low temperature coke reforming. Development was carried out of a revolutionary process with overall balance that pursued the functions of each stage to the utmost.

Currently, SCOPE21 is just one large development project for new coke processes in the world, and it is hoped that it can be put to practical use.

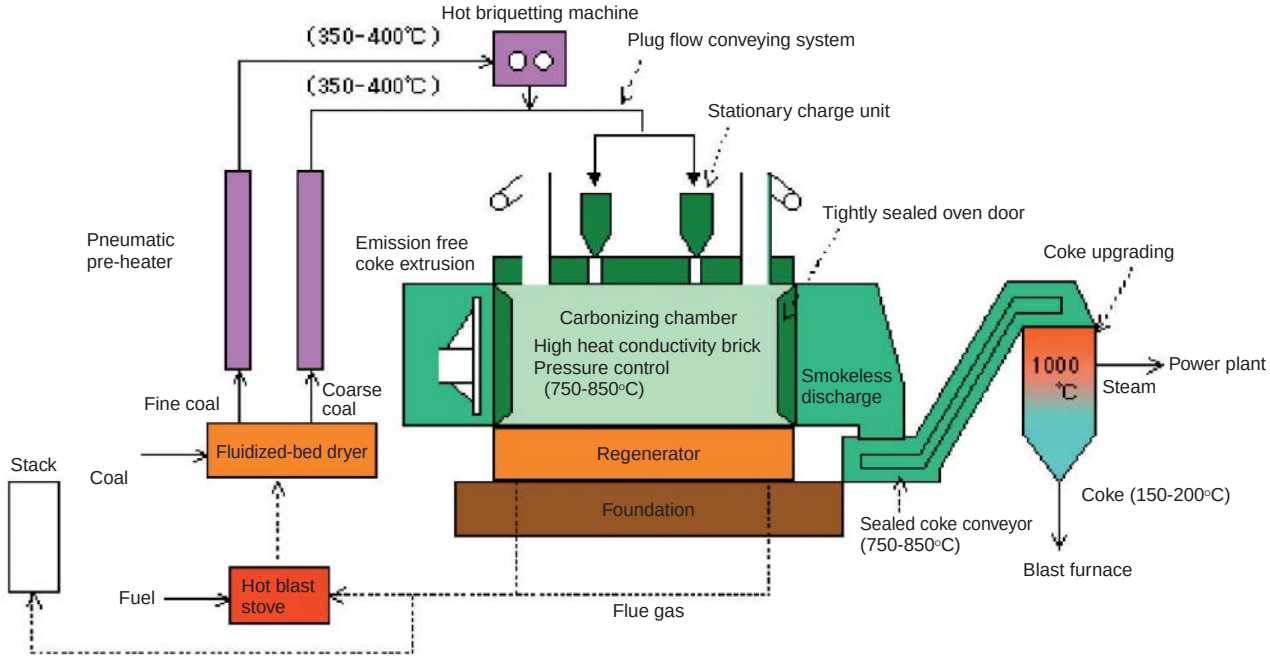


Fig. 1 Process flowchart of next-generation coke oven process

2. Development objectives and technology to be developed

(1) Increasing the ratio of noncaking coal use to 50%

With the aim of increasing the ratio of noncaking coal use to 50%, a level that is currently only approximately 20% (noncaking coal is not the most suitable material for coking), the study develops the technology to increase the bulk density of charging coal through the improvement of caking properties utilizing the rapid heating coal technology and through a process to form the fine coal powder.

(2) Increasing productivity threefold

With an aim to increase the productivity threefold relative to the current level, the study significantly reduces the carbonizing time by increasing the thermal conductivity of the carbonizing chamber wall and by discharging the material at temperatures lower than the normal carbonization point, (medium-to-low temperature carbonization). The resulting insufficient carbonization temperature is compensated for by reheating in the coke dry quenching unit (CDQ) to secure the product quality.

(3) Reducing NOx generation by 30% and achieving smokeless, odorless, and dustless operation

Full-scale prevention of generation of smoke, odor, and dust

during coke production is attained through the sealed transportation of coal using a "plug transportation" method, the sealed transportation of coke, and the prevention of gas leaks from the coke oven by applying intra-furnace pressure control. Furthermore, the improved combustion structure of the coke oven reduces NOx generation.

(4) Energy savings of 20%

The amount of energy necessary to produce coke is to be reduced by 20% through 1) the increase in the temperature to start the carbonization by pre-heating the charging coal to a high temperature, 2) the reduction in carbonization heat by reducing the discharging temperature, 3) applying medium-to-low temperature carbonization, and 4) the easy recovery of sensible heat from the generated gas and combustion flue gas owing to the scale reduction of the facilities, resulting in increased productivity.

3. Progress and development results

The project was conducted as a joint effort between Japan Coal Energy Center, and the Japan Iron and Steel Federation. A pilot plant (6 t/hr) was constructed at Nippon Steel Corp.'s Nagoya Works, (See Photo 1), and test operations were conducted.

Photo 1 Pilot plant

Energy Savings and Economic Evaluation

The SCOPE21 process is composed of innovative technologies, enabling the effective use of coal resources, energy savings, and environmental enhancements. As a result, it has great economic advantages over the conventional process.

Reduction of construction costs

	Coke oven	Pretreatment	Common equipment	Total
Conventional	89	---	11	100
SCOPE21	40	25	19	84

Energy savings

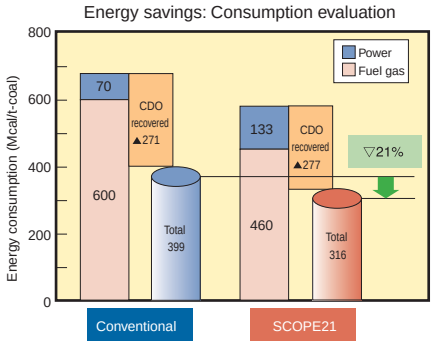
Reduction of total energy use by 21% due to the adoption of a pretreatment process with the direct heating of coal and a high-efficiency coke oven with a heat recovery system.

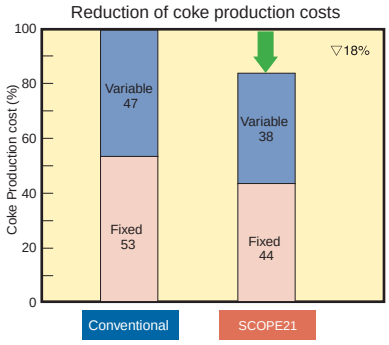
Construction costs

Reduction of 16% by greatly reducing the number of coke ovens even while expanding the coal pretreatment plants and environmental protection measures.

Coke production costs

Reduction of 18% by increasing the poor coking coal ratio and decreasing construction costs even while increasing electricity and fuel gas consumption in the coal pretreatment plant.





SCOPE21 Development schedule

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Survey and study										
Core technology development										
Pilot plant study										

Core technology combination test

Construction

Disassembly and investigation

Test operation

4. Issues and feasibility of practical application

Although there has been progress made in the development of furnace repair technology, coke ovens in Japan continue to age and thus still need to be replaced as scheduled. The developed technology will be introduced to these aging coke ovens, though its introduction will be influenced by economic conditions.

Reference

1) Kunihiko Nishioka et al., Lecture papers at the 12th Coal Utilization Technology Congress, Tokyo, pp.1-2., November 1, 2002.