2B2. Integrated Coal Gasification Combined Cycle (IGCC)

Research and development: Clean Coal Power R&D Co., Ltd.
(Until 2000, the study had been conducted as a joint activity of power companies led by Tokyo Electric Power Co., Inc.)
Project type: Grant for "Demonstration of Integrated Coal Gasification Combined Cycle Power Generation," the Agency of Natural Resources and Energy of the Ministry of Economy, Trade and Industry
Period: 1999-2009

Technology Overview

1. Overview and objective of IGCC demonstration test

Integrated Coal Gasification Combined Cycle (IGCC) is a high-efficiency power generation technology which gasifies coal to be used as the fuel for gas turbines. Japanese power companies promoted the research and development of IGCC technology, applying a Nakoso pilot plant (PP)-type gasifier[1,2] as the core technology[3]. The PP-type gasifier utilizes dry-coal-fed, oxygen-enriched air-blown, pressurized two-stage entrained beds, as shown in Figure 1. This is expected to provide higher efficiency than preceding gasifiers from abroad. On the basis of the feasibility study results, an IGCC demonstration test project was started with the aim of validating IGCC's reliability, operability, maintainability, and profitability, and to confirm the feasibility of a coal-fired IGCC commercial plant.

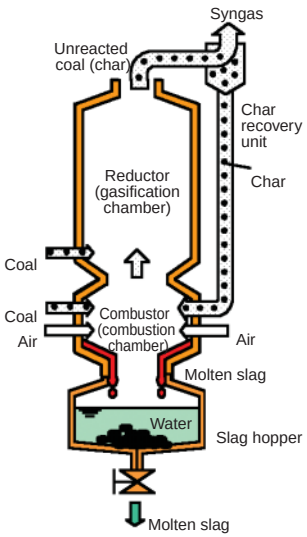

Fig. 1 Nakoso PP-type gasifier

Compared with conventional pulverized coal-fired power plants, IGCC has many advantages, such as:

1. Improved power generation efficiency: Compared with conventional pulverized coal-fired power plants, IGCC can increase power generation efficiency by approximately 20% for commercial plants.
2. Lower environmental burden: Owing to the increase in power generation efficiency, the emissions of SOx, NOx, and dust per generated power unit are lower. In addition, CO_2 emissions are reduced to the level of the heavy-oil-fired power generation process.
3. Flexibility to use different grades of coal: IGCC can use coal with low ash melting points, which is difficult to use in conventional pulverized coal-fired power plants. As a result, IGCC broadens the variety of coal grades that can be used in coal-fired power plants.
4. Increase in fields that can utilize the ash: Since IGCC discharges coal ash in the form of glassy molten slag, the ash is expected to be effectively used as component for civil engineering work.
5. Reduction of water consumption: Since the generated gas is desulfurized directly, IGCC does not need a flue gas desulfurization unit, which consumes large amounts of water. Accordingly, IGCC uses significantly less water than conventional pulverized coal-fired power plants.

2. Specifications and objective of IGCC demonstration plant

Figure 2 shows the process flow of the IGCC demonstration plant. Table 1 lists the main specifications and target values. Figure 3 is a conceptional drawing of the IGCC demonstration plant. The scale of the plant (250 MW, 1700 t/d of coal feed) is about one-half of a commercial plant. The gasifier is of the Nakoso PP-type. A wet gas clean up system with MDEA has been adopted. The gas turbine is a 1200°C-class gas turbine, with a corresponding output of 250 MW.

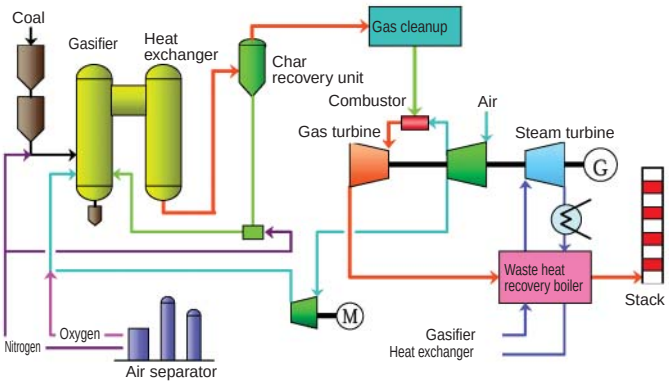

Fig. 2 Process flow of the IGCC demonstration plant

Table 1 Main specifications and target values of IGCC demonstration plant

Output	250 MW class	
Coal feed rate	Approximately 1,700 t/d	
Type	Gasifier	Dry-coal-fed, air-blown, Pressurized, two-stage entrained beds
	Gas cleanup	Wet gas cleanup (MDEA) + gypsum recovery
	Gas turbine	1200°C-class
Target thermal efficiency (LHV)	Gross efficiency	48%
	Net efficiency	42%
Environmental characteristics (target values)	SOx emission concentration	8 ppm (O_2 conversion: 16%)
	NOx emission concentration	5 ppm (O_2 conversion: 16%)
	Dust emission concentration	4 mg/Nm^3 (O_2 conversion: 16%)

3. Organization for executing the IGCC demonstration test

The IGCC demonstrative test is being conducted by Clean Coal Power R&D Co., Ltd. (CCP R&D Co., Ltd.), which was established by nine power companies and J-POWER. The Ministry of Economy, Trade and Industry is subsidizing 30% of the project costs, and 70% of the costs are being borne by a total of eleven entities: nine power companies, J-POWER and the Central Research Institute of Electric Power Industry (Fig. 4).

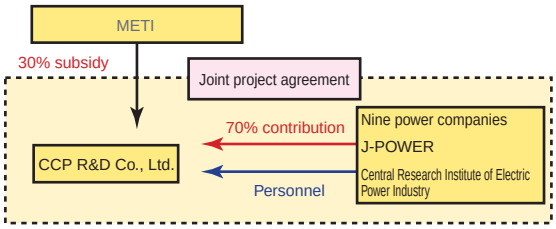

Fig. 4 Scheme of demonstration project

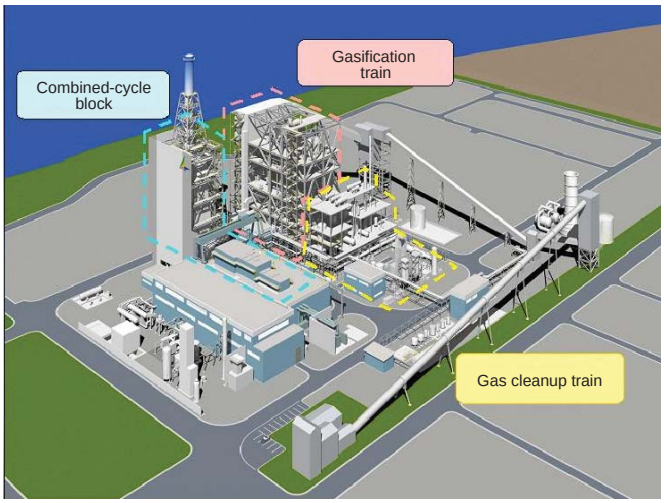

Fig. 3 Conceptional drawing of the IGCC demonstration plant

4. Timetable and progress

Table 2 shows the schedule of the demonstration project. The demonstration plant has been under construction since March 2006. A three-year test operation of the plant is scheduled to begin in the second half of FY2007.

Table 2 IGCC demonstration project timetable

Fiscal year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Preliminary validation test											
Design of demonstration plant											
Environmental assessment											
Construction of demonstration plant											
Plant operation and demonstration test											

5. Activities to date

The pilot plant test (200 t/d of coal feed), which is a preliminary stage of the demonstration test, was carried out from 1986 to 1996 at Joban Joint Power Co., Ltd.'s Nakoso power plant in Iwaki City, Fukushima, (Fig. 5). The pilot plant test was conducted jointly by nine power companies, plus J-POWER and the Central Research Institute of Electric Power Industry, as an entrusted project of NEDO. A pilot plant test of 4,770 hours, including 789 hours of continuous operation, proved the practical applicability of the IGCC technology[3]. Based on the success of the pilot plant test, a demonstration test introduced an optimum system, which was selected following a feasibility study conducted by NEDO. After conducting a variety of surveys, Joban Joint Power Co., Ltd.'s Nakoso power plant was again selected as the site for the demonstration test, which is being conducted at the same site of the pilot plant.

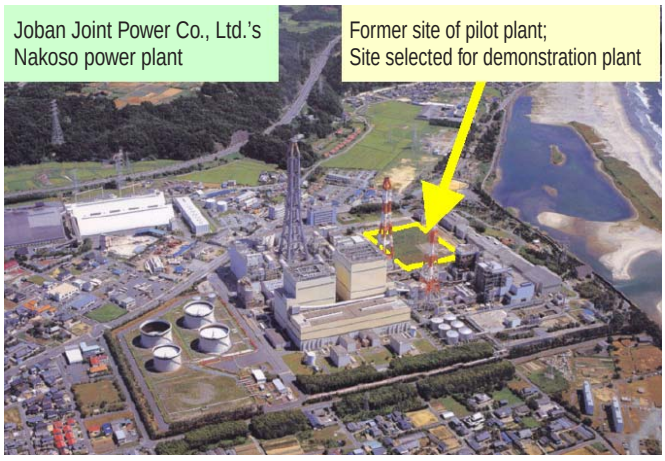

Fig. 5 Site for demonstration test. (Iwaki City, Fukushima)

References

1) Shozo Kaneko et al., "250MW AIR BLOWN IGCC DEMONSTRATION PLANT PROJECT,"Proceedings of the ICOPE-03, pp. 163-167, 2003.
2) Christopher Higman, Maarten van der Burgt, "Gasification," pp. 126-128, 2003.
3) Narimitsu Araki and Yoshiharu Hanai: Bulletin of Japan Energy, 75-9, pp. 839-850, 1996.