2A6. Pressurized Fluidized-bed Combustion Technology (PFBC)

Research and development: Japan Coal Energy Center; and J-POWER
Project type: Coal Production and Utilization Technology Promotion Grant
Period: 1989-1999 (11 years)

Technology Overview

1. Background and process overview

(1) The research and development of pressurized fluidized-bed combined power generation technology was conducted at J-POWER's Wakamatsu Coal Utilization Research Center (now known as Wakamatsu Research Institute) using a 71 MWe-PFBC Plant, the first PFBC plant in Japan. The test plant was the first plant in the world to adopt a full-scale ceramic tube filter (CTF) capable of collecting dust from high-temperature, high-pressure gas at a high-performance level. An overview of the process is shown in Figure 1.

(2) Overview of facilities
Plant output 71.0 MWe
Pressurized fluidized-bed combustion boiler (ABB-IHI production)
Bubbling-type pressurized fluidized-bed, coal water paste (70-75%) injection-type
Combustion temperature: 860°C
Combustion air pressure: 1 MPa

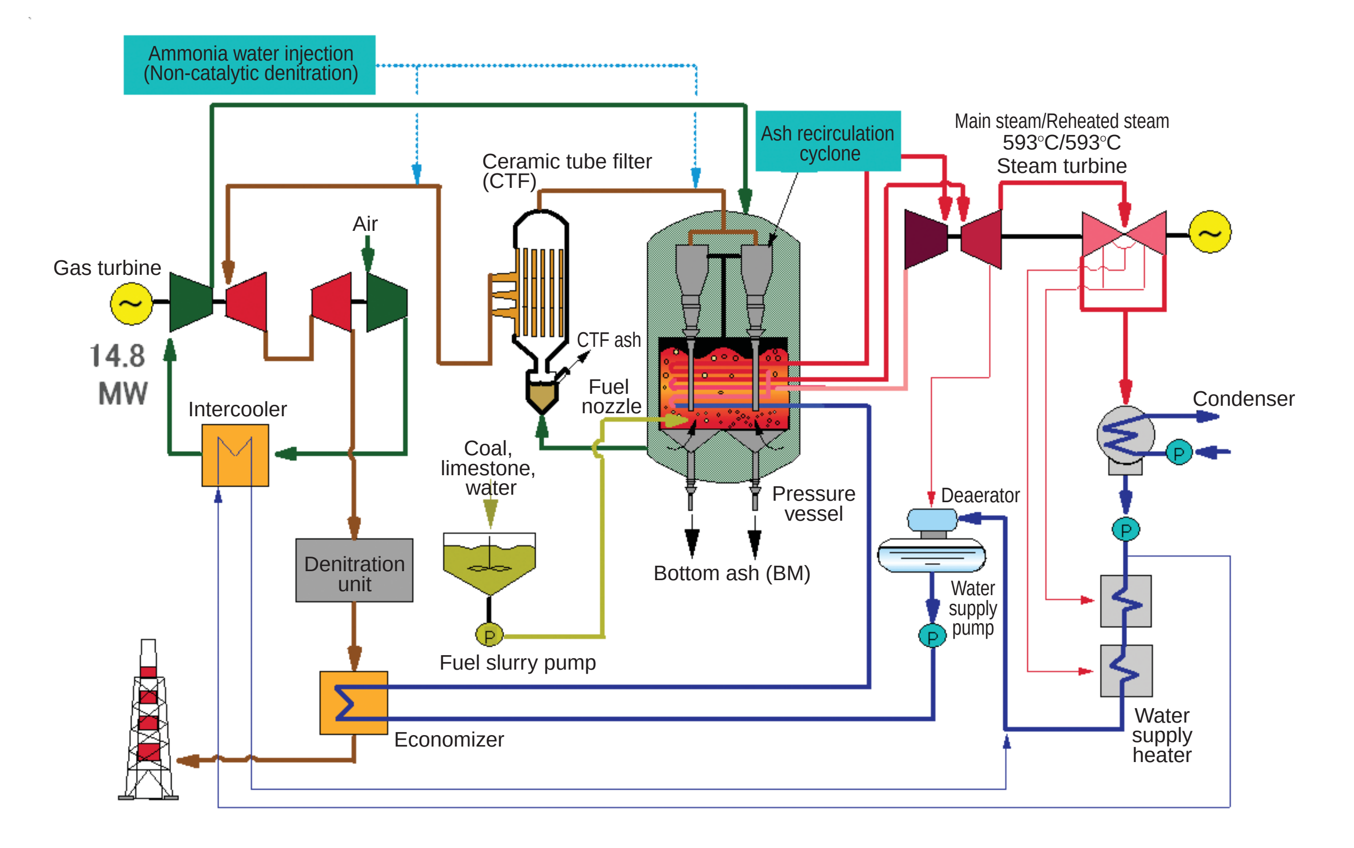


Fig. 1 Flowchart of PFBC process

2. Development objective and technology to be developed

PFBC technology development objectives:

(1) Increase efficiency through combined power generation utilizing pressurized fluidized-bed combustion with a gross efficiency of 43%.

(2) Providing advanced environmental features, including:
SOx reduction through in-bed desulfurization; NOx reduction through low-temperature combustion (approximately 860°C); Dust reduction by CTF; and CO_2 reduction through increased efficiency.

(3) Space-savings through a compact pressurized boiler and the elimination of the desulfurization unit.

Results of PFBC technology development:

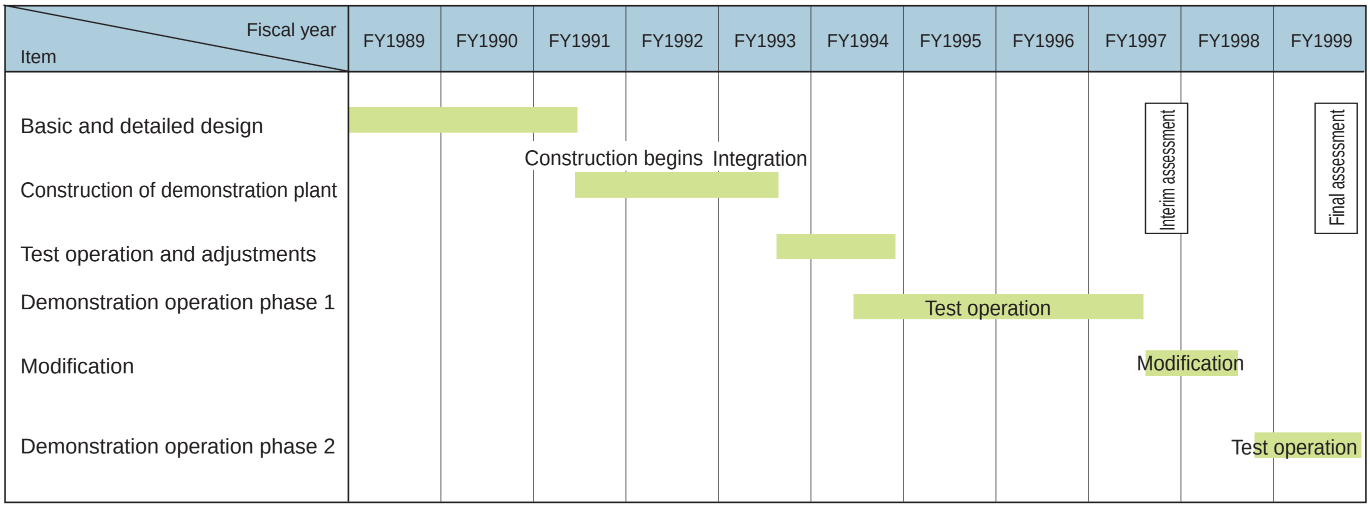
(1) Gross efficiency of 43% was achieved by increasing efficiency through combined power generation utilizing pressurized fluidized-bed combustion.

(2) SOx level of approximately 5 ppm through in-bed desulfurization; NOx level of approximately 100 ppm through low-temperature combustion (approximately 860°C), and dust of less than 1 mg/Nm^3 by CTF.

3. Progress and development results

Detailed design of the facilities began in FY1990 and construction began in April 1992, with equipment installation commencing in October 1992. Test operations began in April 1993, while coal combustion was commenced in September 1993, and 100% load capacity was achieved in January of 1994. The two-stage cyclone system passed inspections before entering operations in September 1994, and the CTF passed inspections before entering operations in December 1994. Phase 1 of the demonstration operation was conducted until December 1997. After that, the plant was modified to adopt the ash-recycling system. Phase 2 of the demonstrative operation was conducted from August 1998 to December 1999. The cumulative operating time of the PFBC system was 16,137 hours, including 10,981 hours in phase 1 and 5,156 hours in phase 2. In phase 2, the system was operated continuously for 1,508 hours. Through the operation, valuable data and findings were made in terms of performance and reliability. Three electric power companies have already applied these results during the construction of commercial facilities.

PFBC development schedule



4. Issues and feasibility of practical application

Due to its environment-friendly characteristics, including SOx emissions of 10ppm or less, NOx emissions of 10 ppm, and dust concentration of 1mg/Nm^3 or less, and also due to the space-savings brought about by the elimination of the desulfurization unit, the PFBC system is highly suitable for urban-operation. These advantages are obtained by: the flexibility to utilize a variety of fuels, such as difficult-to-combust or low-grade materials and waste by utilizing the technology's superior combustion performance; the in-bed desulfurization; the combination of catalytic or non-catalytic denitration; and the high-temperature and high-performance dust collection from the CTF. An outstanding issue is improving the cost-efficiency by fully leveraging these characteristics of the system and by selecting a proper location.

Reference

Yamada et al., "Coal Combustion Power Generation Technology," Bulletin of the Japan Institute of Energy, Vol. 82, No. 11, pp. 822-829, November 2003.