2A5. Coal Partial Combustor Technology (CPC)

Research and development: Japan Coal Energy Center; Kawasaki Heavy Industries, Ltd.; JFE Steel Corp.; Chubu Electric Power Co., Inc.; and J-POWER
Project type: Coal Production and Utilization Technology Promotion Grant
Period: 1978-1986 (9 years)

Technology Overview

1. Background and technology overview

Owing to the abundant reserves and wide distribution of producing countries, the supply of coal is highly stable, and coal is well positioned as an important energy source for the future. However, compared with other fuels, such as oil and gas, coal contains large amounts of ash and nitrogen, which poses many utilization issues, including equipment problems caused by ash, and significant increases in NOx emissions. Furthermore, global warming has become an international concern in recent years, making it an urgent requirement to develop technology to reduce CO_2 emissions, one of the main causes of global warming. Since coal generates a large volume of CO_2 per calorific value, there is a need worldwide to develop technology to use coal in a highly-efficient, environmentally compatible way. A Coal Partial Combustor (CPC) is a furnace where coal and air are injected at high speed into a swirling melting furnace in a tangential direction, thus partially combusting (gasification) the coal under the conditions of a high-temperature, heavy load, and strong reducing atmosphere. After most of the ash in the coal is melted and separated for removal, the produced fuel gas is subjected to secondary combustion. CPC is a technology of coal gasification combustion in a boiler or a gas turbine to utilize coal highly-efficiently and in an environmentally compatible manner. There are two variations of CPC technology: one utilizing atmospheric pressure to produce atmospheric pressure clean gas with low calorific value, and the other under a further pressurized environment to produce highly-efficient power generation in combination with a gas turbine.

2. Atmospheric pressure coal partial combustor technology

Slag-tap boilers aim to reduce the volume and detoxify the ash discharged from the boiler and to use difficult-to-combust coal. They have been constructed and have been operated in a large number of Western countries. The conventional slag-top boiler has the advantages of high combustion efficiency and the recovery of ash as nontoxic molten slag. However, the method has the drawback of significant NOx emissions caused by high-temperature combustion.

Responding to this issue, our technology development focused on the development of a coal partial-combustor system aiming to simultaneously remove the ash from coal and limit NOx emissions. The developed system has the CPC directly mounted to the side wall of the boiler. The combustible gas generated in the CPC is directly injected to the boiler furnace, where the gas is completely combusted with injected air.

As small to medium coal-fired boilers, CPC can significantly reduce NOx emissions while maintaining the compactness of the boiler on a scale similar to that of an-oil fired boiler. It can recover all the coal ash as molten slag. Figure 1 shows a schematic drawing of a atmospheric pressure CPC boiler.

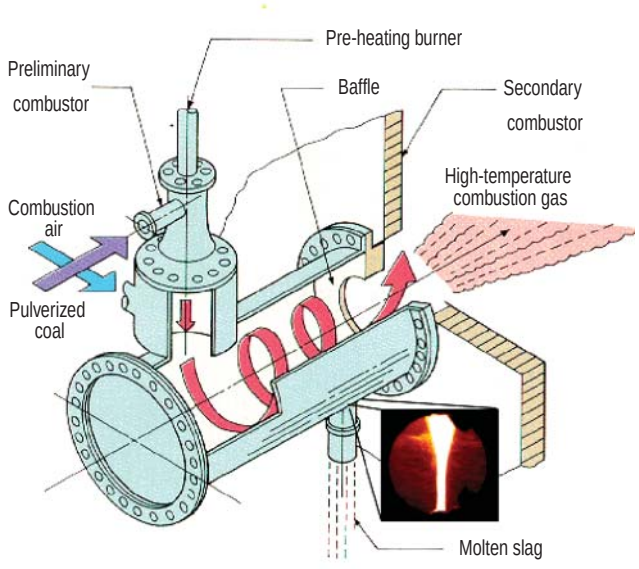

Fig. 1 Schematic drawing of an atmospheric pressure coal partial combustor (CPC) boiler

3. Pressurized coal partial combustor technology

On the basis of the results of the atmospheric pressure CPC development, the development of pressurized CPC technology began, with the objective of developing a high-efficiency power generation system by pressurizing CPC and combining it with a gas turbine.

Figure 2 below shows a basic flow chart of a pressurized CPC pilot plant having 25 t/d of coal gasification capacity (operating at 21% oxygen). The pilot plant ran the coal gas generation test using CPC under a pressure of 20 ata, which can be applied to a gas turbine. The test proved the effectiveness of the pressurized CPC.

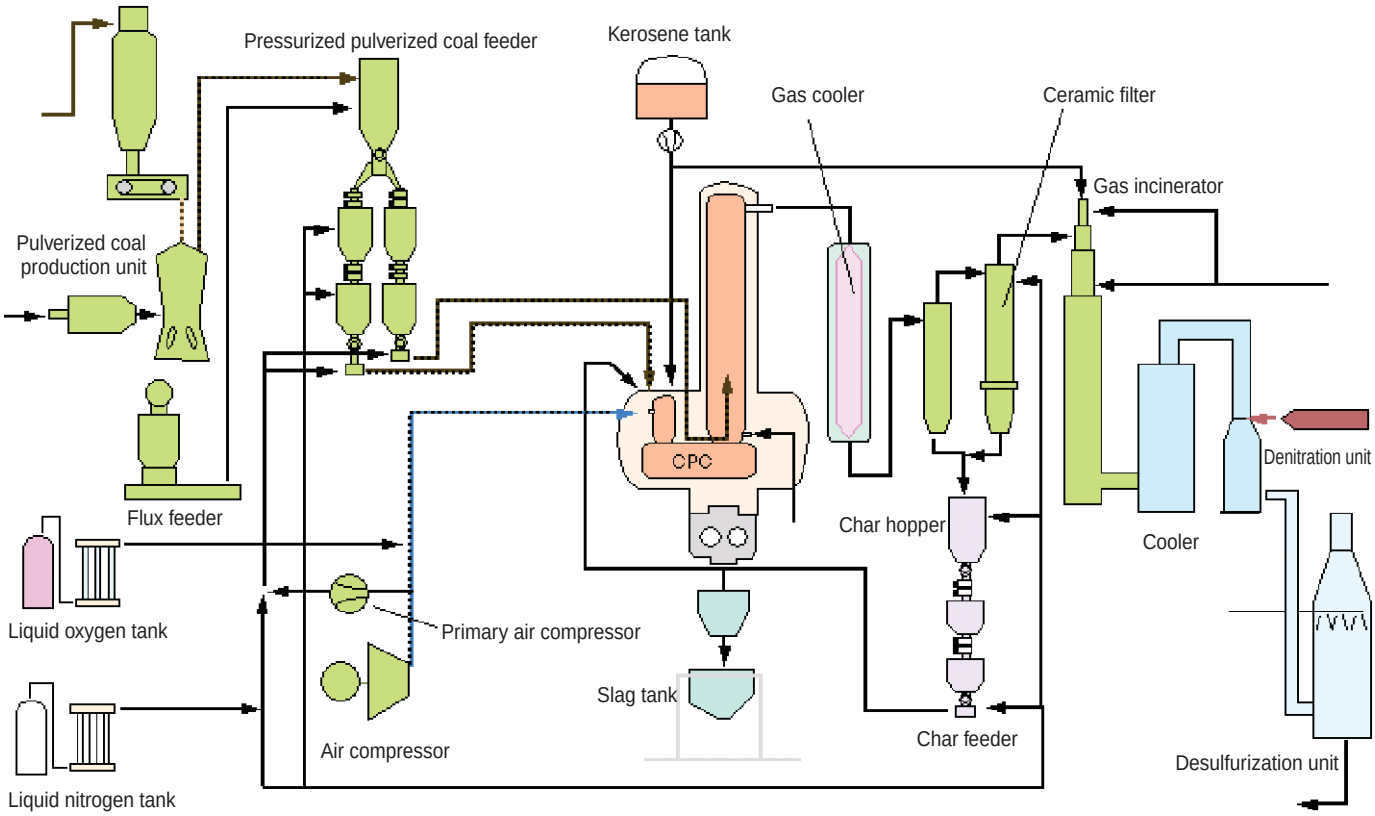

Fig. 2 Basic flow chart of a pressurized CPC pilot plant

4. Issues and feasibility of practical application

Atmospheric pressure CPC technology has already been brought into practical application as a low NOx emission technology in swirling melting furnaces of municipal waste gasification melting furnaces and in very low NOx boilers for heavy oil combustion. Atmospheric pressure CPC technology is also being used in the development of a coal-ash-melting, low NOx boiler. A pilot plant test for the pressurized CPC technology is nearing completion, and the technology is in the research and development stage in the private sector, with the aim of bringing it to practical use. These basic technologies have also been integrated with the development of biomass gasification gas turbine power generation technology.

Photo 1 Pilot plant