

4 - 4 Development of higher efficient Hyper Coal Direct firing Gas Turbine Power Generation System

Abstract

We placed FY 2000 as the year of an interim evaluation with the objective of yielding the results that lead to the future, and the designed objective for the contents and the results of the study was achieved as follows.

1.1 Study on the selective crushing and deashing technology

The largest objective of this filed in FY 2000 was to achieve the target value of alkali content in Hyper Coal (hereinafter referred to as "HPC") of 0.5 ppm or less using de-alkalization technology.

By improving the surface wettability of coal for solvent extraction (alkali content (Na + K) is a few ppm) of Nantong coal and Yanzhou coal using methanol or acetone, 0.6 ppm was achieved with the ion-exchange resin extraction process.

1.2 Study on the solvent deashing technology

The objective of this filed in FY 2000 was to achieve the ash content of 200 ppm or less in coal for solvent extraction and the extraction rate of 60% or over using 1-methylenaphthalene solvent with no hydrogen donation character for bituminous coal (Nantong coal and Yanzhou coal).

For Nantong coal, although 200 ppm of the ash content in HPC was achieved, Using "Yanzhou coal," solvent extraction was conducted at 370 °C, and with high temperature filtration and two stage filtration methods as solid-liquid separation methods, the ash content of less than 200 ppm and the extraction rate of more than 60% were achieved.

1.3 Study on the combustion technology of a gas turbine

To build a high-efficiency power generation system using HPC, it is necessary to establish a technology for directly burning a gas turbine.

The results of combustion tests showed that HPC, generated from bituminous coal (Nantong coal and Yanzhou coal), was expected to burn up in 「one second」 under specific combustion conditions of a gas turbine. These conditions are pressure of 1.5 Mpa, temperature of 1350 °C, air ratio of 2.3, 95% of HPC particle size of 200 mesh or less, and exit oxygen density of 12%.

Based on this result, with improvement in design accuracy of silo type combustors of which concept was designed in last fiscal year and that of the concept of a HPC fired power generation system, the net thermal efficiency was temporarily calculated to be “48%”.

1.4 Study on the evaluating technology for CO₂ emission by using LCA technology. This field's objective in FY 2000 was to evaluate the impact of CO₂ emitted from a HPC fired power generation system on the environment using LCA method and to compare the impact with those of the existing technology such as the pulverized coal-fired power generation system and IGCC. The objective also includes a cost estimate (a rough estimate) of a HPC fired power generation system.

Based on the LCA data derived from the HPC manufacturing process, the dealcalization process and the concept design of a HPC fired power generation system, CO₂ emission was estimated from these energy consumption rates and other factors.

The total CO₂ emission rate of a HPC fired power generation system calculated based on the LCA method was 0.180 kg-C/kwh, 20% reduction compared with that of the existing technology of the pulverized coal-fired power generation system.

Besides, residual coal is available as fuel for pulverized coal boilers, and the CO₂ emission when residual coal is used as fuel can be evaluated as equivalent to that of the conventional pulverized coal-fired power generation system. For a combined system of HPC fired power generation and the pulverized coal-fired power generation using residual coal, its power generating efficiency is 44%, and the CO₂ emission rate is 0.198 kg-C/kwh, reduced by 12% compared with the pulverized coal-fired power generation system individually.

The CO₂ emission of an oxygen brown IGCC. (Inlet Temp. of gas turbine:1300) is 0.186kg-C/kwh, reduced by 15% compared with the pulverized coal fired power generation system.