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Study of Hydrogen Co-firing in an Existing GTCC Power Plant

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Abstract

1. Evaluation of hydrogen co-firing

In this study, we select a specific thermal power station which has large vacant lot as hydrogen receiving terminal. We review about supplying a number of existing gas turbine combined cycle (GTCC) power station with mix fuel of natural gas and hydrogen from the hydrogen receiving terminal through an existing natural gas pipeline. The amount of received and supplied with hydrogen is calculated in consideration of hydrogen co-firing in a number of GTCC power stations. In the result the amount of supplied with hydrogen is about 5.5t/h and 41,000t/y.

Moreover a power station which can achieve high hydrogen co-firing rate relatively without remodeling the equipment is selected to study hydrogen co-firing. The hydrogen co-firing rate in the selected power station is calculated with about 15%-vol. However, the limited hydrogen co-firing rate is evaluated as 9.3%-vol. in consideration of co-firing test on the actual pressure and fluctuation of fuel heat value.

The output of power generation is +0.1%-relatively and the efficiency is -0.1%-relatively in the result of heat balance calculation with hydrogen co-firing rate of 9.3%-vol.

2. Planning of hydrogen supply terminal

In this study, we evaluate receiving terminal of hydrogen in both cases of liquefied hydrogen and methylcyclohexane (MCH). We plan the supply system of liquefied hydrogen and MCH, for example, equipment of unloading, storage, gasification and injection into the gas pipeline. Some main equipment are described as follows;

(1) Liquefied hydrogen

Storage tank: Flat-bottomed cylinder type, 75,000m^3/1tank

Vaporizer: Open rack type or underwater combustion type are dominant. However, they are still in the development stage.

BOG Compressor: BOG accounts for at least half of the hydrogen supply. Optimum operation is required.

(2) MCH

MCH tank: Inner float type, ID31m, H21m, 13,000m^3×3tanks

Toluene tank: Inner float type, ID28m, H21m, 10,100m^3×3tanks

Dehydrogenation reactor: Vertical multi-tubular fixed bed reactor. Separates hydrogen and toluene from MCH by supplying heat via heat medium.

3. Basic design of hydrogen co-firing system

The hydrogen co-firing system in the selected power station is designed and the behavior of mixing hydrogen with natural gas is analyzed. We design electrical instrumentation and control system in hydrogen co-firing in the selected power station.

When the mixed gas of natural gas and 9.3%vol. hydrogen is supplied to the power station in stable property, the combustor of GT can be started up with the mix gas and the load following capability is satisfied.