Development of Dry Gas Cleaning System for Biomass/Refuse Gasification Power Generation
− Performance Verification by Tests with Pilot Plant and Feasibility Evaluation −

Background

Gasification power generation plants have significant potential for highly efficient power production utilizing biomass and refuse derived materials, which will establish the recycling-based society. The suitable capacity of the power plant will be between several hundred kilowatts to a few thousand kilowatts for the expected users including municipalities. The gas purification system for the plant should be superior in operability and easy maintenance by eliminating waste water treatment; high environmental compatibility is also required in the system as well. CRIEPI has suggested the dry gas purification system as displayed in Fig. 1 and has developed a series of sorbents that are required in the system *1. It is necessary to evaluate the gas purification performance of the system with a demonstration plant and to examine feasibility of the commercial size plant.

Objectives

The study aims to prove performance of the dry gas purification system by a series of tests of the developed or selected sorbents in the demonstration plant under a stream of actual biomass-derived gas. According to the test results, the advantage and the feasibility of the dry gas purification is evaluated by designing tentatively the commercial size plant and comparing with a conventional wet system of the same size.

Principal Results

1. Performance of the dry gas purification system

Performance evaluation was tested by installing the developed and selected sorbents in the demonstration plant under simulated gas stream containing various impurities. Power generation test was conducted by introducing the actual biomass gas from biomass gasifier to the plant and by supplying the purified gas to the molten carbonate fuel cell (MCFC). Sufficient performance for impurity removal was attained with copper-based mercury sorbent, glass fiber reinforced halide sorbent and zinc oxide sulfur sorbent as shown in Fig. 2. The purified fuel gas derived from biomass accomplished stable power generation with the MCFC as indicated in Fig. 3. These results demonstrated that the dry gas purification system fulfills the requirement for biomass gasification power generation as well as regulations for environmental protection.

2. Feasibility evaluation of the dry gas purification system

The commercial sized system that includes the fixed bed system utilizing the sorbents was designed by using performance data acquired for the developed and selected sorbents. The plant scale was adjusted to the gasifier with processing capacity of 25 t/d of biomass material. The wet gas purification system with same scale and removal performance was configured by conventional process. The utility, plant size, capital cost and operational cost were compared for both systems. The dry system consumes 30% less auxiliary power (internal consumption rate of 14%), which will contribute to the efficiency increase. Plant size of the dry system is 30% smaller than the wet system because of its simple system configuration, thus the plant cost is possibly reduced by 20%. Operational cost for the dry system is significantly low because the absorbing solvent for wet desulfurization, detergents, and waste water treatment can be eliminated.

These results revealed that the dry gas purification system is superior to the wet system. The dry gas purification system is sufficiently feasible to establish the biomass gasification power generation system.

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Reference

M. Kobayashi, et al., “Process Development for High Temperature Gas Purification System for Biomass/Refuse Derived Fuel Gasification Power Plant. -Feasibility Evaluation of the System by Pilot Plant Tests-” Technical Reports M07022 (in Japanese)

*1 : Kobayashi et al., “Development of Dry Gas Cleaning System for Multiple Impurities for Biomass Derived Gasification-Fuel. -(each report has its specific subtitle according to the developed sorbents) -”, Series of CRIEPI Reports M06007, M06008, M06009 (in Japanese)

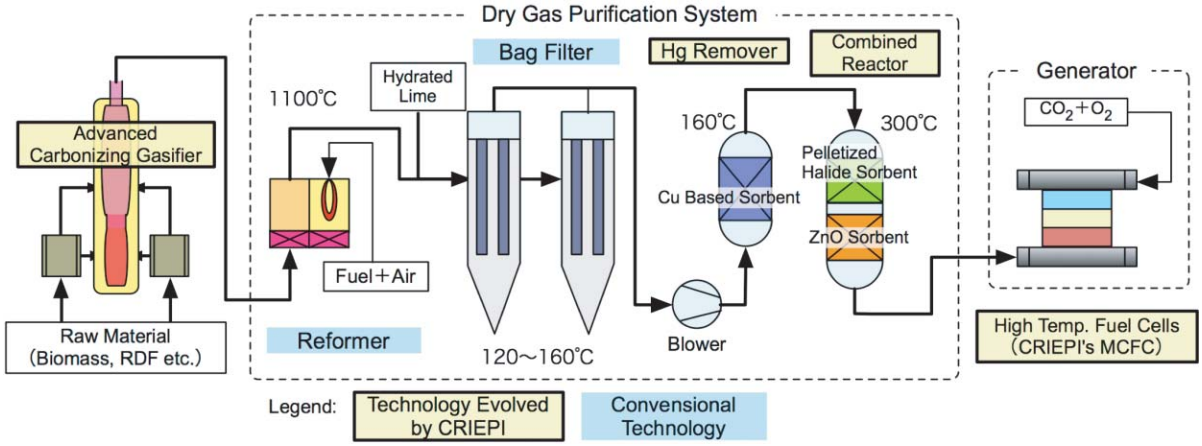

Fig.1 System configuration of dry gas purification system for the biomass/refuse gasification power generation.

The thoroughly dry gas purification system that combines conventional process with the processes based on CRIEPI developed impurity removal sorbents has potential to obtain purified gas applicable to the MCFC power generation.

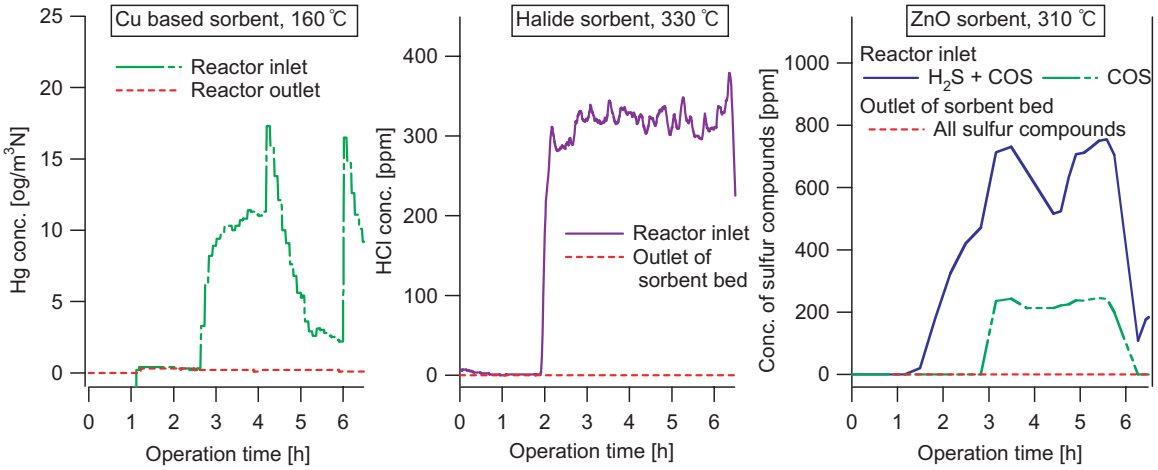

Fig.2 Impurity removal performance of the system evaluated by introducing simulated fuel gas.

Concentration of all impurity was reduced below the detection limit of corresponding analyzer instruments, thus the sufficient performance for impurity removal was demonstrated for copper-based mercury sorbent, glass fiber reinforced halide sorbent, and zinc oxide sulfur sorbent.

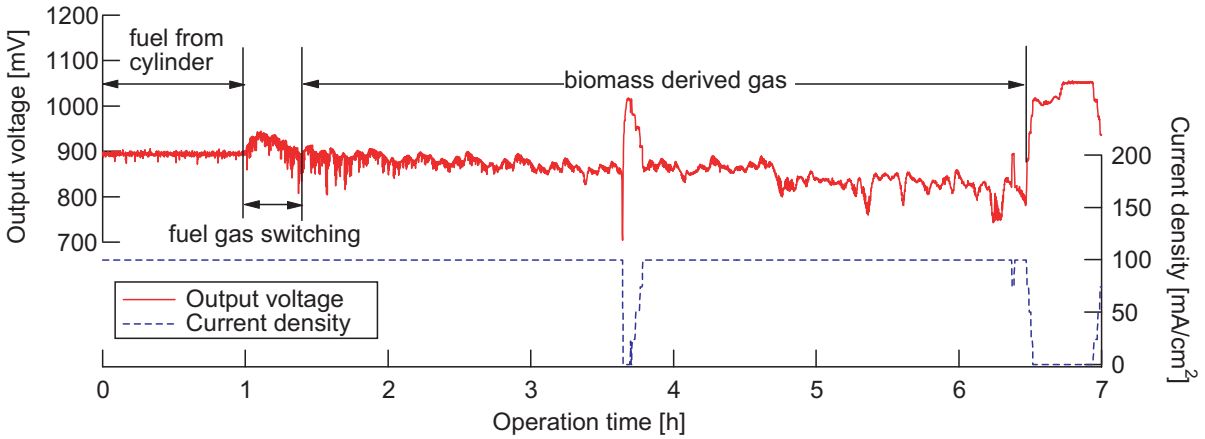

Fig.3 Demonstration test result of the dry gas purification system by operating MCFC with the purified gas.

Stable power generation was accomplished for MCFC fueled with the purified gas from actual raw syngas from biomass gasifier. This confirms that the dry gas purification system fulfills the requirement for biomass gasification power generation as well as regulations for environmental protection