Development of Dry Gas Cleaning System for Multiple Impurities for Biomass Derived Gasification-Fuel − Process Optimization for Zinc Oxide Sorbent and Improved Halide Sorbent −

Background

Simple dry gas cleaning system with high operability is our target to establish biomass gasification power generation systems that are expected to provide smaller-scale efficient energy conversion. A desulfurization sorbent and a halide sorbent should be operated at same temperature to establish the simple system. Zinc oxide sorbent has potential to reduce sulfur compounds such as hydrogen sulfide (H_2S) below 1 ppm, while the desulfurization performance for carbonyl sulfide (COS) is unresolved for the biomass derived gas with high humidity. Basic production procedure for the pelletized halide sorbent made of sodium aluminate was established with our previous work *1. The applicability of the sorbent should be enhanced by increasing capacity of halides and optimum design of the removal processes in actual plant.

Objectives

To suggest practical processes for removal of sulfur compounds and halides to develop an appropriate dry gas cleaning system for biomass derived gas by screening suitable desulfurization sorbent and by improving the halide capacity performance of the sodium aluminate halide sorbent.

Principal Results

1. Feasibility evaluation of simultaneous removal of H_2S and COS with zinc oxide sorbent

The candidate sorbent was selected from the screening tests of commercially available sorbents. The sorbent was subjected to the sulfur breakthrough tests in a fixed bed reactor at the condition expected in the actual plant operation. The sorbent bed with 10 cm depth could reduce concentration of COS below 1 ppm as well as that of H_2S until sulfur load exceeded by 40% the sulfur capacity (Fig.1). It was estimated from this result that the duration of the sorbent exceeds 3 months at the same reaction condition when the bed was installed at depth of 60 cm or above.

2. Improvement of halide sorbent and suggestion of process combination to reduce operational cost for the spent sorbent.

The halide sorbent was improved by applying the glass fiber reinforcement and increased amount of sodium content. The sorbent reconciled the halide capacity and the practical strength of the pelletized sodium aluminate at higher level. The halide sorbent reduced HCl concentration below 1 ppm for the long duration of pre-breakthrough at the condition representing the operation of reactor in an actual gas purification plant. (Fig.2) It is expected that the prior reduction with the injection of fine powder of calcium hydroxide at bag filter will extend the exchange period of the pelletized sodium aluminate sorbent in the fixed bed reactor as a result of the reduction of the sorbent consumption. (Fig.3)

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Future Developments

The demonstration plant of dry gas cleaning system was constructed downstream of the biomass gasifier in our test field. Demonstration of the gas cleaning performance and operability of the processes with the improved halide sorbent and the zinc oxide sorbent is expected in near future, where the actual gasified fuel will be introduced from the air blown type biomass gasifier equipped with fuel carbonizer.

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Reference

M. Kobayashi, et al., 2007, “Integrated Hot Gas Cleaning System for High Temperature Fuel Cell Application Capable of Removing Multiple Impurities Derived from Biomass Gasification.” Proceedings of the 15th European Biomass Conference & Exhibition, pp 1239-1243.

*1 : Nunokawa et al., “Development of Hot Gas Purification System for Multiple Impurities in Biomass/Refuse Derived Gasification gases - Investigation of preparation method for practical molded sodium based sorbent,” Technical Report M05017 (in Japanese)

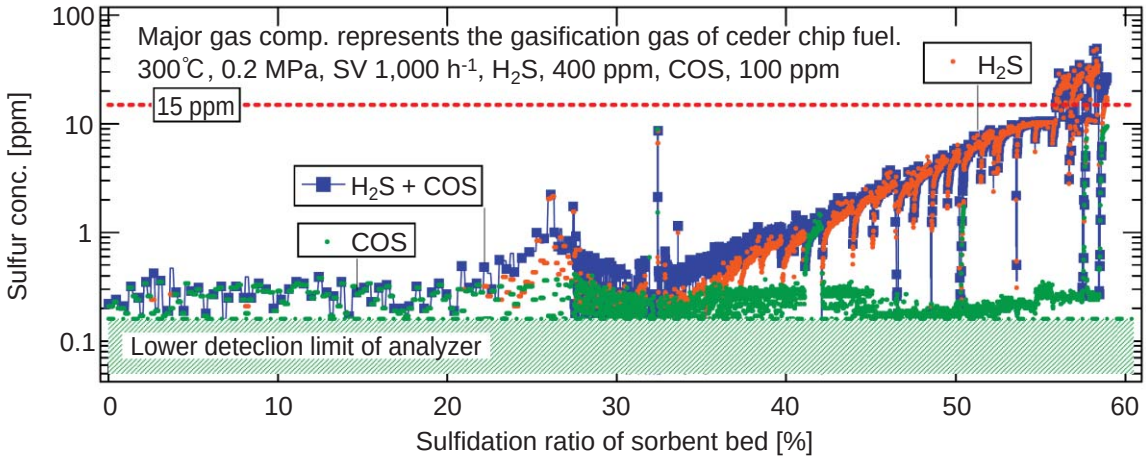

Fig.1 Sulfur breakthrough characteristics of the selected zinc oxide sorbent at the condition expected in actual plant.

The selected zinc oxide sorbent is able to reduces sulfur compounds (H_2S and COS) below 1 ppm for long duration, even the steam concentration reached to 28 vol % in the raw biomass derived gas.

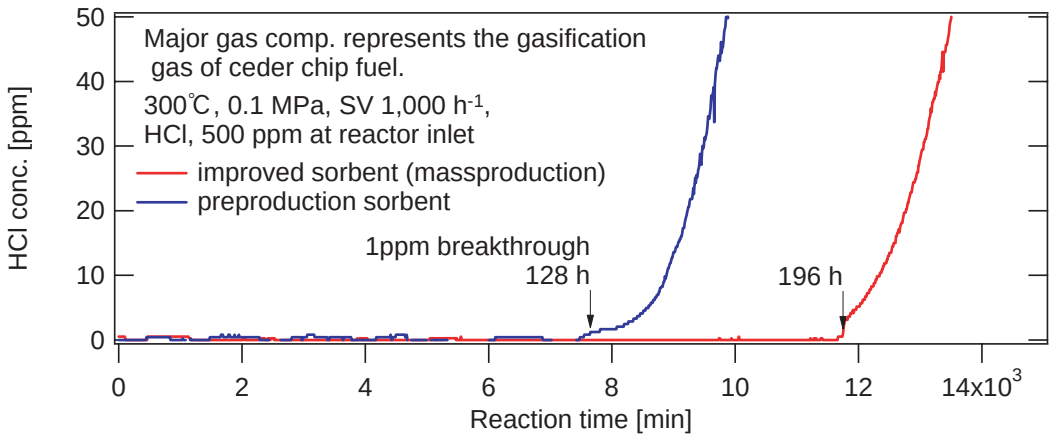

Fig.2 Comparison of HCl breakthrough of the pelletized halide sorbent with enhanced halide capacity and the sorbent of preproduction, which are prepared under industrial production line.

The enhanced halide sorbent had higher halide capacity, which extends the duration of the reduction of HCl below 1 ppm for 50% in the biomass derived gas stream.

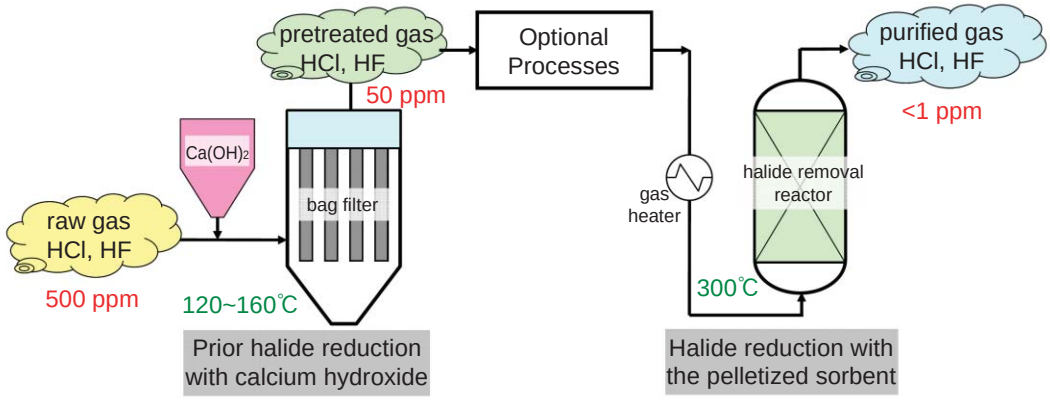

Fig.3 Combinational halide removal process including the slaked lime injection and the fixed bed reactor with the sodium aluminate sorbent, which will reduce the cost for the spent halide sorbent.

The combinational process will reduce the cost of the sorbent by 1/8 and the exchange frequency of the fixed bed reactor by 1/10 compared to the single use of the pelletized sorbent.