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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This research focuses on the tar removal efficiency and capacity based on the physical tar removal technique. It consists of two main parts: 1.) lab-scale: Tar removal by physical technique and process development, and 2) Scaling up: Demonstration in commercial scale biomass gasification plant. The physical gas cleaning techniques and developments were investigated based on the gasification temperature of 800°C, which is an operation condition of both the laboratory experiment and the scaling up plant.

In the lab scale experiment, the followings are investigated; 1) the best operating temperature for three kinds scrubbing medium, which are palm oil, waste cooking oil and waste lubricant oil, 2) the tar removal efficiency and capacity during 10 hours experiment without the regeneration unit, 3) the gravimetric and light tar removal efficiency and capacity during 10 hours experiment with the regeneration unit (the filtration and the centrifugal sedimentation).

Firstly, the operating temperature of the gas cleaning unit is key parameters for improving and optimizing the tar removal efficiency. Three kinds of scrubbing medium were investigated for the tar removal efficiency. The results found that although the high absorbent temperature maximized the mass transfer rate of the high viscous fluid, the increase of the temperature contributed the channel of the stripping and the contacting time reduction for a low viscous fluid. Therefore, the increase of the temperature of palm oil and waste cooking oil could not improve the gravimetric tar removal efficiency due to the low viscosity characteristic, whereas it was effective for the waste lubricant oil. It was summarized that palm oil performs the highest gravimetric tar removal performance among three kinds of absorbent and waste cooking oil was recommended as low cost scrubber medium with a high tar removal efficiency, while waste lubricant oil requires the external heating for improving the tar removal efficiency.

There was an accumulation of tar aerosols and other contaminates in the scrubber by continuation of the cleaning, and these accumulated contaminants strongly affected the mass transfer between the gaseous tar and the scrubbing oil. The contaminants caused the increase of the viscosity, decrease of the turbulence level and the interface mobility resulting in reduction of the overall tar removal performance by continuation of the cleaning. Therefore, the next research was concerned on their tar removal capacity in order to predict the periodic change to the new oil to maintain the tar removal efficiency of the scrubber and to prevent breakdown of downstream machines. In addition, waste char, which is the by-product from the gasification process, was utilized to evaluate the tar removal capacity as well. The tar removal capacity of the combination of waste cooking oil and waste char were investigated. The breakthrough curve was used to identify the appropriate period for replacing the absorbent and the adsorbent. Based on the breakpoint data, 1 litter of waste cooking oil can absorb 14.4 g of tar with 80% removal efficiency and 1 g of waste char can remove 0.15 mg of naphthalene with 76% removal efficiency. In

addition, waste char also adsorbed the gravimetric tar of 48.8 mg-tar/g-waste char with 3.1% increase of the removal efficiency on the average. The results were utilized for scaling up in commercial plants

It was found that a huge amount of absorbent are required for maintaining the tar removal performance of the scrubber which is not economical and environmentally friendly system. The next step of this research work proposed the oil regeneration idea for recovering the tar removal capacity of the scrubbing oil. The overall tar removal efficiency was almost completely recovered by the filtration and the centrifugal sedimentation techniques. The tar and impurities contained in the absorbent were effectively removed by these methods. The experiments were conducted to compare the performance between the non-regenerated and the regenerated oil. The non-regenerated oil performed the lowest tar removal efficiency. While the utilization of the regenerative unit, the tar removal efficiency was able to be improved to 78% and 83% on the average along 10 hours experiment period by the filtration and the centrifugal sedimentation, respectively.

Based on the successful lab-scale results, the gas cleaning system employing the physical tar removal methods by the combination of the palm oil scrubber and the filtration regeneration unit and the adsorber were implemented in a commercial scale facility. The 600kW_{th} bubbling fluidized bed gasifier with rice husk feedstock was utilized to study the tar removal capacity of the physical cleaning system. By the use of series of cyclone, ceramic filters, air cooler, water coolers, vegetable oil base venturi scrubber with the oil regeneration unit, stable tar removal during 20 hours operation with 95% of tar removal on the average was demonstrated. Combined with the adsorber, 99% by the mixed gasified char pecked bed adsorber could be achieved meeting with the syngas quality requirement for IC-engines.

This research proved an effective and low cost gas cleaning system for treating biomass tar with a long period of the operation.