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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 physical tar removal using oil-based absorption in a scrubber for biomass gasification. The study on the tar removal by the absorption technique is divided into three main aspects that is the absorbent selection, the scrubber type and the absorbent regeneration. 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 and pilot-scale experiment.

For the absorbent selection, Chapter 2 first investigated the characteristics of tar in syngas and found that the majority of tar was ranked in the following order; non-polar tar (60%) > condensable tar (25%) and polar tar (15%). Then, the tar removal performance of pure vegetable oil was compared to the emulsified oil. It was found that the emulsified oil performs better tar removal than pure vegetable oil in all water content proportions. The emulsified oil mainly enhanced the gravimetric tar removal performance by increasing the polar tar removal efficiency with no significant decrease of the light tar removal efficiency. The choice of the absorbent for biomass tar removal can be ranked in the following order; 7.5% emulsified oil > vegetable oil > waste cooking oil > water.

For the scrubber type, Chapter 3 first investigated a fundamental study on the microbubbles formation utilizing a venturi scrubber in order to optimize the operational condition at the best absorption surface area. It was found that the specific absorption surface area at d/D = 0.17 was the lowest due to the bubble coalescence while the highest one was achieved at d/D = 0.42 with the highest oil throat velocity. Then, the tar removal performance of venturi scrubber were investigated and found that the tar removal efficiency linearly increased with the increase of the specific absorption surface area. The gravimetric removal efficiency of the venturi scrubber was higher than that of the bubbling scrubber at all specific absorption surface areas, while there was no light tar observed. The feasibility of the venturi scrubber for tar removal has been proved at the pilot-scale gasifier by the use of physical gas cleaning system comprised of the following; a series of a cyclone, a ceramic filter, an air cooler, water coolers, the venturi scrubber and the packed bed adsorber. This system could achieve the syngas quality requirement for internal combustion engines. In Chapter 4, the investigation on the venturi scrubber was further studied, where the relationship between the Reynolds number and the tar removal performance was focused. It could be concluded that the performance of the venturi scrubber was also better than the bubbling scrubber at all values of the Reynold numbers. The optimum condition for tar removal was at the highest Reynolds number for both of vegetable oil and emulsified oil. Furthermore, the overall volumetric liquid-slide mass-transfer coefficient also increased with the increase in the syngas Reynolds number. The performance of the scrubber for biomass tar removal can be ranked in the following order; venturi scrubber > bubbling scrubber with mixing stirrer > packed-bed scrubber.

For the absorbent regeneration, Chapter 5 studied the tar removal efficiency and capacity of the oil scrubber combining the regeneration unit (a series of the filtration and the air-blown stripping) in order to upgrade and prolong the absorbent lifetime and then compared to other techniques (non-regeneration, filtration and centrifugal sedimentation). The gravimetric and light tar removal efficiency and capacity of a series of the filtration and the air-blown stripping markedly improved compared to other regeneration techniques. In addition, there was no significant change of the gravimetric and light tar removal efficiency after each regeneration compared to new oil. Therefore, there is a possibility for utilizing regenerated absorbent without changing it to the new one for a longer period of the operation. Furthermore, the air with the stripped gravimetric and light tars could be used as the gasifying agent in the gasifier for energy recycling. The performance of the absorbent regeneration technique can be ranked in the following order; a series of the filtration and the air-blown stripping > the centrifugal sedimentation > the filtration > non-regeneration.

Finally, the flow work of the low-cost and effective physical gas cleaning unit for tar removal

in a commercial-scale gasifier was designed as following. It consisted of a series of a cyclone, a ceramic filter, an air cooler, a cooking oil based venturi scrubber with a regenerative unit (a series of the filtration/centrifuge and the air-blown stripping) and a packed bed adsorber, respectively. Soot and particles are trapped by the cyclone and the ceramic filter. Then, some of the gravimetric and light tar are condensed when passing through the air cooler. Finally, all of the gravimetric and light tar are absorbed and adsorbed by the venturi scrubber and the packed bed adsorber, respectively. The used absorbent is regenerated by using a series of the filtration unit/centrifuge and the air-blow stripping unit to prolong the absorbent lifetime.