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Title(English)	Synergetic effect in the co-gasification process of coal-algae blend under CO2 atmosphere
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Thesis outline

Chapter1. Introduction

In this chapter, we introduced the research background, the potential energy recovery from coal and biomass through thermochemical conversion technologies, a brief literature review of gasification technology and the catalytic mechanisms in the co-gasification process. Moreover, the kinetic models that used in this study were explained. Finally, the objectives of this study and the originality were sated.

Chapter2. Kinetics modeling and synergetic effects evaluation in coal-algae blend co-gasification under CO_2 atmosphere

In this chapter, Newlands coal char and spirulina algae char are prepared separately in a fixed bed reactor with the pyrolysis temperature of 900^{o} C, and the isothermal CO_2 co-gasification experiment is done using the thermogravimetric analyzer in the temperature range of 800-1000^{o} C. The volumetric model (VM), the shrinking core model (SCM), the random pore model (RPM) and the modified random pore model (MRPM) are applied to describe the gasification kinetics of the samples. The results show that the synergetic effect are observed for all ratios while 50%wt blends demonstrates the best performance which may be attributed to the high content of potassium included in the algae char which in turn promotes the catalytic effect. Among the above-mentioned models, RPM is found to be the best for the prediction of the conversion profile among all tested models except for the algae sample which is failed to fit the data by RPM and hence MRPM is applied for the algae sample only. Then RPM and MRPM are adopted to calculate the kinetics parameters. The activation energy

and the pre-exponential factor are determined using the Arrhenius equation.

Chapter3. Effect of the hydrothermal treatment of algae on the catalytic activity of the solid residue in the co-gasification process with coal

In this chapter, solid residues from the hydrothermal treatment (HTT) of algae produced at the temperatures of 180, 210 and 240°C are utilized to produce char in the fixed bed reactor at the temperature of 900°C. Coal char and virgin algae char are produced at the same condition as well. The thermogravimetric study is conducted to highlight the effect of HTT on the catalytic activity of algae solid residue in the co-gasification process with coal, and the result is compared with the coal-algae co-gasification behavior. The kinetic modeling and the synergetic evaluation are conducted. Results show some loss of the catalytic effect of algae residue by HTT and this may be due to the fact that a part of the mineral matter of algae is shifted to the aqueous phase during HTT. However, co-gasification of coal-HTT solid residue is still showing synergetic effects.

Chapter4. Investigation of coal-algae blend co-gasification behavior in the downdraft fixed bed reactor under CO_2 atmosphere

In this chapter, CO_2 gasification experiments are conducted employing the lab scale downdraft fixed bed reactor. The experiments are executed at two different temperatures of 950 and 1000°C for 10, 30 and 50% wt algae blend. Furthermore, the effect of the CO_2 partial pressure on the syngas production is tested. Results show that an obvious increase in the syngas production especially when higher amount of algae is presented in the blend such as in the case of 50%wt blend. This synergetic effect is mainly attributed to the catalytic activity of the high content of alkali and alkaline metals of

algae. Results of the experiments changing the CO_2 partial pressure show that the syngas production yield is enhanced as the flow rate of CO_2 increases from 100 to 200 ml/min, while the excessive increase in the flow rate above 200ml/min resulted in the decrease of the syngas production yield.

Chapter5. Experimental drop tube furnace co-gasification of coal-algae blend under CO_2 atmosphere

In this chapter, In order to evaluate the performance of co-gasification of coal-algae blend under different contact conditions, the co-gasification experiment is conducted in the drop tube furnace at three different temperatures of 900, 1000 and 1100 °C for coal, algae and 50 wt% blend samples.

Chapter6. Conclusion and recommendations

This chapter summarizes the important achievements of this research. and mention some recommendations about possible commercialization of coal–algae co-gasification.