論文 / 著書情報
Article / Book Information

題目(和文)	石炭と藻類のCO2共ガス化プロセスにおける相乗効果
Title(English)	Synergetic effect in the co-gasification process of coal-algae blend under CO2 atmosphere
著者(和文)	カディ ナシム エム エメ
Author(English)	NASIM M. N. QADI
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第10521号, 授与年月日:2017年3月26日, 学位の種別:課程博士, 審査員:吉川 邦夫,高橋 史武,竹下 健二,加茂 徹,時松 宏治,梶谷 史朗
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10521号, Conferred date:2017/3/26, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	環境理工学創造 Environmental Science and Technology 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 工学） (Engineering)
学生氏名： Student's Name	QADI Nasim M N	指導教員（主）： Academic Advisor(main)	吉川 邦夫
		指導教員（副）： Academic Advisor(sub)	高橋 史武

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

Although algae is well known as feedstock for bio-oil production due to its high lipid content, gasification of algae is still in the preliminary stage. Researches on the co-gasification process of algae with other feedstock are very scarce in literatures. The co-gasification processing of coal could be a promising pathway for energy recovery from algae. Enhancing the energy balance of coal gasification is essential for cost-effective energy production processes. The catalytic activity that comes from the alkali and alkaline earth metal of algae can help to enhance the coal gasification energy balance as it provides cheap catalyst. Indeed, co-gasification of coal with land-based biomass has been intensively studied, and the results in most cases were encouraging.

The objectives of this research are to test the catalytic effect that occurs in the co-gasification process of coal-algae blend. The kinetic modeling is investigated for various combination of coal with virgin algae and with the solid residue of hydrothermally treated algae. The synergetic effects were evaluated at the thermogravimetric scale in terms of the reactivity for chars prepared in a fixed bed reactor. The blending effect on the gas production yield was investigated using the fixed bed downdraft lab-scale set up and the drop tube furnace set-up.

Firstly, at TGA scale experiments, char was prepared in a fixed bed reactor under N_2 atmosphere at the temperature of 900 ºC, then a series of gasification experiments were conducted using TGA for pure algae char, pure coal char and 50wt%, 30wt% and 10wt% algae blended char samples utilizing CO_2 as a gasification agent at temperatures governed by the chemically-controlled reaction; in order to quantify the synergy on the co-gasification reactivity as a consequence of the catalytic activity that comes from the inherited alkali and alkaline content (AAEM) in algae ash, and also to perform the kinetics modeling. The effects of the blending ratio and the co-gasification temperature on the syngas gas production yield and composition were investigated.

From the results of TGA co-gasification experiment of coal char with virgin algae char, it was found that the coal char gasification was much slower than the algae char gasification. The synergy was confirmed for all studied blending ratios, however, it decreased with the reduction of the algae char weight ratio presented in the blend. The increase of the co-gasification temperature from 900 ºC to 950 ºC decreased the synergy effect. The random pore model and the modified random pore model performed better than other models. The activation energy of the blended samples was lower than the coal char gasification.

As this research aims not only to utilize the virgin algae in the co-gasification process with coal, but also to test the co-gasification of the solid residue from the hydrothermal treatment (HTT) of algae with coal. The effect of the HTT operation temperature on the produced char were tested where hydrochars were prepared at three different HTT temperatures. The effect of blending of algae HTT solid residue chars with coal char were compared with the results of blending with the virgin algae char.

From the results of co-gasification experiments of coal with HTT solid residue char, it was shown that HTT influenced the inorganic content and the textural properties of the produced chars. The catalytic index decreased HTT temperatures increased. Despite the relative decrease in the synergetic effect exhibited from the HTT chars, the synergetic effect was comparable to the synergetic activity from the virgin algae char

Secondly, at lab-scale downdraft fixed bed reactor, the role of CO_2 partial pressure on the coal gasification was studied, and the effect of the algae blending ratio in the co-gasification experiment with coal and under CO2 atmosphere was investigated. Results showed that the gas production yields from co-gasification experiment were higher than the predicted ones especially for a higher blending ratio suggesting the occurrence of the synergetic effect. The thermal conversion efficiency of algae gasification was enhanced when it was utilized in the co-gasification process with coal. It was demonstrated that the co-gasification is a promising pathway for effective utilization of algae.

Finally, Co-gasification of coal and algae were conducted in drop tube furnace DTF under CO_2 atmosphere. Syngas components of H_2 and CO were analyzed for sole gasification of each fuel and for the blended sample, as well. Experimental CO component showed higher value than the calculated one, especially at 1100 ºC. Some interactions between both fuels in the gaseous phase may promoted the secondary reactions and enhance the gas yield

Recommendations:

1. The application of hydrothermally treated char from algae would be good option to be used in Entrained-flow gasification as no preprocessing is needed.
2. At lower temperature especially when the catalytic effect is targeted to improve the performance during co-gasification. Fluidized bed reactor is preferred as perfect particles mixing and contact conditions can be achieved.

（博士課程）
Doctoral Program

東京工業大学
Tokyo Institute of Technology