論文 / 著書情報
Article / Book Information

題目(和文)	不均一触媒を導入した溶融塩反応器によるバイオマスの熱化学変換
Title(English)	Thermochemical Conversion of Biomass in Molten Salt Reactor with Heterogeneous Catalysts
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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10138号, 授与年月日:2016年3月26日, 学位の種別:課程博士, 審査員:関口 秀俊,久保内 昌敏,多湖 輝興,渕野 哲郎,森 伸介
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10138号, Conferred date:2016/3/26, 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	Chemical Engineering　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　(Engineering)
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

In this research work, we aim to investigate thermochemical conversion of biomass (mainly pyrolysis and CO_2 gasification) in molten salt reactor with heterogeneous catalysts. Two systems consisting of non-preheated molten salt and preheated molten salt, were used in this study to investigate the enhancements of pyrolysis and CO_2 gasification by adding catalyst. The former system is simply method by constantly heating a well mixture of cellulose, molten salt, and catalyst, thereby noncontact of cellulose to salt and catalyst was minimized. In pyrolysis, a suitable fraction of catalyst in molten salt, an appropriate ratio of molten salt to cellulose, and reaction temperature were determined. In CO_2 gasification, it is not only cellulose but also biomass wastes and char were experimentally studied. In the later system, a preheated molten salt reactor is used to demonstrate whether the catalyst suspending in molten salt can still enhance the reactions. Based on the experimental results in both two systems, conceptual process designs of pyrolysis and CO_2 gasification are carried out to demonstrate the efficient continuous process of syngas production in the molten salt with heterogeneous catalyst. The contents of thesis are structured in the following chapter.

Chapter I: Introduction, describes the background, motivation, literature survey, objectives, and research approach. Utilization of solar-heated molten salt as reaction medium in pyrolysis and gasification is a promising way to store solar energy in a form of syngas with upgrading biomass to transportable biofuel. Addition of heterogeneous catalyst to molten salt was expected to enhance the production yield, rate, and H_2 fraction.

Chapter II: Non-preheated molten salt, demonstrates and discusses the experimental results of pyrolysis and gasification in non-preheated molten salt. As non-preheated molten salt system, a mixture of cellulose, salt, and catalyst ($Ni/\gamma Al_2O_3$) was constantly heated to the target temperature while evolving product gases were analysed. In this system, well contact between reactant, catalyst, and medium could be achieved. In cellulose pyrolysis, a combined molten salt and catalyst exhibited the best catalytic reaction medium for syngas production. A best catalyst fraction in molten salt (7wt%), an appropriate mass ratio of salt to cellulose (140) and suitable temperature range (700-800°C), were determined. In CO_2 gasification, cellulose, biomass wastes, and char were used as feedstock. The enhancements were relatively similar to the pyrolysis case. However, the reverse water gas shift reaction was observed, resulting in decreased H_2 fraction. Activation energies from both pyrolysis and gasification were calculated to show the catalytic enhancements of the nickel catalyst. The combined molten salt and $Ni/\gamma Al_2O_3$ catalyst would be a promising medium for syngas production.

Chapter III: Preheated molten salt, demonstrates a feasibility of practical utilization of molten salt combined with heterogeneous catalyst as reaction medium for syngas production. The preheated molten salt combined with heterogeneous catalysts was still effective for cellulose conversion. Among various catalysts including Ni/Activated carbon, $Ni/\gamma Al_2O_3$, $Ni/\alpha Al_2O_3$, and nickel powder, the Ni/Ac exhibited the best performance for syngas production in term of production yield, rate, as well as catalyst deactivation. It was ascribed to the high surface area of activated carbon support. The mechanisms of cellulose pyrolysis and kinetics of CO_2 gasification were proposed.

Chapter IV: Conceptual process design, describes the calculation results from conceptual process designs of thermochemical conversions in molten salt with heterogeneous catalyst. It was developed and designed for a demonstration of pilot plant construction. Combined pyrolysis and gasification (CO_2 gasification of cellulose) decreased H_2 content due to the effect of reverse water gas shift reaction (RWGR). Separated pyrolysis and gasification can solve the RWGR problem and produce high quality and high yield of syngas.

Chapter V: Conclusion, summarizes the findings obtained from this study, and provide to future prospects. Thermochemical conversions of biomass to syngas was significantly improved by addition of heterogeneous nickel catalyst to molten salt.