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著者(和文)	Al-Ali Khalid
Author(English)	Khalid Al-Ali
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種別(和文)	論文要旨
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（博士課程）
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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)
学生氏名： Student's Name	Al-Ali Khalid	指導教員（主）： Academic Advisor(main)	Prof. Sekiguchi H.
		指導教員（副）： Academic Advisor(sub)	-

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

The study is relevant to solar thermal energy conversion to chemical fuels (Energy Storage), especially the solar-aided catalytic methane dry reforming reaction, employing molten salt as the heat carrier material. Direct Contact Bubble Reactor (DCBR) was proposed to promote solar thermal energy storage with a higher energy conversional capacity, higher thermal efficiency and greater simplicity of construction. There are many areas of uncertainty with respect to methane dry reforming processes in the DCBR. The conversion efficiency of the solar thermal energy to chemical energy needs to be improved. Empirical investigations along with modeling and simulation seem to provide useful information for the solar energy conversion process in the DCBR. The contents of the thesis are structured into the following seven chapters.

Chapter ONE is **General Introduction** aims to describe the background of the research. The concept of a thermo-chemical process for "solar fuels" production was briefly explained. Different reactor types and layouts for solar-aided methane reformer were broadly summarized. The proposal of the DCBR is an effective solution for the intermittent nature of the solar energy, which provides stable operation under the fluctuations of solar irradiation and achieves thermal uniformity inside the reactor.

Chapter TWO addresses **Physical Aspects of the Bubbly Flow in DCBR**, and how the bubble creation process affects the conversion efficiency of dry methane reforming reaction system, i.e. bubble size and rising velocity determine the reaction residence time. In addition, this chapter covers the empirical estimations of bubble rise in water. Another fundamental phenomenon important to the process is the physical interaction mechanisms between Ni-Al_2O_3 catalyst powder and the rising bubbles.

Chapter THREE is **Performance of DCBR** which addresses the empirical investigation of methane dry reforming over nickel-alumina catalyst in an alkali molten carbonate salt system at lower catalyst/molten-salt ratios. Carburized nickel-based catalyst can be the promising candidate, and provide such activity in the molten carbonate salt bath. The experimental results of the bubbly flow reactor in the DCBR were compared with the catalytic reactions of an indirectly heated fixed bed reactor (IHFBR). It is tentatively

suggested that a combination of the DCBR and the IHFBR would provide tremendous solution for the Ni-Al_2O_3 catalyst regeneration cycles during the carburizing/de-carburizing processes.

Chapter FOUR is **Modeling and Simulation** of the endothermic reaction with respect to kinetics of the methane dry reforming in a direct-contact bubbling reaction system containing molten salt and Ni-Al_2O_3 powder catalyst. The reforming process was simulated, using commercial software for chemical kinetics, for a single reactor model at temperature in the range of 600-900°C under 1 atm. The model examines the catalytic surface reactions based on postulated heterogeneous reaction mechanisms for CH_4 dry reforming on Ni-Al_2O_3 Catalyst. The catalyst activity was characterized using a catalyst-bubble contact model. The predicted data were validated with the empirical results from a laboratory reformer. The detailed simulation studies were used to identify the essential characteristics of the reaction mechanism in the DCBR.

Chapter FIVE presents a comprehensive study of **Micro-kinetics Analysis** for the catalytic methane dry reforming in terms of elementary chemical reactions to identify valuable insights into the key reactions, species and relationships in complex systems. The reduced reaction route network comprising the dominant pathways, the identified quasi-equilibrium and the rate determining steps, were used to determine the simplified rate expressions that predict the full model fairly well.

Chapter SIX presents **Comparisons of the Performance between DCBR and Indirectly Heated Tubular Reactor (IHTR)** in order to evaluate the reactor performance in terms of heat transfer along with the available catalytic active surface area. The results suggest a combination system of the DCBR and the IHTR as a suitable configuration for process intensification associated with higher thermal efficiency.

Chapter SEVEN is **Conclusion and Future Prospects**, which summarizes the results obtained from this study, and provides references to future prospects.