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学 位 (博 士) 論 文 要 旨
(Doctoral thesis abstract)

論文提出者 Ph. D. Candidate	生物システム応用科学府 <u>食料エネルギーシステム科学</u> 専攻 一貫制博士課程 平成 <u>31</u> 年度入学(Your Entrance Fiscal Year) 氏名 <u>宇川 (佐藤) 龍</u> (Your Name (Family, First))				
主指導教員 氏 名 Chief Advisor's Name	伏見 千尋	副指導教員 氏 名 Vice Advisor's Name	稲澤 晋	副指導教員 氏 名 Vice Advisor's Name	寺田 昭彦 秋澤 淳 西舘 泉
論文題目 Title	Development of material and energy-circulating levulinic acid production processes by effective byproducts utilization 副生成物を有効活用した物質・エネルギー循環型レブリン酸製造プロセスの新規開発				
<p>論文要旨 (和文要旨(2000 字程度)または英文要旨(500words)) ※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。 Write a summary in Japanese (2000 characters) or in English (500words). If the abstract is written in Japanese, needed to translate into English.</p> <p>A novel process for the production of levulinic acid (LA) from biomass was developed through both reaction experiments and process development. H_2SO_4 is a widely used catalyst for the production of LA from biomass. However, the recycling process for it is challenging, and it is strongly corrosive. The objective of this Dissertation is to propose a new catalyst system that can replace H_2SO_4 and to establish new design guidelines for a sustainable biorefinery process. This Dissertation identifies energy and economic challenges in the LA production process and introduces a new reaction system to reduce separation efforts. Additionally, the energy and economic feasibility of this process is evaluated. The author has also developed a process that is independent of regional differences in resources, utilizes byproducts as effectively as possible, and minimizes waste from the process. Solid byproducts were utilized to process heat by combustion.</p> <p>In Chapter 2, a novel process was established to produce LA from glucose, an intermediate to LA. A catalyst system was designed to combine AlCl_3 and choline chloride (ChCl), which has high selectivity to LA and lower environmental impact. The designed process compared the reaction time of glucose–LA among 90, 120, and 180 min in energy requirement and economics. To minimize the energy requirement and the costs in the separation section, a suitable solvent was selected for the extraction of LA and the byproduct formic acid (FA). The energy requirements and economics of the designed process were evaluated.</p> <p>In Chapter 3, a novel process for the production of LA was developed using wheat straw as the biomass feedstock. In Chapter 2, the author recognized that the separation of FA was an energy and economic bottleneck, thus the process was designed using an aqueous solution of FA as a catalyst. Moreover, the author discovered that biomass-derived furfural is a suitable solvent for LA extraction. Hence, the author used biomass-derived furfural as the extraction solvent in the same process. Cooling water usage was identified as a new indicator to assess the feasibility of implementing the process independent of regional resource differences. The designed process compared FA concentrations among 60, 70, and 80wt% in the usage of cooling water, energy requirement, and the economics.</p> <p>In Chapter 4, the author proposed an $\text{FA}/\text{AlCl}_3/\text{ChCl}$ combined catalyst system for the cellulose–LA reaction with different FA concentrations than those used in Chapter 3, and with the $\text{AlCl}_3/\text{ChCl}$ catalyst used in Chapter 2, since the concentration of FA was found to have a significant effect on the energy and economics of the separation. Reaction experiments were conducted with varying FA concentrations among 10, 20, and 30wt%, with and without ChCl, and the process was newly developed based on the</p>					

resulting data. Cooling water consumption, energy, and economics were evaluated, and the most balanced process in terms of yield, energy requirement, and economics was presented.

In Chapter 5, the conclusions of this Dissertation are summarized. The design concept from this research is expected to contribute significantly to developing biorefineries in the future.

(英訳) ※和文要旨の場合(300 words)

If the abstract is written in Japanese, needed to translate into English.(300 words)