

(様式 5)

2022 年 12 月 13 日
Year Month Day

学位（博士）論文要旨

(Doctoral thesis abstract)

論文提出者 (Ph.D. candidate)	工学府博士後期課程 応用化学 専攻 (major) 2022 年度入学 (Admission year) 学籍番号 22832302 氏名 内野 貴行
主指導教員氏名 (Name of supervisor)	伏見 千尋
論文題目 (Title)	Carnot Battery System by using a Fluidized Bed Integrated with a Biomass Power Plant for Renewable Energy Utilization
<p>【Abstract】</p> <p>It was investigated to improve and evaluate a $\text{CaO}/\text{Ca}(\text{OH})_2$ thermochemical heat storage (TCS) system with a fluidized bed. The aim is for promoting the storage and utilization of renewable energies with lower cost. This dissertation focuses on creating a dynamic model of the fluidized bed, evaluating the absorption of the variable renewable energy (VRE) fluctuation, creating the TCS system integrated with a biomass power plant, evaluating and improve the energy efficiencies and flexibility of the power generation, and evaluating the economics of the proposed process.</p> <p>In Chapter 2, a dynamic model of a fluidized bed reactor for $\text{CaO}/\text{Ca}(\text{OH})_2$-based TCS was created for evaluating the absorption of the VRE fluctuations. The reduced-order model is required for facilitating the calculation and practical application. Hence, the author developed a simplified dynamic model, investigated the influences of the VRE fluctuation on reactor temperature by fluctuating the input energy, and evaluated the performances of the fluidized bed using nitrogen or steam as the fluidizing gas.</p> <p>In Chapter 3, the author created the biomass power generation process integrated with the TCS system using the fluidized bed with $\text{CaO}/\text{Ca}(\text{OH})_2$ particles. In the power generation strategy, one day was separated three times; normal operation (only organic Rankine cycle (ORC) was worked), charging, and discharging times. The ORC working fluid was R245fa and the power output during the normal operation was set to 1 MWe. The integrated process was evaluated from energy storage efficiency, the TCS system efficiency, and round-trip efficiency, and the effects of operational parameters regarding the TCS system were examined. The flexibility of power generation was also evaluated. In addition, the improvement process was proposed and evaluated.</p> <p>In Chapter 4, the process described in Chapter 3 was improved. This chapter focuses on the following three points. First, the energy efficiencies were evaluated by varying the two organic working fluid (R245fa and R1233zd), the turbine inlet temperature, superheated temperature of the working fluid, and the scale of the power generation. In addition, the performance of the TCS system and ORC was evaluated by varying the fluidized bed volume. Second, the process performance was evaluated during charging time when the heat source supplied to the TCS system fluctuated. Third, the economics of the TCS system were calculated.</p> <p>In Chapter 5, the main conclusions obtained in this dissertation were summarized and future research works are suggested.</p>	