別紙様式３

学位論文の要旨

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学位論文 題　　目	Development of solar to gas conversion system using high efficiency photovoltaic and catalyst （高効率太陽電池と触媒を用いた太陽光由来ガス変換システムの開発）

【論文の要旨】（和文の場合 1, 200 字程度、英文の場合 800 語程度）

This thesis analyzes the solar to gas conversion concerning the operation parameters under actual field operation and provides the potential conversion efficiency in Japan based on the outdoor test, performed at University of Miyazaki.

The first chapter introduces the basic knowledge and general introduction to proceed to the next chapters. It includes the concept of the system, objectives of the research, and outlines of this thesis.

The second chapter provides an approach to the solar to gas conversion system, installed at the University of Miyazaki, Japan. The concept of outdoor solar to hydrogen and solar to methane systems is described in detail. Additionally, the components of actual solar to gas conversions such as concentrator photovoltaics, the DC/DC converters, the electrochemical cells, and the methanation system are provided. The experimental procedures and attempts to perform the methanation system are fully described. The methanation system was investigated on sunny days and cloudy days. The operation parameters and methane concentration were analyzed. It also describes the estimation methods for solar to methane conversion efficiency. The concept of methanation energy consumption is outlined in this section. In this approach, the system provided CO_2 conversion efficiency of 97.6%, and solar to methane conversion efficiency of 13.8% at the reactor's operating temperature of 260 °C.

The third chapter focuses on a detailed analysis to better understand the power consumption of the methanation system on hydrogen generation. To improve the system with less energy consumption, the factors increasing its consumption are reviewed. Although the heat released during the reaction maintains the reaction and reduces power consumption, extreme heat can result in catalyst degradation. Therefore, it is crucial to decrease the heat without increasing the power consumption while improving the methane concentration. The reaction rate is mainly dependent on the flow rate of the feed gases and the main factor of the reaction heat. Furthermore, hydrogen from the electrolysis process is provided to the methanation system. Therefore, in this section, the influence of hydrogen flow rate on the energy consumed by the Sabatier reaction is highlighted. In addition, methane concentration is analyzed at various hydrogen generation rates. It is also important to improve or maintain the methane concentration

while minimizing the operation temperature and power consumption. This study achieved a methane composition of 98.4% at the operating temperature of 220 °C under controlled hydrogen flow.

The fourth chapter proposed an approach to estimate the potential solar to hydrogen and solar to methane conversion efficiencies of 837 places in Japan. It is important to identify the efficient system providing a high conversion on the intended locations before realizing the outdoor implementation. Based on the outdoor optimum results, Nationwide's annual solar to gas conversion efficiency from two types of the flat-PV module is proposed and approximated. The simulation concept to approach the conversion efficiencies of each part is fully described. The nationwide forecasted results are provided in graphs. In addition, the types of PV that can provide efficient solar to gas conversion in Japan are discussed in this chapter.

In the fifth chapter, the results were summarized and concluded. It also discusses the potential to improve the system in the future.

（注１） 論文博士の場合は、「専攻、入学年度」の欄には審査を受ける専攻のみを記入し、入学年度の記入は不要とする。
（注２） フォントは和文の場合 10.5 ポイントの明朝系、英文の場合 12 ポイントの times 系とする。
（注３） 学位論文題目が外国語の場合は日本語を併記すること。
（注４） 和文又は英文とする。