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TEMPERATURE DISTRIBUTION OF METHANO-HYDROGEN PEROXIDE AUTOTHERMAL REFORMING FOR PEM FUEL CELL IN SPACE EXPLORATION

Abstract

The concern of technology of fuel cell using hydrogen has been continually increased. It has been actively tried to commercialize fuel cell system. The methods to supply hydrogen to the fuel cell are divided into 3 ways; (1) hydrogen stored as hydrogen – cryogenic liquid or at high pressure, (2) hydrogen stored as man-made fuel – methanol, ammonia, sodium borohydride, (3) electrolysis. The fuel cell system has been estimated to apply to various applications. It was successfully applied to space exploration in USA. It seems that the fuel cell system will be increasingly widely applied to space program. However, hydrogen/oxygen tank was used in space exploration, USA. There are disadvantages in terms of handling and storage. Specially, hydrogen has much lower storage density.

The purpose of this research is to find efficient hydrogen supply method. The research was conducted by using methanol-hydrogen peroxide reforming process. This reforming process has the advantage in terms of the weight and volume of the system because it does not require combustor for heating and air-pump for partial oxidation reaction in the existing reformer. Therefore, it is suitable to air independent condition. In this reforming process, the heat of hydrogen peroxide decomposition was provided to methanol steam reforming process (endothermic reaction). The partial oxidation reaction was operated by oxygen obtained by decomposition of hydrogen peroxide.

It considered the temperature between auto-ignition point of methanol and heat of hydrogen peroxide decomposition. And it confirmed the temperature of thermal equilibrium between methanol steam reforming (endothermic reaction) and hydrogen peroxide decomposition (exothermic reaction). The temperature of thermal equilibrium reached when 65 percent hydrogen peroxide was decomposed. Simultaneously, the research was conducted to reduce carbon monoxide because the carbon monoxide poisoning of fuel cell was serious problem. It reduced to 100 ppm CO level by using Pt catalyst. It estimates that it is applicable level to high temperature PEM fuel cell. As a result, it generated hydrogen for operating 8 watt class PEM fuel cell by using current reformer scale.

The research is underway to scale up the reformer and reduce to 10 ppm CO level for applying to low temperature PEM fuel cell.

If the research of this reforming process is successfully conducted, It can be expected that it will contribute greatly to space exploration by using long term applicable methanol-hydrogen peroxide reforming process.