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Hydrogen production from superheated steam decomposition by plasma reactor

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Hydrogen based energy are gaining interest as a suitable alternative energy for usage and many researches are currently being engaged towards a lasting hydrogen economy. Electrolysis of water is one of the promising methods of producing hydrogen as a high purity product can be achieved. [1]

However, this process requires a substantial amount of energy to separate water into hydrogen and oxygen. Recent developments utilize non-thermal plasmas for reforming gas and liquid compounds contsaining hydrogen. [2] Water vapor plasmolysis have the potential to have an advantage and is cleaner compared to conventional electrolysis. [3] Although expensive, plasma micro reactor produces energetic species at atmospheric temperature which through a series of reaction combine to form hydrogen and oxygen. Superheated steam is currently drawing much attention in various industries, taking advantage of its high temperature and energy at low pressure as well as high thermal conductivity compared to saturated steam. Dissociation of superheated steam using dielectric barrier discharge (DBD) plasma reactor at atmospheric pressure have been considered and is being tested for its hydrogen production yield.

Experiments were conducted to determine the amount of decomposition of superheated steam using plasma reactor utilizing dielectric barrier discharge. A superheated steam generator was used to supply superheated steam and is connected directly to the plasma reactor. The reactor used was a micro plasma membrane reactor (MPMR) with flow channel of 1 mm wide, 4.5 mm deep and a total length of 1010 mm. Argon was used to promote steam decomposition and was supplied directly into the steam generator. Atmospheric pressure plasma was generated through dielectric barrier discharge (DBD) using a high voltage pulse power supply (Sawafuji Electric).

The temperature of superheated steam was preset at 250°C through the steam generator and the flow rate of Argon and steam was varied with one being held constant against the other. The experiment was conducted with an applied voltage ranging from 10 kV to 18 kV at a pulse repetition frequency of 10 kHz. The decomposed gas was collected and was analyzed using gas chromatography for its hydrogen concentration. H_2 concentration of 0.125 mol min^{-1} increased drastically at 16 kV compared to 0.100 mol min^{-1} and 0.075 mol min^{-1}. Hydrogen generation rate for 4.5 mm flow channel at 18 kV was found to be 0.40 mL min^{-1}, 0.21 mL min^{-1}, 0.08 mL min^{-1} for 0.125 mol min^{-1}, 0.100 mol min^{-1} and 0.075 mol min^{-1} respectively.

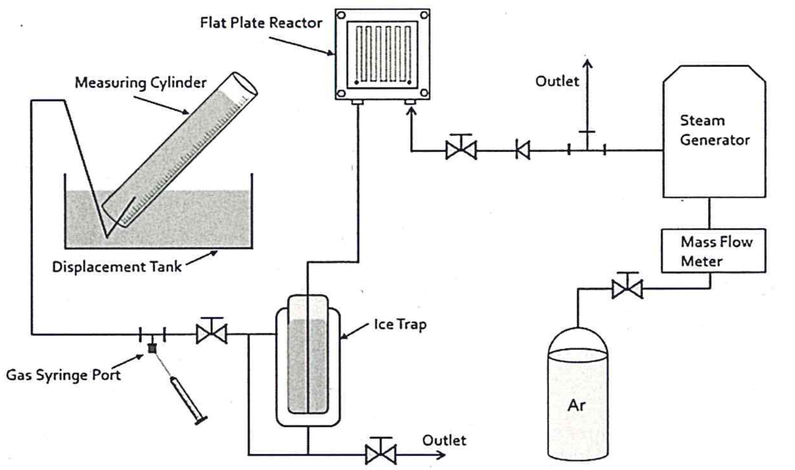

Fig. 1 Experimental setup for superheated steam composition by plasma reactor

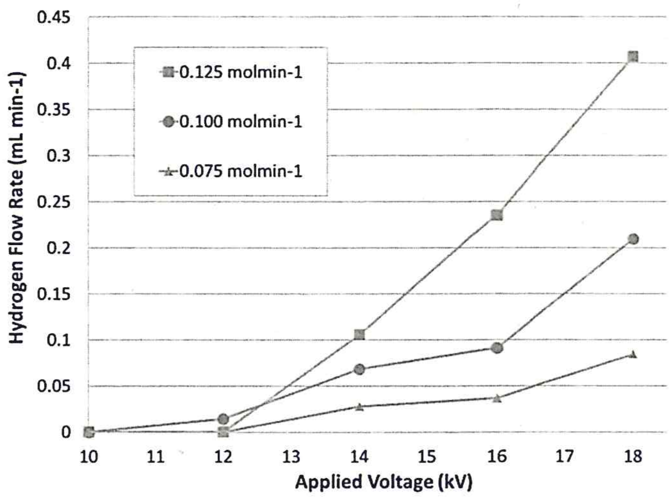

Fig. 2 Hydrogen flow rate of decomposed gas for 4.5 mm react

Reference

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