Hydrogen production by radio frequency plasma stimulation in methane hydrate at atmospheric pressure

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**Abstract**

Methane hydrate, formed by injecting methane into 100 g of shaved ice at a pressure of 7 MPa and reactor temperature of 0 °C, was decomposed by applying 27.12 MHz radio frequency plasma in order to produce hydrogen. The process involved the stimulation of plasma in the methane hydrate with a variable input power at atmospheric pressure. It was observed that production of CH\textsubscript{4} is optimal at a slow rate of CH\textsubscript{4} release from the methane hydrate, as analyzed by in light of the steam methane reforming (SMR) and the methane cracking reaction (MCR) processes in accordance with the content of gas production. In comparison with the steam methane reforming (SMR), it was found that methane-cracking reaction (MCR) was dominant in conversion of CH\textsubscript{4} into hydrogen. An H\textsubscript{2} content of 55% in gas production was obtained from conversion of 40% of CH\textsubscript{4} at an input power of 150 W. The results clearly show that hydrogen can be directly produced from methane hydrate by the in-liquid plasma method.

**Highlights**

- The in-liquid plasma method was applied to methane hydrate at atmospheric pressure.
- Steam methane reforming and methane cracking reactions convert the released CH\textsubscript{4} into hydrogen.
- The lower input power of 27.12 RF plasma gives higher hydrogen content in product gases.
- The power consumed was estimated average of 6.8% of the input power.

**Keywords**

- Methane hydrate; Radio frequency plasma; Hydrogen; Plasma in-liquid