

Auto-thermal reforming property of Ni-based structured catalyst for dry reforming of methane

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Auto-thermal dry reforming of methane (ATR-DRM) is a combined system of endothermic dry reforming of methane (DRM) and exothermic methane oxidation for producing a synthesis gas (a mixture of H₂ and CO). This system has an advantage of energetic efficiency because the heat required for the endothermic reaction is directly supplied from the exothermic reaction [1]. In order to take full advantage of this system, the structured catalyst is feasible since the catalyst has the efficient transport property of thermal energy by conductional heat transfer. We have already developed a Ni-based structured catalyst for DRM in the previous study [2]. The present study focuses on an investigation of the catalytic property of the Ni-based structured catalyst for ATR-DRM system.

The Ni/Al₂O₃ structured catalyst was prepared on a honeycomb-type stainless steel-fin substrate by combining sol-gel method and electroless plating technique, as previously reported [2]. The catalytic performance was performed with a plug flow reactor. The catalyst weight over the fin substrate was 250 mg. After H₂ reduction at 600°C for 1 h, the reactions were conducted under the following conditions; contact time (W/F) was 0.4 g·h mol⁻¹; feed gas composition was CH₄/CO₂/O₂/N₂ = 1/1/x/1-x (x = 0, 0.2, 0.3, 0.4); total pressure was 0.1 MPa; and setting temperature was 550–700°C.

Fig.1 shows the effect of O₂ feeding on the reforming performance of the Ni/Al₂O₃ structured catalyst. The O₂ addition to the DRM atmosphere caused an increase of methane conversion. Especially, when CH₄/CO₂/O₂/N₂ feed ratio was 1/1/0.2/0.8, the methane conversion at 700°C increased by 16%

compared to only DRM. In addition, the methane conversion was further enhanced by increasing the O₂ partial pressure. The Ni structured catalyst showed a high performance for ATR-DRM system.

Fig.2 shows a reactor temperature profile from the inlet of the catalyst to the outlet at 700°C in ATR-DRM. Under only DRM, the catalyst temperature dropped by about 40°C due to a progress of a high endothermic reaction at the inlet position. On the other hands, the temperature gradient of the catalyst under ATR-DRM was smaller than that under DRM. Especially, the maximum decrease of the temperature was only 15°C at 1/1/0.4/0.6 of CH₄/CO₂/O₂/N₂ feed ratio. These results suggested that the generated exothermic heat of the methane oxidation was efficiently utilized in ATR-DRM.

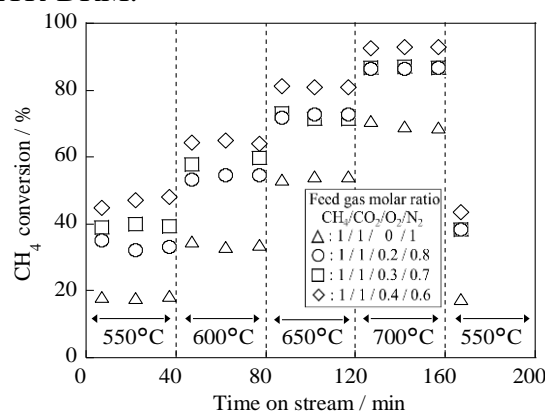


Fig.1 Effect of oxygen partial pressure change on ATR-DRM

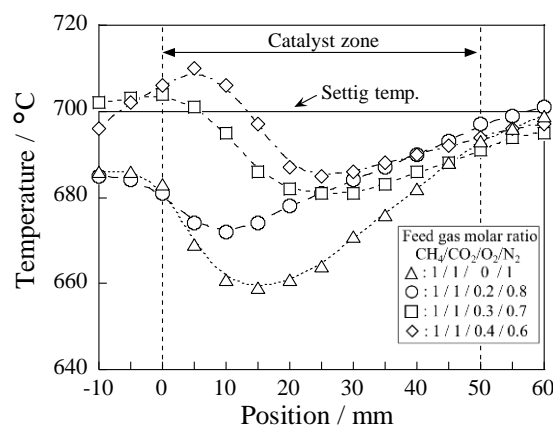


Fig.2 Temperature profile inside reactor setting at 700°C

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