Effect of $CeZrO_2$-modification of (Pd-Rh)/Al_2O_3 catalyst upon CH_4 bi-reforming performance

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Reforming of biogas by steam to syn gas is of significance for viable conversion of renewable energy resources because biogas consists primarily of the most simple and inexpensive hydrocarbon (CH_4) and the most stable carbon oxide (CO_2), both of which are major greenhouse gases. To optimize the reaction condition and catalyst for steam-reforming of biogas will be more systematic if they are to be investigated in the context of CH_4 bi-reforming, i. e., reforming of CH_4 in the presence of two reagents, carbon dioxide and steam. Some of our previous works on CH_4 bi-reforming have been performed to develop the process operating condition over the nano-scale, active and stable PdRh catalyst supported on Al_2O_3 that is coated on a metal foam substrate designed to fit the SOFC fuel processor application [1, 2].

In the present study, $CeZrO_2$-modification of Al_2O_3 support was optimized with respect to catalyst activity and stability as well as syn gas product yield and selectivity for CH_4 bi-reforming based on the reference operating condition obtained from Aspen Plus process simulation and previous experiments. $CeZrO_2$/Al_2O_3 weight ratio of the Pd-Rh catalyst support was varied as 0/100, 15/85, 25/75, 35/65, 50/50 and 75/25, and the catalyst performances were evaluated and compared in terms of CH_4 and CO_2 conversions, H_2/CO ratio of product syn gas, transient or accumulated coke deposition, and process thermal efficiency. CH_4 bi-reforming reaction runs were performed in a heat exchanger platform type reactor in the modes of transient activity screening and 200 hrs on-stream stability test. The fresh and used catalysts were characterized by BET surface area and porosity measurements, noble metal dispersion, and SEM as well as TEM analysis. Optimum relative abundance of $CeZrO_2$ within the alumina support was addressed for enhancing CH_4 bi-reforming performance of the Pd-Rh/Al_2O_3 catalyst.

Table 1. Characterization of the Pd-Rh catalysts.

Catalysts	$CeZrO_2$/Al_2O_3 ratio	surface area (m^2/g)	PGM dispersion (%)
mfc-1	0/100	126.3	52.2
mfc-2	15/85	94.9	40.7
mfc-3	25/75	88.3	33.1
mfc-4	50/50	84.1	30.2
mfc-5	75/25	79.5	26.2
mfc-6	100/0	69.8	21.0

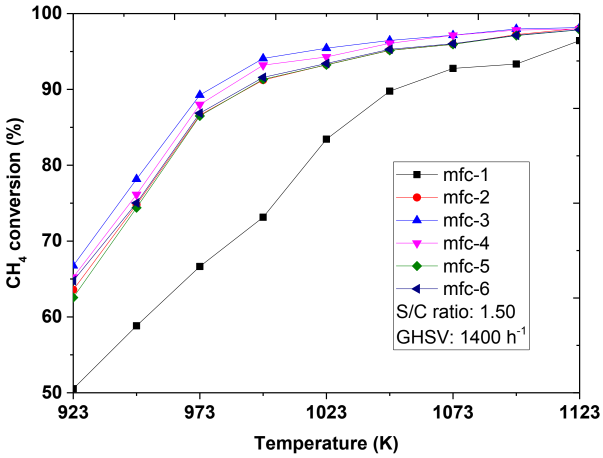

Fig. 1 CH_4 conversion from CH_4 bi-reforming

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