Long-Term Activity Tests of Rh/Al-Ce-Zr Catalyst Coated on Metal Foam Plate for Auto-Thermal Reforming of Liquid Hydrocarbons

No-Kuk Park, Yong Han Jeong, Tae Jin Lee*
Yeungnam University, Gyeongsan, Korea

*E-mail: tjlee@ynu.ac.kr

Recently, lack of energy is headed constantly. In this reason, the research about alternative energy is needed [1]. Fuel cell could be utilized for this problem. Diesel reforming can be used for hydrogen source of fuel cells. Because of high energy density, well-constructed infrastructure and wild application properties of diesel, it can be utilized at fuel cell source. However, diesel reforming reaction was occurred carbon coking reaction, so this additional reaction must be suppressed for using fuel cells. In this case, auto-thermal reforming has been considered for diesel reforming.

Auto-thermal reforming has less reaction to carbon coking than other diesel-reforming methods. Supply of both oxygen and steam makes auto-thermal reforming effective to suppress carbon coking formation [2].

In this study, a long-term performance test for the auto-thermal reforming of dodecane was carried out for 500 h at 800 ^{o}C to evaluate the durability of the metal foam catalyst, which is prepared by coating the Rh/Al-Cu-Zr-based reforming catalyst on the metal foam plate. In addition, the thermal stability of the supported reforming catalyst and the coke formation over the surface of catalyst were investigated while the reaction was in progress.

The yield of hydrogen by diesel auto-thermal reforming increased with increasing reaction temperature, and was obtained 5, 15 and 43% at 600, 700 and 800 °C, respectively. The fuel conversions at same conditions were 20, 85 and 100%. The high hydrogen yield was obtained at 2.5 of steam/carbon ratio when reforming reaction was carried out at 800. The optimum condition of oxygen/carbon was also confirmed to 0.25. In this study, long-term activity test of Rh/Al-Ce-Zr based catalyst was carried out under the optimum auto-thermal reforming condition. The composition of hydrogen and carbon monoxide in dry product gas was maintained to approximately 45% and 11% during 500 h, respectively. The theoretical composition of syn-gas, which is calculated by material balance under same condition, was 56%. Therefore, it was concluded that the catalytic activity of Rh/Al-Ce-Zr based catalysts is excellent on diesel auto-thermal reforming. The carbon content on the surface of catalysts after 100, 200, 300, 400 and 500hr reactions was investigated by EDX analysis and the carbon deposition was not observed, as shown Table. 1. It was also confirmed by TEM analysis that the crystal size of catalytic support materials increased with increasing reaction time. It was concluded that the change of crystal size is occurred by the sintering of alumina and the crystallization of $CeZrO_2$ at high temperature condition. However, catalytic deactivation by the change of crystal structure was not observed for 500 h. It was expected that the crystallization of $CeZrO_2$ prevents the deactivation by carbon deposition due to carbon oxidation of lattice oxygen in $CeZrO_2$.

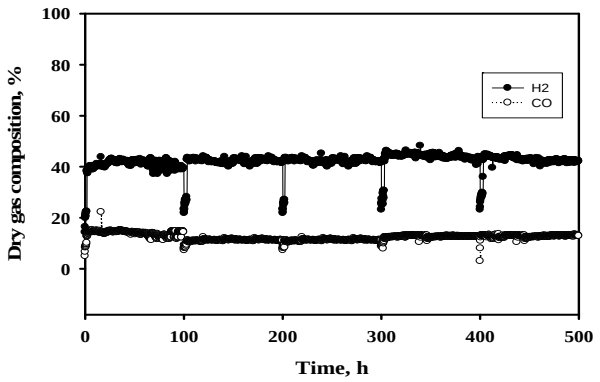

Fig.1 XRD patterns of $CeZrO_2$.

Table 1 EDX analysis about catalyst

	0~ 100 hr	100~ 200 hr	200~ 300 hr	300~ 400 hr	400~ 500 hr
C	0.00	2.33	3.07	2.80	2.69
O	29.18	29.23	30.92	28.59	29.32
Al	14.19	10.21	13.32	11.90	12.99
Cr	17.60	21.28	17.86	19.83	19.28
Fe	24.39	22.32	22.07	24.31	19.97
Ni	10.63	12.01	8.64	11.31	12.65
Zr	4.02	2.62	3.24	1.27	3.10

REFERENCES

[1] S.H. Lee, M.S. Bae, J.M. Bae and S.O. Katikaneni, Int. J. Hydrogen Energy, 40 (2015) 3207.

[2] S. Yoon, I. Kang, and J.M. Bae, Int. J. Hydrogen Energy, 33 (2008) 4780.