Development of Non-Noble Metal Catalysts for Hydrogen Production via Steam Reforming of Plastic Waste-Derived Light Oil

Chae-Yeon Park[1], Hye-Min Lee[1], Jin-sik Bang[1], Su-Bin Min[1], and Dae-Woon Jeong[2*]

[1]Department of Environmental Engineering, Changwon National University, 20 Changwondaehak-ro, Changwon, Gyeongnam 51140, Republic of Korea
[2]School of Smart & Green Engineering, Changwon National University, 20 Changwondaehak-ro, Changwon, Gyeongnam 51140, Republic of Korea
**Corresponding Author E-mail: dwjeong@changwon.ac.kr*

ABSTRACT

Plastic wastes have become a serious environmental issue because of their poor recyclability and degradation properties. Through pyrolysis, plastic wastes can be transformed into light oil that may be used as an efficient material for hydrogen production by means of steam reforming. The problem is that steam reforming requires the usage of expensive noble metals as catalysts. This research aimed at investigating the efficiency of non-noble metals Ni, Co, and Fe (5 wt%) deposited on mesoporous silica for hydrogen production from dodecane. The catalysts (5 wt.%) were prepared by impregnation, calcined at 800 °C. The catalysts were characterized using TPR, N_2 physisorption, H_2 and CO chemisorption, and XRD. Reactions were carried out in a quartz reactor at 800 °C with a steam-to-carbon ratio of 2.5 and a GHSV of 27,690 $mL \cdot gcat^{-1} \cdot h^{-1}$ over 20 h time-on-stream, with products analyzed by Micro GC. All catalysts retained their mesoporous structures (SBET > 200 $m^2\ g^{-1}$) and achieved similar dodecane conversions (30-40%). Despite similar conversions, Ni/SiO_2 achieved a substantially higher H_2 yield (~10-14%) than Co/SiO_2 (~3-5%) and Fe/SiO_2 (~1.5-3%). H_2-TPR showed that Ni/SiO_2 reduced at a higher temperature than Co/SiO_2 and Fe/SiO_2, consistent with a stronger metal-support interaction, while chemisorption confirmed higher Ni dispersion (3.0%) relative to Co (2.5%) and Fe (2.2%). These results indicate that metal choice, rather than conversion rate, is the dominant factor governing H_2 production efficiency, identifying Ni/SiO_2 as the most promising non-noble-metal catalyst for hydrogen production from plastic waste-derived light oil.

Keywords: Plastic waste pyrolysis/ Steam reforming/ Non-noble metal catalyst/ Hydrogen production