Catalytic pyrolysis of polypropylene with Ni/ SiO_2 over Mn/SiO_2

Soo Hyun Kim[1], Roosse Lee[1], Jong Ha Hwang[1], Eun Nam Son[2], See Hoon Lee[1], Jung Min Sohn[1*]

[1] Department of Mineral Resources & Energy Engineering, Chonbuk National University, Jeonju, Jeollabuk-do, 54896, Korea.
[2]Department of Energy Storage and Conversion Engineering, Chonbuk National University, Jeonju, Jeollabuk-do, 54896, Korea.

*E-mail: jmsohn@chonbuk.ac.kr

Plastic wastes are high potential as renewable energy sources, but they are thrown out and then continuously accumulated, causing serious problems in environmental pollution [1]. Pyrolysis was carried out for recycling plastic wastes. Many studies have been carried out to research the effects of pyrolysis on the yield of oil in a fluidized bed reactor [2]. A Fluidized bed reactor can transfer heat quickly from a heat source to a raw material by a sand, and many researches have been focused on fast pyrolysis in a fluidized bed [3]. Since the product oil through the thermal decomposition reaction is a low quality liquid fuel, it is chemically reformed with catalysts for quality improvement [4]. The use of a metal catalyst, Ni-based, increases the activity and selectivity, and reduces carbon deposition on the catalyst surfaces [5]. In this study, experiments were carried out with polypropylene which was the main raw material of plastic wastes, and Ni/SiO_2 and Mn/SiO_2 were used as catalysts. SiO_2 was chosen as a support since it was bed material in a fluidized reactor. Also, the yield of product oil by thermally decomposing polypropylene according to the change in catalyst and space velocity was investigated.

The reactor system consist of pyrolyzer and catalytic reactor connected vertically. The temperature of pyrolyzer was set to 600 ℃ to avoid wax formation inside reactors and the temperature of catalyst bed was set to 500 ℃. When the target temperature was reached, the pyrolysis furnace was moved down and a fast pyrolysis was started. The collected gas components were analyzed using Gas Chromatography (6500GC, YL Instrument Co.) and the condensed oil was analyzed using Gas Chromatography/Mass Spectrometry (GCMS QP2010 plus, Shimazu Co.). 5 wt% Ni and 5 wt% Mn were impregnated on SiO_2, respectively.

Fig. 1 showed the yield of oil as catalysts type and space velocity. Compared to SiO_2, Ni/SiO_2 and Mn/SiO_2 catalytic pyrolysis of polypropylene, resulted in the yield of oil was relatively lower than using Ni/SiO_2 and Mn/SiO_2. Using a catalyst Mn/SiO_2, the yield of oil was gradually increased from 64.29 % at 10,000 hr^{-1}, to 69.57 % at 30,000 hr^{-1}. So, with Mn/SiO_2, the yield of oil production was effectively enhanced at higher space velocity. From the oil analysis results, the aromatic series tended to increase as the space velocity increased in all cases. Major product in oil was olefin series regardless of the kinds of catalyst and space velocity. In the case of the Naphten series, the maximum production was observed at a space velocity 10,000 hr^{-1}, and then decreased as increasing the space velocity. Conclusively, Mn/SiO_2 could be used in a fluidized bed reactor for maximizing oil yield.

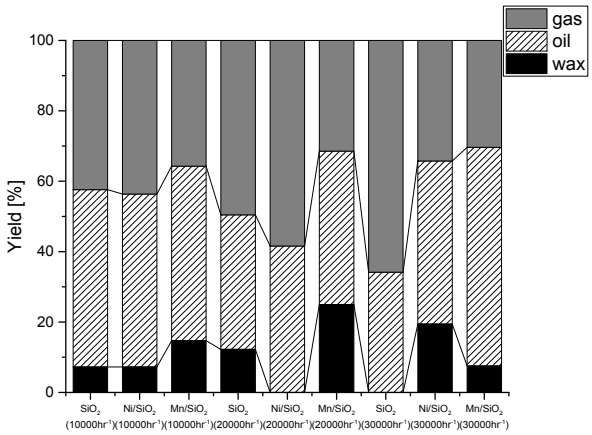

Fig.1 The yield of oil as catalysts type and space velocity.

REFERENCES

[1] E. A. Asamany, M. D. Gibson and M. J. Pegg. Fuel, 193 (2017) 178.
[2] H. Zhang, R. Xiao, H. Huang and G. Xiao. Bioresour. Technol., 100 (2009) 1428.
[3] K. S. Yoo, M. S. Eom and S. H. Lee, Appl. Chem. Eng., 27 (2016) 478.
[4] Q. Lu, Y. Zhang, Z. Tang, W. Li and X. Zhu. Fuel, 89 (2010) 2096.
[5] P. H. Blanco, C. Wu, J. A. Onwudili and P. T. Williams. Appl. Catal., B., 134 (2013) 238.