Mg-Al Hydrotalcite as a Solid Catalysts for Biodiesel production from Soybean Oil

Hsuan-Ming Chang, Yu-Chih Chen, Jyh-Cherng Shieh*

Bioenergy Research Center/Department of Bio-Industrial Mechatronics Engineering/National Taiwan University
1, Sec. 4, Roosevelt Rd., Taipei, Taiwan
Tel: +886-2-3366-5348, E-mail: jcshieh@ntu.edu.tw

ABSTRACT

In this work, an environmentally benign process for the transesterification of soybean oil to biodiesel by using Mg-Al hydrotalcite as heterogeneous catalyst was developed. The Mg-Al hydrotalcite with Mg/Al molar ratio of 3.0 were synthesized by co-precipitation method. The hydrotalcites calcined at various temperatures (450°C, 550°C, 650°C) were characterized by XRD, SEM, and surface area analysis. The results indicated that the flat structure was still observed with decreasing particle size calcined at 550°C and further reducing the size after calcination at 650°C. For the sample calcinated at 550°C reflected that Al^{+3} cations were dispersed in the structure of MgO. In addition, the spinel phase, $MgAl_2O_4$, appeared in the sample calcinated at 650°C. Furthermore, the total surface area of the catalysts was increased with calcination temperature.

In order to investigate the effects of various reaction variables such as molar ratio of methanol to oil, calcination temperature, the catalyst loading and reaction time on the conversion of soybean oil, a series of transesterification of soybean oil was carried out at 60°C with sodium hydroxide and hydrotalcite as catalyst. The experimental data showed that best conditions for hydrotalcite preparation and transesterification reactions are as follows: calcination temperature 550°C, molar ratio of soybean oil to methanol of 6:1, reaction time 360 min, and catalyst dosage 5%. The yield of fatty acid methyl ester (biodiesel fuel) was 78%. Moreover, a study of the catalyst's recyclability indicated that the spent hydrotalcite cannot be directly reused for the transesterification. However, while the used catalyst was regenerated by calcinations at 550°C for 3h, the conversion ratio was decreased to 72%. Repeating the regeneration process, the oil conversion ratio was further decreased to 62%.

Keywords: Biodiesel, Heterogeneous catalyst, Transesterification