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Article / Book Information

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（博士課程）
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	Agus Wahyudi	指導教員（主）： Academic Supervisor(main)	Prof. Dr. Hirofumi Hinode
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Red mud is a residue of bauxite processing in alumina industry through the Bayer process. It is highly alkaline waste material with a pH of 10-13 due to the using of caustic soda solution during the process. For every ton alumina produced, the process generates up to two tonnes of red mud as by-product and generally it is disposed in tailing pond or dumped at sea. According to the European List of Waste, red mud is not categorized as hazardous waste. However, it is not guarantee for the future effect especially in large quantities. The alkaline nature and the oxides/minerals content in red mud, such as iron, aluminum, silicon, titanium, can cause environmental problems and leading to the contamination of ground water under severe conditions.

Research on red mud utilization have been conducted and keep developing, such as for building material, adsorbent, coagulant, metal recovery, ceramic production, soil amandment and catalyst. For catalyst and catalysis, red mud has been studied in some applications, such as for hydrogenation and liquefaction process, hydrodechlorination reactions, and exhaust gas clean up. Aside from that, by utilizing the base property of this waste, it is possible to use it as a base catalyst for biodiesel production. Transesterification process in biodiesel production needs a base catalyst for deprotonating alcohol to convert it into alkoxide. Alkoxide is a strong nucleophilic so it can be easily react with triglyceride to produce methyl esters as the main product and glycerol as a by product. However, as a waste material, red mud contains high mineral constituents and can act as poison in catalytic reaction.

The previous study reported that red mud potentially to be used as a basic catalyst for biodiesel production. The calcined red mud was tested for its catalytic activity in several reaction conditions. However, the highest yield of biodiesel using this catalyst was still lower than the standard specification, although a high amount of methanol had been used (24:1 methanol/oil molar ratio). The EN14214 standard stated that the product should meet the minimum biodiesel yield of 96.5%.

In this work, red mud was modified by soda-lime calcination and was applied as a solid base catalyst for biodiesel production. The red mud was mixed with sodium carbonate and limestone (calcium carbonate) at the molar ratio of Na_2O/Al_2O_3 and CaO/Si_2O_3 of 1.5 and 2, respectively. The calcination temperature was varied from 500, 700, and 900°C, and was conducted for 2 h under air flow. It was found that the crystallite phase changed and sodium aluminate and sodium silicate were formed at 700 and 900°C. These two compounds have proven to show activity as solid catalyst for the transesterification reaction, due to high basicity and high efficiency for biodiesel production. The basicity of the prepared catalysts tend to increase

with the increase of calcination temperature. Calcination also has an effect on the morphology of the samples. Catalyst calcined at 700 and 900°C formed sponge or porous structures. These structures occurred due to agglomeration among red mud, sodium carbonate and limestone during calcination at certain temperatures. Agglomeration structures with spaces between agglomerates are preferable for solid catalysts for transesterification reaction, because the channels containing basic sites at the internal surface can be optimized as the entry of triglyceride and methanol.

The catalytic activity was tested through transesterification of canola oil and methanol to produce biodiesel. The effects of the methanol/oil molar ratio, catalyst amount, reaction temperature, and reaction time were also studied to obtain the optimum reaction conditions. The optimum reaction conditions were a 12:1 methanol/oil molar ratio, 4 wt% catalyst amount, 60ºC reaction temperature, and 2 hours reaction time, which resulted in 99.6% FAME yield. This result was higher than using commercial calcium oxide catalyst, with a FAME yield of 94.3% using the same reaction conditions.

Deactivation of modified red mud catalyst was also studied in this work to obtain the factor(s) that responsible to degradation of its properties and activities. The results revealed that the main cause of the catalyst deactivation is due to obstruction of the active sites by contaminants. As a consequence, the contaminants affect in decrease of the specific surface area as well as the basic strength of the catalyst, and considerably reduce its catalytic activity. The regeneration by washing with hexane and calcination can effectively regenerate the physical and chemical properties, and recover its catalytic activity close to that of the fresh one. Furthermore, by this regeneration method, the catalyst can be reused up to three times without any significant loss of activity.

The findings of this research could be used as future reference for the design of an efficient and eco-friendly method of utilizing red mud, which is a waste from alumina industry, into a solid catalyst for biodiesel production.