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Treatment of Biodiesel Wastewater with Hydrothermal Electrolysis

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[Introduction]

Biodiesel fuels have garnered much attention recently. Because they have various advantages as alternative to petroleum-based fuel, e.g., they are renewable, posses a favorable energy balance, have lower harmful emissions and are non-toxic. However, this rise in the production of biodiesel has created the problem of disposing glycerol, which is generated as the major by-product.

In this study, we investigated hydrothermal electrolysis of model biodiesel wastewater and tried to decompose by-product glycerol into value-added chemicals. Moreover, we tried to understand the effect of electricity loading on the decomposition of glycerol by comparing hydrothermal electrolysis with hydrothermal degradation experiments.

For this purpose, sub-critical water was chosen as a reaction medium because it offers essential advantages compared to other substances. For example, in sub-critical region, the dielectric constant is much lower; ion product is about three times larger than ambient water. As a result water becomes an excellent solvent for organic species.

[Experimental and Analysis]

Aqueous electrolyte solutions were prepared by dissolving an alkali (NaOH) in de-ionized water and then given amount of glycerol was charged in the solutions. Electrolysis was carried out using both batch (Figure 1) and flow type reactors made of SUS 316 stainless steel.

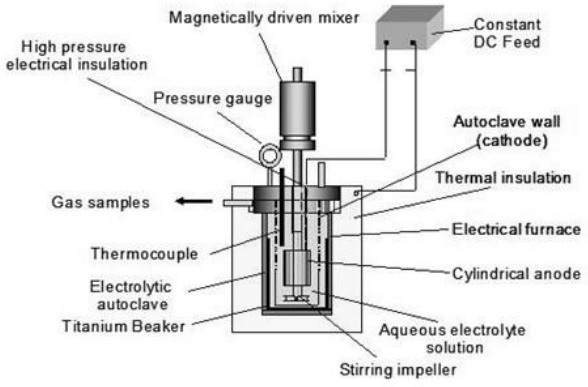

Figure 1: Batch reactor for hydrothermal electrolysis

For batch experiments 250 mL and for flow reactor 500 mL of feed solution was loaded into the titanium beaker. In batch experiments reactor was pressurized to 3 MPa with argon gas and then heated up to 280 °C. Once the reactors had been heated up to the desired temperature, constant electrical current was applied to carry out the electrolysis reaction for a period of 30-90 min. For comparison, we performed hydrothermal degradation experiments without any current at same conditions.

At the end of experiments, gas products were analyzed by GC-TCD and liquid products were analyzed by HPLC and GC-FID. The total organic carbon in the liquid product was monitored by TOC analyzer.

[Results and Discussion]

In both experiments, lactic acid was the main product. Figure 2 shows the optimum conditions for the production of lactic acid by hydrothermal electrolysis of glycerol with alkali.

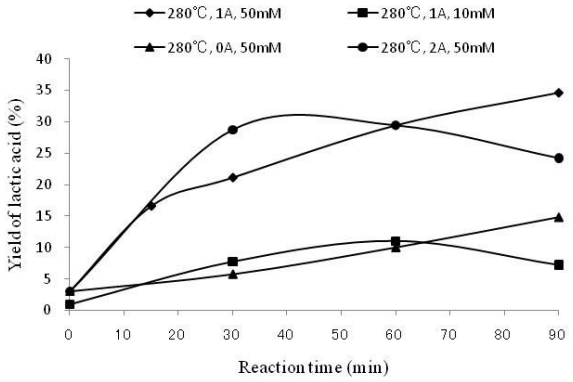

Figure 2: Optimum condition for lactic acid production

As a gaseous product, H_2 was produced. In batch experiments, generated H_2 was 1.3 times that of generated by flow reactor. By the addition of methanol in flow experiments, small amount of CO_2 was also generated.

For the comparison of the conversion of glycerol with both reactors, at the end of 90 min electrolysis, 84 % of glycerol was decomposed with 2 A current by autoclave electrolysis. In the case of flow reactor, max conversion was 92 % with 1A after 90 min.

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