Ordered Mesoporous Alkali Metal Catalyst for Recycling Waste Glycerol from Biodiesel Manufacturing Process

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In the last few decades, biodiesel has attracted considerable attention as a renewable energy source. However, more than 3 billion liters of waste glycerol from annual biodiesel production contaminates the environment by emitting pollutants in its elimination process. To tackle this issue, a series of alkali metal oxide catalysts were prepared for recycling waste glycerol to a high-value product, glycerol carbonate(GC), by transesterification with dimethyl carbonate(DMC). Al-KIT-6, aluminum grafted mesoporous silica structure was utilized as the supporter of the catalyst, with its vast surface area over 600m2/g and prominent ion-exchange capacity. In the screening process, each alkali metal oxide catalysts(Li2O, Na2O, K2O, Rb2O with Al-KIT-6) were tested in the same condition to compare their applicability as a catalyst. Catalysts were examined by glycerol conversion rate, GC selectivity, GC yield, XRD, and nitrogen adsorption. Na2O/Al-KIT-6 exhibited the highest result, so it was tested in various conditions to optimize the reaction of the catalyst. Na2O/Al-KIT-6 reacted in the optimal condition showed 98.6% conversion rate and 100% GC selectivity. The catalyst also exhibited no noticeable drop in both conversion rate and selectivity for at least five cycles, once regenerated after 3rd cycle. By its outstanding reusability, Na2O/Al-KIT-6 catalyst recycles the greatest amount of waste glycerol, leaving remaining waste glycerol at least 3 times less than previously developed catalysts with ¼ of price. Na2O/Al-KIT-6 also reduces pollutants to 1.4% and produces GC substantially cheaper than the market price. Thus, both environmental and economic benefits of Na2O/Al-KIT-6 as an industrial catalyst were proved.