Heterogeneous Catalyst and Process for Production of Biodiesel

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Introduction

Current biodiesel manufacture via alkali-catalyzed transesterification is limited by availability of refined oil feed stocks. While non-refined feed stocks, such as crude oils, rendered animal fat, and yellow/brown greases, are inexpensive and readily available, their high free fatty acids (FFA) content limits their use since the acids unfavorably react with the base catalysts employed.

There is an opportunity to reduce biodiesel production costs and environmental impact by applying modern catalyst technology, which will allow increased use of low-cost high-FFA feedstock, and reduce water and energy requirement. Esterification by sulfuric acid catalyst can be done but then the acid must be neutralized and disposed of with concurrent environmental and corrosion related problems. Apart from a few reports[1,2] on esterification of model compounds, utilization of solid catalysts has not been explored thoroughly. Nalan et. al.[3] studied several acidic polymeric catalysts for the esterification of fatty acids. The highest FFA conversion (45.7%) was obtained over polymer catalyst Amberlyst™ 15. These reports show solid catalysts have problems of high cost, severe conditions, slow kinetics, incomplete conversions, and limited lifetime.

We thus embarked on developing a novel polymer catalyst, named Amberlyst™ BD20, to overcome these difficulties. We will discuss the chemistry of catalysis, reaction rates, kinetics, mechanisms and a continuous process with reactor design optimized for conversion, longevity, ease of use, and economic impact.

Materials and Methods

Amberlyst BD20 is a patent-pending catalyst manufactured by Dow Chemical. Esterification was evaluated by processing an oil prepared by dissolving 10 wt. % of pure stearic acid (> 97 %, Fluka, Germany) in a low-acid vegetable oil (0.04 %) bought in the supermarket.

Results and Discussion

Comparison of Amberlyst BD20 catalyst with sulfuric acid shows identical behavior with low FFA feed stocks, but with higher FFA content, sulfuric acid catalysis becomes sluggish, and lower overall yields are achieved (Graph below). More than 20 oils were tested, and in each case, the catalyst was effective at converting the FFAs to the corresponding esters.

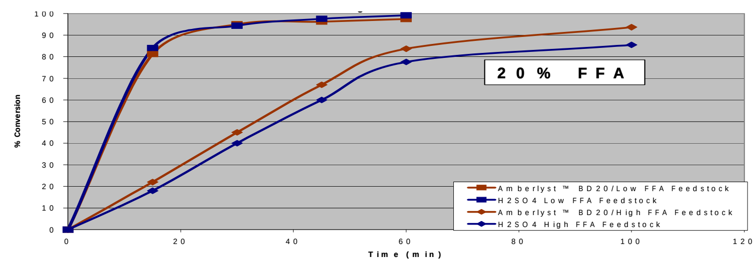

Figure 1. Reaction Profile of Heterogeneous vs Homogeneous Catalysis

Significance

The new polymeric catalyst, Amberlyst BD20 offers highly specialized morphology providing excellent accessibility of the supported catalytic sites for demanding molecules such as fatty acids. Using Amberlyst BD20 catalyst, it is possible to design a continuous process able to convert FFAs in low-cost feed stocks for further processing into biodiesel.

References

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