Water & Process Solutions

Specifically-Designed AMBERLYST™ BD20 Catalyst Leads to Effective and Efficient Conversion of FFAs to FAME

At-a-Glance

LOCATION

Pittsburgh, PA

Purpose:

To demonstrate the viability of heterogeneous polymeric catalysis technology for Free Fatty Acid esterification

Introduction

The use of biodiesel produced by the transesterification of triglycerides with methanol to produce fatty acid methyl esters (FAME) both as a renewable energy resource and an economical alternative to fossil fuels is receiving great interest. However, these triglyceride oils can be costly, and producers are continually searching for less expensive feedstocks. Unfortunately, these lower cost feedstocks often have unacceptably high levels of free fatty acids (FFAs). The presence of these FFAs in the standard biodiesel process leads to poorer process economics and increased problems in separation during the transesterification reaction due to the formation of soaps. To address this, The Dow Chemical Company has developed AMBERLYST™ BD20 catalyst specifically designed for the effective and efficient conversion of FFAs to FAME, enabling biodiesel manufacturers greater flexibility with feedstocks for transesterification, with the added benefit of meeting increasingly challenging biodiesel quality standards.

Background

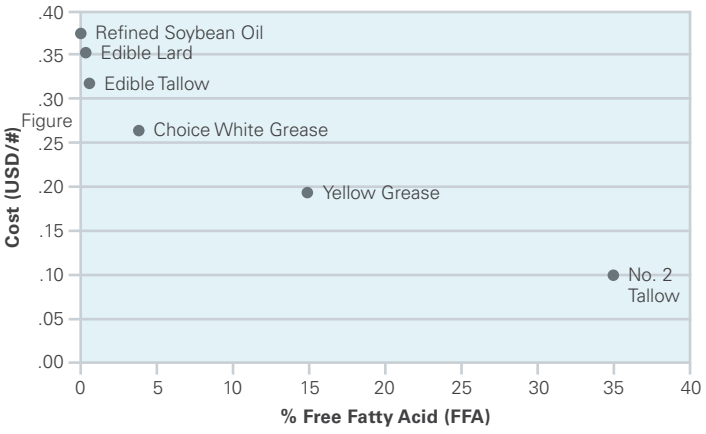
In order to protect consumers, grow the economy, and strengthen national security, the Commonwealth of Pennsylvania developed an Energy Independence Strategy. The Commonwealth is investing over $600 million "to spur the development of alternative and renewable energy sources", as well as to increase conservation and energy efficiency in homes and small businesses.[1]

[1] http://www.depweb.state.pa.us/portal/server.pt/community/energy_independence/10473

Through the Pennsylvania Department of Environmental Protection's Energy Independence Strategy and their Alternative Fuels Incentive Grant Program, The Dow Chemical Company was awarded a $752,000 grant to demonstrate, on a pilot scale, the use of heterogeneous catalysis for esterification of fatty acids to allow for the use of lower cost feedstocks.

> "Alternative Fuel Incentive Grant projects will promote and build markets for advanced or renewable energy technologies. The intent is to provide a stimulus for opportunities that better manage our fuel resources in a way that also improves our environment, supports economic development and enhances our quality of life."[2]

One of the biggest economic challenges for biodiesel is that over 90% of FAME manufacturing costs are associated with raw material costs. And although lower cost feedstocks are available, as the feedstock cost goes down, the concentration of free fatty acid (FFA) increases (Figure 1).



Figure

Unfortunately, the presence of free fatty acids significantly reduces the effectiveness of the standard transesterification process for producing biodiesel. The FFA neutralizes the sodium methoxide catalyst and also forms a soap which leads to poor liquid – liquid separation after the transesterification reaction.

A solution to the FFA problem is the addition of an esterification process in front of the standard transesterification step. By esterifying with methanol, the FFAs are converted to biodiesel which can then be run through the standard transesterification process without issue. In addition to the ability to utilize a lower cost feedstock by consuming the FFA in the esterification the neutralization of the sodium methoxide catalyst is eliminated. This, in turn, reduces the amount of soap formed and the resulting rag layer in the liquid-liquid separation. Ultimately the final biodiesel yield increases from the improved separation, reduced transesterification catalyst losses, and the direct formation of FAME during the esterification step.

The potential to utilize lower cost feed oils and greatly improve the economics of biodiesel production led the Pennsylvania Department of Energy to partner with The Dow Chemical Company to demonstrate the performance of the Amberlyst™ BD20 catalyst. The Amberlyst™ BD20 catalyst was tested under a range of conditions (Table 1).

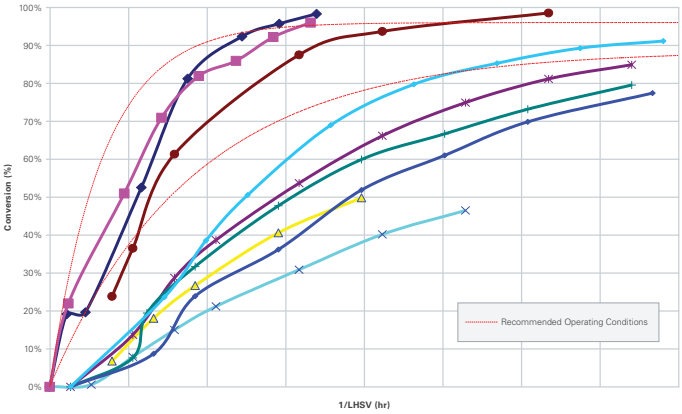
Table 1: Range of Test Conditions Run on PADEP Pilot Plant

	Minimum	Maximum
FFA Concentrations (wt%)	1%	40%
MeOH:FFA (molar)	5	20
Temperature (°C)	85	105

[2] http://www.portal.state.pa.us/portal/server.pt/community/alternative_fuels_incentive_grant-move_to_grants/10492

By testing under a range of conditions a detailed understanding along with a complete record of reaction data of the Amberlyst BD20 catalyst and its performance for esterifying the conversion of FFA to biodiesel was developed (Figure 2). A kinetic model was developed from this data and has been used to recommend designs and operating conditions to potential biodiesel producers supporting the Pennsylvania Department of Environmental Protection's goal to promote biodiesel production.

Figure 2: Conversion Profile of Esterification Reaction Data using Dow's Amberlyst BD20



Conclusion

The success of the pilot unit, which processed over 8,000 gallons of feedstock while in service, demonstrated the use of a heterogeneous catalysis for esterification of FFAs in a variety of less costly, crude feedstocks. Most importantly, the data generated from the testing has been successfully used to create a complete model to use for the design and operation of future biodiesel production plants. Because the pilot plant was constructed as a mobile unit it can now be used for trial at biodiesel facilities anywhere.

For more information about DOW Amberlyst™ BD20 Catalyst, call the Dow Water & Process Solutions business:

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