Biofuels, bioenergy

The University of Georgia Research Foundation, Inc.

Technology Commercialization Opportunity

Production of Higher Quality Bio-oils by In-line Esterification of Pyrolysis Vapor

UGARF Case: 1443
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School: College of Agriculture. BioAg Engineering
Intellectual Property Status: Patent Pending.

Introduction

Bio-oil is a potential renewable energy source for electricity and heat generation as well as being an alternative transportation fuel. However, several hurdles must be crossed before bio-oil can be used reliably. One of the main issues is storage stability of the oils. During storage, there is potential for bio-oils to undergo changes due to oxidative and thermal degradation. Oxidation can lead to polymerization and significantly increasing viscosity. Thermal degradation causes partial decomposition of components and can lead to loss of volatiles. Both storage conditions lead to viscosity and compositional changes. Most applications for bio-oils require that bio-oils retain favorable initial physical properties during storage, shipment and use, otherwise, filters, injectors, input lines, etc. may become obstructed and the fuel become unusable. In addition, the high level of reactive species and water content of bio-oil makes it unstable under normal storage conditions, which lead to increased viscosity over time. In addition, high oxygen and water content also lower the heating value of the fuel. During aging, bio-oil viscosity and chemical composition change dramatically mainly due to polymerization reactions. A higher degree of polymerization results in an exponential increase in viscosity. Polymerization reactions that lead to viscosity increases are accelerated at higher storage temperatures and it has been shown that rate of change in viscosity can increase from 0.009 cP/day when stored at -20°C to more than 300 cP/day at 90^{o}C. Therefore, the development of a means to stabilize bio-oils, providing for longer shelf-life and without compromising their thermal, chemical and physical properties is highly desirable. Moreover, such means should be incorporated upstream in the manufacturing of the bio-oil, thus circumventing the costs of adding post-manufacturing processing steps.

Technology Summary

UGA researchers have developed a novel process for the upstream esterification of organic acids present in bio-oils, thus minimizing the concentration of species that lead to changes of viscosity of bio-oils, over time. The process is self-catalyzed. Furthermore, the esterification leads to reduced viscosity and higher energy content of the bio-oil. Added benefits of esterification are (i) the reduction of free-oxygen content in the bio-oil, which further increases its heat content, (ii) the removal of coke-forming precursors, and (iii) a slight cooling of the system, leading to higher yield of recovered oily distillates. Total bio-oil production is in the 58% to 70% of the mass of the starting biomass.

Advantages

- Production of more stable and less viscous bio-oils, with higher energy capacity and low water contents
- No need for further processing of produced bio-oil. Stabilization process takes place upon bio-oil production
- Economically important esters can be obtained in large yields, from the stable bio-oil, thus establishing bio-oils as an important source of commodity chemicals

Potential Applications

- Production and stabilization of bio-oils and commodity chemicals.

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