FUEL AND FUEL BLENDING COMPONENTS FROM BIOMASS DERIVED PYROLYSIS OIL

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Provisional Application Ser. No. 61/042,741 filed Apr. 6, 2008, the contents of which are hereby incorporated by reference in its entirety.

STATEMENT OF GOVERNMENT INTEREST

This invention was made under CRADA PNNL/259 between UOP LLC and Alliance for Sustainable Energy, LLC, as operator of the National Renewable Energy Laboratory on behalf of the United States Department of Energy, and Battelle Memorial Institute, as operator of the Pacific Northwest National Laboratory on behalf of the United States Department of Energy. The Government has certain rights in this invention.

BACKGROUND OF THE INVENTION

This invention relates to processes for obtaining hydrocarbons from biomass. More particularly, this invention relates to the treatment of pyrolysis oil produced from the pyrolysis of biomass to produce fuel or fuel blending or additive components. The fuel or fuel additives or blending components may include those in the gasoline boiling point range, the diesel boiling point range, and the aviation boiling point range.

Renewable energy sources are of increasing importance. They are a means of reducing dependence on petroleum oil and provide a substitute for fossil fuels. Also, renewable resources can provide for basic chemical constituents to be used in other industries, such as chemical monomers for the making of plastics. Biomass is a renewable resource that can provide some of the needs for sources of chemicals and fuels.

Biomass includes, but is not limited to, lignin, plant parts, fruits, vegetables, plant processing waste, wood chips, chaff, grain, grasses, corn, corn husks, weeds, aquatic plants, hay, paper, paper products, recycled paper and paper products, and any cellulose containing biological material or material of biological origin. Lignocellulosic biomass, or cellulosic biomass as used throughout the remainder of this document, consists of the three principle biopolymers cellulose, hemicellulose, and lignin. The ratio of these three components varies depending on the biomass source. Cellulosic biomass might also contain lipids, ash, and protein in varying amounts. The economics for converting biomass to fuels or chemicals depend on the ability to produce large amounts of biomass on marginal land, or in a water environment where there are few or no other significantly competing economic uses of that land or water environment. The economics can also depend on the disposal of biomass that would normally be placed in a landfill.

The growing, harvesting and processing of biomass in a water environment provides a space where there is plenty of sunlight and nutrients while not detracting from more productive alternate uses. Biomass is also generated in many everyday processes as a waste product, such as waste material from crops. In addition, biomass contributes to the removal of carbon dioxide from the atmosphere as the biomass grows. The use of biomass can be one process for recycling atmospheric carbon while producing fuels and chemical precursors. Biomass when heated in an environment at short contact times with low or no oxygen, termed pyrolysis, will generate

a liquid product known as pyrolysis oil. Synonyms for pyrolysis oil include bio-oil, pyrolysis liquids, bio-crude oil, wood liquids, wood oil, liquid smoke, wood distillates, pyroligneous acid, and liquid wood.

The product of the biomass pyrolysis, the pyrolysis oil, contains what is known as pyrolytic lignin. Pyrolytic lignin is the water insoluble portion of the pyrolysis oil. An advantage of the process is that the pyrolysis oil may be optionally processed without prior separation of the pyrolytic lignin to produce fuel blending components or fuels that work with engines or devices that are currently distributed around the world without requiring upgrades to those engines.

SUMMARY OF THE INVENTION

The invention provides a process for producing high yields of naphtha, aviation, and or diesel fuel, blending components, or related products from biomass. The biomass undergoes pyrolysis to generate pyrolysis oil. The whole pyrolysis oil may be processed or optionally at least a portion of the aqueous phase may be removed to provide a pyrolytic lignin enriched pyrolysis oil generated from biomass. The pyrolysis oil, or a pyrolytic lignin enriched pyrolysis oil, is treated in a partial deoxygenation zone generating a partially deoxygenated stream. Water, gasses, and light ends are removed and the remainder of the partially deoxygenated stream is further treated in a full deoxygenation zone to produce a deoxygenated product stream. The deoxygenated product stream comprises hydrocarbon compounds that when fractionated are useful as gasoline and naphtha, aviation fuel, or as additives to, or blending components of, one or both products. The product stream can also be upgraded to produce a diesel fuel, blending component, or additive. Furthermore, the product stream can serve as a source of chemicals or chemical feedstocks.

After the full deoxygenation zone, water light ends, and gasses may be removed from the effluent of the full deoxygenation zone. Hydrogen may be separated and recycled. In one embodiment the first and full deoxygenation zones are combined and housed within in a single reactor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a process flow scheme for one embodiment of the invention where the whole pyrolysis oil is processed.

FIG. **2** shows a process flow scheme for one embodiment of the invention where at least a portion of the aqueous phase of the pyrolysis oil is separated from the pyrolysis oil, and at least the pyrolytic lignin is processed.

FIG. **3** shows a process flow scheme for one embodiment of the invention where the partial deoxygenation zone and the full deoxygenation zone are combined as sequential zones housed within in a single reactor.

FIG. **4** is a plot of the boiling point distribution of several fully deoxygenated pyrolysis oils which shows the hydrocarbon products produced have a wide boiling point range with significant fractions in the range for each fuel.

DETAILED DESCRIPTION OF THE INVENTION

In the U.S. and worldwide, there are huge amounts of lignocellulosic material, or biomass, which is not utilized, but is left to decay, often in a landfill, or just in an open field or forest. The material includes large amounts of wood waste products, and leaves and stalks of crops or other plant material that is regularly discarded and left to decay in fields. The emergence of inedible lipid-bearing crops for the production