

FUEL PRODUCTION FROM FEEDSTOCK CONTAINING
TRIGLYCERIDE AND/OR FATTY ACID ALKYL ESTER

FIELD OF THE INVENTION

[0001] This invention relates to the production of a fuel composition from a feedstock that comprises lipid material and mineral oil. More particularly, this invention relates to the production of at least one transportation fuel composition from a feedstock that comprises mineral oil and lipid material selected from the group consisting of triglyceride, fatty acid alkyl ester and a combination thereof, wherein the production includes at least one hydrocracking step.

BACKGROUND OF THE INVENTION

[0002] Due to a variety of environmental and energy concerns, there has been a high interest in promoting the use of biological materials in the manufacture of fuel products, particularly in transportation fuels. In the manufacture of fuels, one area of interest has been the production of suitable diesel fuel via processing of vegetable oils and animal fats that contain triglycerides of fatty acids.

[0003] A standard approach for converting vegetable oils or other fatty acid derivatives into fuels such as diesel type fuels has been accomplished by a transesterification reaction. This reaction involves contacting the vegetable oil with methanol in the presence of a catalyst, such as sodium hydroxide. The product that is produced is a fatty acid methyl ester, and the product can be used directly as a diesel fuel or blend component for diesel fuel.

[0004] Various problems with fuel quality have been associated with the fuel products formed from a simple transesterification reaction process, however. Some of these problems include poor cold flow properties and low oxidation stability.

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[0005] Hydroprocessing is one type of process that has been proposed to overcome some of the problems associated with fuels produced from a vegetable oil type feedstock. For example, U.S. Patent Application Publication No. 2009/0166256 discloses a process for the manufacture of diesel range hydrocarbons that are low in sulfur and that include up to 20% by weight of a biocomponent feedstock. The process includes the use of a staged co-hydrotreating process for the manufacture of diesel range hydrocarbons from at least one biocomponent feedstock and at least one mineral hydrocarbon feedstock.

[0006] Additional processes for producing high quality fuel from biological material are still sought. In particular, processes are sought that are capable of producing a variety of transportation fuels including gasoline, kerosene, jet fuel, and diesel. It is also highly desired that the processes be carried out so as to reasonably control undesired side reactions. Undesired side reactions can result in not only reduced quality fuels but can adversely affect catalysts used in the reaction process.

SUMMARY OF THE INVENTION

[0007] This invention provides processes for producing fuel, particularly transportation fuel, from biological material, *e.g.*, lipid material. The product includes one or more high quality transportation fuels such as gasoline, kerosene, jet fuel, and diesel fuel.

[0008] According to one aspect of the invention, there is provided a method of producing transportation fuel. The method includes producing or providing a feedstock containing lipid material and mineral oil. Preferably, the lipid material can be selected from the group consisting of triglycerides, fatty acid alkyl esters, and combinations thereof. The feedstock can be hydrocracked to produce the transportation fuel.

[0009] According to another aspect of the invention, there is provided a method of producing transportation fuel that includes a step of preparing or providing a feedstock containing mineral oil at a content of not greater than 99 wt % mineral oil, based on total weight of the feedstock, and a lipid material selected from the group consisting of triglycerides, fatty acid alkyl esters and combinations thereof. Preferably, the feedstock can have an initial boiling point of at least 100°C and/or a final boiling point of not greater than 500°C. The feedstock can be hydrocracked to produce the transportation fuel.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0015] This invention provides processes for producing one or more high quality fuels, particularly at least one transportation fuel, from feedstock that includes biological material, *e.g.*, lipid or lipidic material. The processes can be carried out without producing a significant amount of undesirable side reactions such as cracking, polymerization, and aromatization, which can be a consequence of large heats of reaction. As a result, the invention provides for the production of product that is high in quality. Additionally, catalyst used in the process is not adversely affected to any significant extent.

[0016] The feedstock that is used in the invention comprises both lipid material and mineral oil. By “mineral oil” is meant a fossil/mineral fuel source, such as crude oil, and not the commercial organic product, such as sold under the CAS number 8020-83-5, *e.g.*, by Aldrich. In one embodiment, the lipid material and mineral oil are mixed together prior to processing. In another embodiment, the lipid material and mineral oil are provided as separate streams into an appropriate processing unit or vessel.

[0017] The term "lipid material" as used according to the invention is a composition comprised of biological materials. Generally, these biological materials include vegetable fats/oils, animal fats/oils, fish oils, pyrolysis

oils, and algae lipids/oils, as well as components of such materials. More specifically, the lipid material includes one or more type of lipid compounds. Lipid compounds are typically biological compounds that are insoluble in water, but soluble in nonpolar (or fat) solvents. Non-limiting examples of such solvents include alcohols, ethers, chloroform, alkyl acetates, benzene, and combinations thereof.

[0018] Major classes of lipids include, but are not necessarily limited to, fatty acids, glycerol-derived lipids (including fats, oils and phospholipids), sphingosine-derived lipids (including ceramides, cerebroside, gangliosides, and sphingomyelins), steroids and their derivatives, terpenes and their derivatives, fat-soluble vitamins, certain aromatic compounds, and long-chain alcohols and waxes.

[0019] In living organisms, lipids generally serve as the basis for cell membranes and as a form of fuel storage. Lipids can also be found conjugated with proteins or carbohydrates, such as in the form of lipoproteins and lipopolysaccharides.

[0020] Examples of vegetable oils that can be used in accordance with this invention include, but are not limited to rapeseed (canola) oil, soybean oil, coconut oil, sunflower oil, palm oil, palm kernel oil, peanut oil, linseed oil, tall oil, corn oil, castor oil, jatropha oil, jojoba oil, olive oil, flaxseed oil, camelina oil, safflower oil, babassu oil, tallow oil and rice bran oil.

[0021] Vegetable oils as referred to herein can also include processed vegetable oil material. Non-limiting examples of processed vegetable oil material include fatty acids and fatty acid alkyl esters. Alkyl esters typically include C₁-C₅ alkyl esters. One or more of methyl, ethyl, and propyl esters are preferred.

[0022] Examples of animal fats that can be used in accordance with the invention include, but are not limited to, beef fat (tallow), hog fat (lard),

turkey fat, fish fat/oil, and chicken fat. The animal fats can be obtained from any suitable source including restaurants and meat production facilities.

[0023] Animal fats as referred to herein also include processed animal fat material. Non-limiting examples of processed animal fat material include fatty acids and fatty acid alkyl esters. Alkyl esters typically include C₁-C₅ alkyl esters. One or more of methyl, ethyl, and propyl esters are preferred.

[0024] Algae oils or lipids are typically contained in algae in the form of membrane components, storage products, and metabolites. Certain algal strains, particularly microalgae such as diatoms and cyanobacteria, contain proportionally high levels of lipids. Algal sources for the algae oils can contain varying amounts, *e.g.*, from 2 wt% to 40 wt% of lipids, based on total weight of the biomass itself.

[0025] Algal sources for algae oils include, but are not limited to, unicellular and multicellular algae. Examples of such algae include a rhodophyte, chlorophyte, heterokontophyte, tribophyte, glaucophyte, chlorarachniophyte, euglenoid, haptophyte, cryptomonad, dinoflagellum, phytoplankton, and the like, and combinations thereof. In one embodiment, algae can be of the classes Chlorophyceae and/or Haptophyta. Specific species can include, but are not limited to, *Neochloris oleoabundans*, *Scenedesmus dimorphus*, *Euglena gracilis*, *Phaeodactylum tricornutum*, *Pleurochrysis carterae*, *Prymnesium parvum*, *Tetraselmis chui*, and *Chlamydomonas reinhardtii*.

[0026] The lipid material portion of the feedstock can be comprised of triglycerides, fatty acid alkyl esters, or preferably combinations thereof. In one embodiment, the feedstock can include at least 0.05 wt % lipid material, based on total weight of the feedstock provided for processing into

fuel, preferably at least 0.5 wt%, for example at least 1 wt%, at least 2 wt%, or at least 4 wt%.

[0027] Additionally or alternately, the feedstock can include not more than 40 wt% lipid material, based on total weight of the feedstock, preferably not more than 30 wt%, for example not more than 20 wt% or not more than 10 wt%.

[0028] In one embodiment, the lipid material contains triglyceride. Types of triglycerides can be determined according to their fatty acid constituents. The fatty acid constituents can be readily determined using Gas Chromatography (GC) analysis. This analysis involves extracting the fat or oil, saponifying (hydrolyzing) the fat or oil, preparing an alkyl (*e.g.*, methyl) ester of the saponified fat or oil, and determining the type of (methyl) ester using GC analysis. In one embodiment, a majority (*i.e.*, greater than 50%) of the triglyceride present in the lipid material can be comprised of C₈ to C₂₂ fatty acid constituents, based on total triglyceride present in the lipid material. For clarity, when a fatty acid or fatty acid ester molecule is specified as a "C_{xx}" fatty acid, fatty acid constituent, or fatty acid ester, what is meant is that "xx" is the number of carbons on the carbon side of the carboxylate linkage, *i.e.*, including the carboxylate carbon, whereas, in fatty acid esters, the ester carbons are not included in the "C_{xx}" and are the carbons on the oxygen side of the carboxylate linkage, *i.e.*, stopping at the carboxylate oxygen. Further, a triglyceride is a molecule having a structure identical to the reaction product of glycerol and three fatty acids. Thus, although a triglyceride is described herein as being comprised of fatty acids, it should be understood that the fatty acid component does not necessarily contain a carboxylic acid hydrogen. In the processes of the present invention, a majority of the triglyceride present in the lipid material can preferably be comprised of C₁₀ to C₁₈, for example C₁₂ to C₁₈, fatty acid constituents, based on total triglyceride present in the lipid material.

[0029] In a particular embodiment, the lipid material includes triglyceride, with at least 20 wt%, preferably at least 30 wt%, for example at least 40 wt%, of the triglyceride being comprised of lauric acid (C 12:0) constituents. Using the notation “C xx:yy” indicates a compound having “xx” carbons on the main chain, *i.e.*, on the carbon side of the carboxylate group including the carboxylate carbon, and having “yy” double bonds on that main chain. Additionally or alternately, the lipid material includes triglyceride, with 40 wt% to 60 wt%, for example from 42 wt% to 58 wt% or from 44 wt% to 55 wt%, of the triglyceride being comprised of lauric acid constituents. Unless otherwise unambiguously specified, percentages expressed herein are percentages based on a number total of elements or constituents.

[0030] Additionally or alternately, the lipid material includes triglyceride, with at least 2 wt%, preferably at least 5 wt%, for example at least 10 wt%, of the triglyceride being comprised of myristic acid (C 14:0) constituents. Additionally or alternately, the lipid material includes triglyceride, with 10 wt% to 28 wt%, for example 12 wt% to 26 wt% or 14 wt% to 24 wt%, of the triglyceride being comprised of myristic acid constituents.

[0031] Additionally or alternately, the lipid material includes triglyceride, with at least 2 wt%, preferably at least 3 wt%, for example at least 5 wt%, of the triglyceride being comprised of palmitic acid (C 16:0) constituents. Additionally or alternately, the lipid material includes triglyceride, with 2 wt% to 12 wt%, for example 3 wt% to 10 wt% or 5 wt% to 8 wt%, of the triglyceride being comprised of palmitic acid constituents.

[0032] Additionally or alternately, the lipid material includes triglyceride, with at least 0.5 wt%, preferably at least 1 wt%, for example at least 2 wt%, of the triglyceride being comprised of stearic acid (C 18:0) constituents. Additionally or alternately, the lipid material includes

triglyceride, with 0.5 wt% to 60 wt%, for example 1 wt% to 55 wt% or 2 wt% to 50 wt%, of the triglyceride being comprised of stearic acid constituents.

[0033] Additionally or alternately, the lipid material includes triglyceride, with at least 5 wt%, preferably at least 6 wt%, for example at least 7 wt%, of the triglyceride being comprised of oleic acid (C 18:1) constituents. Additionally or alternately, the lipid material includes triglyceride, with 5 wt% to 30 wt%, for example 6 wt% to 25 wt% or 7 wt% to 20 wt%, of the triglyceride being comprised of oleic acid constituents.

[0034] Additionally or alternately, the lipid material includes triglyceride, with at least 2 wt%, preferably at least 3 wt%, for example at least 4 wt%, of the triglyceride being comprised of erucic acid (C 22:1) constituents. Additionally or alternately, the lipid material includes triglyceride, with 2 wt% to 70 wt%, for example 3 wt% to 65 wt% or 4 wt% to 60 wt% of the triglyceride being comprised of erucic acid constituents.

[0035] In one embodiment, the lipid material comprises fatty acid alkyl ester. Preferably, the fatty acid alkyl ester comprises fatty acid methyl esters (FAME), fatty acid ethyl esters (FAEE), and/or fatty acid propyl esters.

[0036] In a particular embodiment of the invention, the lipid material portion of the feedstock comprises fatty acid alkyl ester, and a majority of the fatty acid alkyl ester present in the lipid material is preferably FAME.

[0037] In another embodiment of the invention, the lipid material portion of the feedstock can comprise at least 20 wt%, preferably at least 30 wt%, for example at least 40 wt% fatty acid alkyl ester, preferably FAME, based on total weight of the lipid material. Preferably, a majority of the fatty acid constituents of the fatty acid alkyl ester, preferably FAME, can be selected from the group consisting of caprylic acid (C 8:0), capric acid

(C 10:0), lauric acid (C 12:0), myristic acid (C 14:0), palmitic acid (C 16:0), palmitoleic acid (C 16:1), stearic acid (C 18:0), oleic acid (C 18:1), linoleic acid (C 18:2), linolenic acid (C 18:3), erucic acid (C22:1), and combinations thereof. In a particular embodiment, a majority of the fatty acid constituents of the FAME present in the lipid material portion can be selected from the group consisting of lauric acid (C 12:0), myristic acid (C 14:0), palmitic acid (C 16:0), palmitoleic acid (C 16:1), stearic acid (C 18:0), oleic acid (C 18:1), and combinations thereof, based on total amount of FAME present in the lipid material portion.

[0038] The feedstock provided according to this invention comprises a mineral oil. Examples of mineral oils can include, but are not limited to, straight run (atmospheric) gas oils, vacuum gas oils, demetallized oils, coker distillates, cat cracker distillates, heavy naphthas (optionally but preferably at least partially denitrogenated and/or at least partially desulfurized), diesel boiling range distillate fraction (optionally but preferably at least partially denitrogenated and/or at least partially desulfurized), jet fuel boiling range distillate fraction (optionally but preferably at least partially denitrogenated and/or at least partially desulfurized), kerosene boiling range distillate fraction (optionally but preferably at least partially denitrogenated and/or at least partially desulfurized), and coal liquids. The mineral oil that is included as a part of the feedstock can comprise any one of these example streams or any combination thereof that would be suitable for hydrocracking with the lipid material portion. Preferably, the feedstock does not contain any appreciable asphaltenes. In one embodiment, the mineral oil can be mixed with the lipid material portion and then hydrotreated to form a hydrotreated material. In another embodiment, the mineral oil can be hydrotreated to reduce the nitrogen and/or sulfur content before being mixed with the lipid material portion.

[0039] The mineral oil component can contain nitrogen-containing compounds (abbreviated as “nitrogen”). For example, the mineral oil can contain at least 5 wppm nitrogen, based on total weight of the mineral oil component. Preferably, the mineral oil will contain not greater than 1.0 wt% nitrogen, based on total weight of the mineral oil component. In general, at least a majority of the nitrogen will be in the form of organonitrogen compounds.

[0040] The mineral oil will typically contain sulfur-containing compounds (abbreviated as “sulfur” or “sulfur content”). Such compounds can typically be present in the mineral oil at a sulfur content greater than 500 wppm, or often greater than 0.1 wt%, based on total weight of the mineral oil. Preferably, the sulfur content of the mineral oil will not be greater than 6 wt%, preferably not greater than 4 wt%, based on total weight of the mineral oil.

[0041] In one embodiment, the feedstock can include not greater than 99 wt% mineral oil, based on total weight of the feedstock. Preferably, the feedstock can include not greater than 98 wt%, for example not greater than 95 wt%, not greater than 90 wt%, not greater than 85 wt % mineral oil, or not greater than 80 wt%, based on total weight of the feedstock.

[0042] Additionally or alternately, the feedstock can include at least 50 wt% mineral oil, based on total weight of the feedstock. Preferably, the feedstock can include at least 60 wt%, for example at least 70 wt%, at least 75 wt%, or at least 80 wt% mineral oil, based on total weight of the feedstock.

[0043] According to one aspect of the invention, the feedstock that is hydrocracked can have an initial boiling point of at least 100°C, preferably at least 150°C, for example at least 180°C or at least 200°C. The basic test method of determining the boiling points or ranges of such feedstock, as well as the fuel compositions produced according to this invention, can be

by performing batch distillation according to ASTM D86-09e1, Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure.

[0044] Additionally or alternately, the feedstock can have a final boiling point of not greater than 500°C, preferably not greater than 450°C, for example not greater than 400°C.

[0045] The process of the invention includes a step of hydrocracking the feedstock to produce the desired fuel product. Hydrocracking refers to a process by which certain hydrocarbon molecules in a provided feedstock are broken into simpler molecules to produce a fuel product. Typically, the fuel product can include one or more transportation fuels, such as gasoline, kerosene, jet fuel, and/or diesel, and these individual fuels can typically be separated into their component parts by fractionation.

[0046] The hydrocracking process can be carried out by contacting the feedstock, optionally but preferably with a hydrocracking catalyst, in the presence of hydrogen to form the product. The addition of hydrogen provides benefit to the cracking aspect of the process, in that the fuel product that is produced is typically more highly saturated, and can be further reduced in undesirable heteroatoms, such as nitrogen, oxygen, and sulfur, and can advantageously also be reduced in aromatic content and/or in unsaturations.

[0047] In one embodiment, the hydrocracking catalyst used in the process of this invention can comprise an amorphous base or zeolite base and one or more Group VIII or Group VIB metal hydrogenation components. In another embodiment, the hydrocracking catalyst can comprise a crystalline zeolite cracking base upon which is deposited at least one Group VIII or Group VIB metal hydrogenating component. Suitable Group VIII and Group VIB metals can include cobalt, nickel, iron, molybdenum, tungsten, and combinations thereof. Suitable supports,

additionally or alternately to zeolitic and/or amorphous bases, can include relatively high specific surface area metal oxides such as silica, silica-alumina, alumina, and titania. While one preferred embodiment includes a catalyst comprising a Group VIB metal and a Group VIII metal (*e.g.*, in oxide form, or preferably after the oxide form has been sulfidized under appropriate sulfidization conditions), optionally on a support, the catalyst may additionally or alternately contain additional components, such as other transition metals (*e.g.*, Group V metals such as niobium), rare earth metals, organic ligands (*e.g.*, as added or as precursors left over from oxidation and/or sulfidization steps), phosphorus compounds, boron compounds, fluorine-containing compounds, silicon-containing compounds, promoters, binders, fillers, or like agents, or combinations thereof. The Groups referred to herein refer to Groups of the CAS Version as found in the Periodic Table of the Elements in Hawley's Condensed Chemical Dictionary, 13th Edition. By way of illustration, suitable Group VIII/VIB catalysts are described, for example, in one or more of U.S. Patent Nos. 6,156,695, 6,162,350, 6,299,760, 6,582,590, 6,712,955, 6,783,663, 6,863,803, 6,929,738, 7,229,548, 7,288,182, 7,410,924, and 7,544,632, U.S. Patent Application Publication Nos. 2005/0277545, 2006/0060502, 2007/0084754, and 2008/0132407, and International Publication Nos. WO 04/007646, WO 2007/084437, WO 2007/084438, WO 2007/084439, and WO 2007/084471, *inter alia*.

[0048] The zeolite cracking bases, which can be used as a component of the hydrocracking catalyst, can also be referred to as molecular sieves. These materials can be composed of silica, alumina and one or more exchangeable cations, such as sodium, magnesium, calcium, and one or more other metals such as transition and/or rare earth metals.

[0049] In one embodiment of the invention, a large pore crystalline molecular sieve can be used. Preferably, the crystalline molecular sieve has a Constraint Index of less than 2, for example not more than 1. The method

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by which the Constraint Index is determined is fully described in U.S. Patent No. 4,016,218, which is incorporated herein by reference.

[0050] Additionally or alternately, the hydrocracking catalyst can comprise a molecular sieve having a pore size of at least 7 angstroms, preferably at least 7.4 angstroms, for example at least 8 angstroms. Particularly preferred is a hydrocracking catalyst comprised of a molecular sieve having a pore size of not greater than 15 angstroms.

[0051] Examples of zeolite molecular sieves that can be used in the hydrocracking catalyst include, but are not limited to, Zeolite Beta, Zeolite X, Zeolite Y, faujasite, Ultrastable Y (USY), Dealuminized Y (Deal Y), Mordenite, ZSM-3, ZSM-4, ZSM-18, ZSM-20, and the like, and combinations thereof.

[0052] It is also preferred that the hydrocracking catalyst have at least some acidity. Preferably, the hydrocracking catalyst has an alpha value greater than 1, more preferably greater than 5, for example greater than 10. The alpha value is a measure of zeolite acidic functionality and an approximate indication of the catalytic cracking activity of a catalyst compared to a standard catalyst. The alpha test gives the relative rate constant (rate of normal hexane conversion per volume of catalyst per unit time) of the test catalyst relative to the standard catalyst which is taken as an alpha of 1 (Rate Constant = 0.016 sec^{-1}). The alpha test is described in U.S. Patent No. 3,354,078 and in several articles in *J. Catalysis*: 4, 527 (1965); 6, 278 (1966); and 61, 395 (1980), to which reference is made for a description of the test. The experimental conditions of the test used to determine alpha values include a constant temperature of about 538°C and a variable flow rate, as described in detail in *J. Catalysis*, 61, 395 (1980). The use of alpha value for acidic zeolites is described in greater detail in U.S. Patent No. 4,016,218 and in the 1966 *J. Catalysis* article.

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[0053] It is not necessary that the hydrocracking catalyst be highly acidic, although a highly acidic catalyst can be used. In one embodiment, the hydrocracking catalyst can have an alpha value of not greater than 200, for example not greater than 100.

[0054] Hydrocracking can be carried out under conditions effective for producing the desired fuel product. In one preferred embodiment, the hydrocracking can be carried out at an average reaction temperature from 300°F (149°C) to 900°F (482°C), preferably from 550°F (289°C) to 800°F (427°C).

[0055] Additionally or alternately, hydrocracking can also be carried out at an average reaction pressure from 400 psia (27 atm or 2.8 MPaa) to 3000 psia (200 atm or 21 MPaa), preferably from 500 psia (34 atm or 3.5 MPaa) to 2000 psia (140 atm or 14 MPaa).

[0056] Additionally or alternately, the hydrogen containing treat gas rate in hydrocracking can range from 300 scf/bbl (53 Nm³/m³) to 5000 scf/bbl (890 Nm³/m³), for example from 2000 scf/bbl (360 Nm³/m³) to 4000 scf/bbl (710 Nm³/m³).

[0057] Treat gas, as referred to in this specification, can be either pure hydrogen or a hydrogen-containing gas, which contains hydrogen in an amount at least sufficient for the intended reaction purpose(s), optionally in addition to one or more other gases (*e.g.*, nitrogen, light hydrocarbons such as methane, and the like, and combinations thereof) that generally do not adversely interfere with or affect either the reactions or the products. Impurities, such as H₂S and NH₃, are typically undesirable and would typically be removed from the treat gas before it is conducted to the reactor. The treat gas stream introduced into a reaction stage can preferably contain at least about 50 vol%, for example at least about 75 vol%, hydrogen.

[0058] Liquid hourly space velocity in hydrocracking, in volumes/volume/hour ($V/V/Hr$ or Hr^{-1}), will typically range from 0.1 to 10, preferably from 1 to 5.

[0059] While these hydrocracking conditions are mentioned in separate embodiments, it is contemplated that such hydrocracking reactions can be subject to any combination of two or more, or even all, of the characteristics/conditions of the reactions disclosed herein.

[0060] Any type of reactor suitable for hydrocracking can be used to carry out the process. Examples of such reactors can include, but are not limited to, trickle bed, ebullating bed, moving bed, fluidized bed, and slurry reactors.

[0061] One or more fractions can be removed or recovered from the hydrocracked product as the fuel composition according to this invention. In one embodiment, the feedstock can be hydrocracked to produce the transportation fuel. The transportation fuel can also be fractionated into at least one fractionated component, *e.g.*, selected from the group consisting of gasoline, kerosene, jet fuel, diesel, and combinations thereof.

[0062] In one embodiment, the process can be carried out to produce or recover a kerosene type or a gasoline type jet fuel. In one embodiment, the process can be carried out to produce or recover a kerosene type jet fuel having an ASTM D86 90% distillation point within the range from 250°C to 290°C, preferably from 260°C to 280°C. Alternately, the process can be carried out to produce or recover a gasoline type jet fuel having an ASTM D86 90% distillation point within the range from 200°C to 240°C, preferably from 210°C to 230°C.

[0063] In another embodiment, the process can be carried out to produce or recover a kerosene type jet fuel having an ASTM D86 10% distillation point within the range from 150°C to 200°C, preferably from

160°C to 180°C. Alternately, the process can be carried out to produce or recover a gasoline type jet fuel having an ASTM D86 10% distillation point within the range from 110°C to 140°C, preferably from 120°C to 130°C.

[0064] In another embodiment, the process can be carried out to produce or recover diesel fuel, *e.g.*, having an ASTM D86 90% distillation point within the range from 260°C to 350°C, preferably from 280°C to 340°C. Alternately, the process can be carried out to produce or recover diesel fuel having an ASTM D86 10% distillation point within the range from 200°C to 240°C, preferably from 210°C to 230°C.

[0065] Additionally or alternately, the present invention includes the following embodiments.

[0066] Embodiment 1. A method of producing transportation fuel, comprising: providing a feedstock containing lipid material and mineral oil, wherein the lipid material is selected from the group consisting of triglycerides, fatty acid alkyl esters, and combinations thereof; and hydrocracking the feedstock to produce the transportation fuel.

[0067] Embodiment 2. The method of embodiment 1, wherein the mineral oil is comprised of straight run gas oils, vacuum gas oils, demetallized oils, coker distillates, cat cracker distillates, heavy naphthas, diesel boiling range distillate fraction, jet fuel boiling range distillate fraction, kerosene boiling range distillate fraction, coal liquids, or a combination thereof.

[0068] Embodiment 3. The method of embodiment 1 or embodiment 2, wherein the feedstock has an initial boiling point of at least 100°C, a final boiling point of not greater than 500°C, or both.

[0069] Embodiment 4. The method of any of the previous embodiments, wherein the feedstock includes at least 0.05 wt% lipid material, based on total weight of the feedstock.

[0070] Embodiment 5. The method of any of the previous embodiments, wherein the feedstock includes not greater than 99 wt% mineral oil, based on total weight of the feedstock.

[0071] Embodiment 6. The method of any of the previous embodiments, wherein the lipid material portion of the feedstock includes triglyceride and a majority of the triglyceride present in the lipid material is comprised of C₈ to C₂₂ fatty acid constituents, based on total triglyceride present in the lipid material.

[0072] Embodiment 7. The method of any of the previous embodiments, wherein the lipid material portion of the feedstock is comprised of at least 20 wt% fatty acid alkyl ester, based on total weight of the lipid material in the feedstock.

[0073] Embodiment 8. The method of any of the previous embodiments, wherein the transportation fuel is recovered as at least one fractionated component selected from the group consisting of gasoline, kerosene, jet fuel, and diesel.

[0074] Embodiment 9. The method of any of the previous embodiments, further comprising the step of fractionating the transportation fuel into at least one fractionated fuel component selected from the group consisting of gasoline, kerosene, jet fuel, and diesel fuel.

[0075] The principles and modes of operation of this invention have been described above with reference to various exemplary and preferred embodiments. As understood by those of skill in the art, the overall invention, as defined by the claims, encompasses other preferred embodiments not specifically enumerated herein.

CLAIMS

1. A method of producing transportation fuel, comprising:
providing a feedstock containing lipid material and mineral oil, wherein the lipid material is selected from the group consisting of triglycerides, fatty acid alkyl esters, and combinations thereof; and hydrocracking the feedstock to produce the transportation fuel.

2. The method of claim 1, wherein the mineral oil is comprised of straight run gas oils, vacuum gas oils, demetallized oils, coker distillates, cat cracker distillates, heavy naphthas, diesel boiling range distillate fraction, jet fuel boiling range distillate fraction, kerosene boiling range distillate fraction, coal liquids, or a combination thereof.

3. The method of claim 1 or claim 2, wherein the feedstock has an initial boiling point of at least 100°C, a final boiling point of not greater than 500°C, or both.

4. The method of any of the previous claims, wherein the feedstock includes at least 0.05 wt% lipid material, based on total weight of the feedstock.

5. The method of any of the previous claims, wherein the feedstock includes not greater than 99 wt% mineral oil, based on total weight of the feedstock.

6. The method of any of the previous claims, wherein the lipid material portion of the feedstock includes triglyceride and a majority of the triglyceride present in the lipid material is comprised of C₈ to C₂₂ fatty acid constituents, based on total triglyceride present in the lipid material.

7. The method of any of the previous claims, wherein the lipid material portion of the feedstock is comprised of at least 20 wt% fatty acid alkyl ester, based on total weight of the lipid material in the feedstock.

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8. The method of any of the previous claims, wherein the transportation fuel is recovered as at least one fractionated component selected from the group consisting of gasoline, kerosene, jet fuel, and diesel.

9. The method of any of the previous claims, further comprising the step of fractionating the transportation fuel into at least one fractionated fuel component selected from the group consisting of gasoline, kerosene, jet fuel, and diesel fuel.