catalytic cracking method using oil/fat such as plant oil or waste cooking oil as a raw material. According to such a method, among fatty acid glycerin esters, hydrocarbons derived from hydrocarbon groups of fatty acids, propane derived from glycerin moieties, and carbon dioxide and carbon monoxide derived from ester groups are generated.

[Prior Art Documents]

[0004]

[Patent Document 1] JP5234456B

[Non-Patent Documents]

[0005]

[Non-Patent Document 1] Journal of the Japan Institute of Marine Engineering, 2012, Vol. 47, No. 1, pp. 45-50

[Summary ~~of the Invention~~]

[Problems to be solved ~~by the Invention~~]

[0006]

In the production of a so-called "next-generation biodiesel fuel" whose main components are hydrocarbons, raw materials that can be used are limited. For example, it is difficult to use, as the raw materials, fatty acid glycerin ester-containing wastes such as waste glycerin, which is produced as a by-product of the production of fatty acid alkyl ester or the like, and free fatty acid-containing wastes such as a high acid value oil, which has an extremely high acid value, among waste cooking oils. In recent years, the treatment of such wastes has become an urgent issue, and the development of a method that can utilize these wastes as the raw materials is desired also in the production of next-generation biodiesel fuel.

[0007]

The present ~~invention~~disclosure has been made in view of the above problems, and an object of the present ~~invention~~disclosure is

to provide a method for producing a biodiesel fuel whose main components are hydrocarbons, that is, a novel production method that can use a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester.

[Means for solving the Problems]

[0008]

As a result of intensive studies to solve the above problems, the present inventor has found that a biodiesel fuel whose main components are hydrocarbons can be efficiently produced through adding an inorganic acid or enzyme to a raw material containing at least one of glycerin and a fatty acid glycerin ester to separate them and using the obtained oil component, or using a fatty acid alkyl ester obtained by further esterifying the oil component, to subject the above oil component or fatty acid alkyl ester to a catalytic cracking method. The present inventor has thus accomplished the present ~~invention~~disclosure.

Specifically, the present ~~invention~~ disclosure is as follows.

[0008a]

In an aspect, there is provided a method for producing a biodiesel fuel, comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid;

an esterification step of reacting the first oil component with a monohydric alcohol to obtain a fatty acid alkyl ester by using a method other than an alkali catalyst method, the method being at least one method selected from a group consisting of an acid catalyst method, an acid-

alkali catalyst method, a biocatalyst method, an ion-exchange resin method, a supercritical method, a subcritical method, and a solid catalyst method; and

a catalytic cracking step of bringing the fatty acid alkyl ester into contact with a catalyst to obtain a hydrocarbon.

[0008b]

In another aspect, there is provided a method for producing a biodiesel fuel, comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid; and

a catalytic cracking step of bringing the first oil component into contact with a catalyst to obtain a hydrocarbon.

[0008c]

In another aspect, there is provided a method for producing a fatty acid alkyl ester, comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid; and

an esterification step of reacting the first oil component with a monohydric alcohol to obtain a fatty acid alkyl ester by using a method other than an alkali catalyst method, the method being at least one method selected from a group consisting of an acid catalyst method, an acid-alkali catalyst method, a biocatalyst method, an ion-exchange resin method, a supercritical method, a subcritical method, and a solid catalyst method.

[0008d]

In another aspect, there is provided a method for purifying glycerin from a raw material that contains at least one of glycerin and a fatty acid glycerin ester, the method comprising:

a first separation step of mixing the raw material with an inorganic acid to separate a first oil component and a first glycerin liquid;

a neutralization step of neutralizing the obtained first glycerin liquid with an alkaline substance; and

a second separation step of separating a second oil component and a precipitated inorganic salt from the neutralized glycerin liquid to obtain a purified glycerin.

[0009]

(1) A method for producing a biodiesel fuel, comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid;

an esterification step of reacting the first oil component with a monohydric alcohol to obtain a fatty acid alkyl ester by using a method other than an alkali catalyst method, the method being at least one method selected from the group consisting of an acid catalyst method, an acid-alkali catalyst method, a biocatalyst method, an ion-exchange resin method, a supercritical method, a subcritical method, and a solid catalyst method; and

step is 200°C to 600°C.

(12) The method described in (11), wherein the reaction temperature is adjusted by electromagnetic induction heating.

[Effect ~~of the Invention~~]

[0010]

According to the present ~~invention~~disclosure, a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester can be used in the method for producing a biodiesel fuel whose main components are hydrocarbons, and free fatty acid-containing wastes and fatty acid glycerin ester-containing wastes, for example, can be effectively recycled.

[Brief Description of Drawings]

[0011]

FIG. 1 is a diagram illustrating a flow for obtaining a first oil component in a first embodiment of the present invention.

FIG. 2 is a diagram illustrating a flow for obtaining a fatty acid alkyl ester in a second embodiment of the present invention.

FIG. 3 is a diagram illustrating a flow of a catalytic cracking step in an embodiment of the present invention.

[Embodiments for Carrying out the Invention]

[0012]

Hereinafter, embodiments of the present invention will be described.

The method for producing a biodiesel fuel according to an embodiment of the present invention includes: a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin

[Name of Document] Claims

1. A method for producing a biodiesel fuel, comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid;

an esterification step of reacting the first oil component with a monohydric alcohol to obtain a fatty acid alkyl ester by using a method other than an alkali catalyst method, the method being at least one method selected from a group consisting of an acid catalyst method, an acid-alkali catalyst method, a biocatalyst method, an ion-exchange resin method, a supercritical method, a subcritical method, and a solid catalyst method; and

a catalytic cracking step of bringing the fatty acid alkyl ester into contact with a catalyst to obtain a hydrocarbon.

2. The method according to claim 1, comprising:

a neutralization step of neutralizing, with an alkaline substance, the first glycerin liquid obtained by using the inorganic acid in the first separation step; and

a second separation step of separating a second oil component and a precipitated inorganic salt from the neutralized glycerin liquid,

wherein the esterification step includes reacting the second oil component together with the first oil component.

3. The method according to claim 1 or 2, comprising:

a neutralization step of neutralizing, with an alkaline substance, the first glycerin liquid obtained by using the inorganic acid in the first separation step;

a second separation step of separating a second oil component and a precipitated inorganic salt from the neutralized glycerin liquid; and

an alcohol separation step of separating a monohydric alcohol from the glycerin liquid from which the second oil component and the inorganic salt are separated,

wherein the monohydric alcohol separated in the alcohol separation step is used as the monohydric alcohol in the esterification step.

4. A method for producing a biodiesel fuel, comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid; and

a catalytic cracking step of bringing the first oil component into contact with a catalyst to obtain a hydrocarbon.

5. The method according to claim 4, comprising:

a neutralization step of neutralizing, with an alkaline substance, the first glycerin liquid obtained by using the inorganic acid in the first separation step; and

a second separation step of separating a second oil component and a precipitated inorganic salt from the neutralized glycerin liquid,

wherein the catalytic cracking step includes bringing the second oil component into contact with the catalyst together with the first oil component.

6. The method according to any one of claims 1 to 5, wherein the raw material in the first separation step

contains at least one of a high acid value oil having an acid value of 10 mgKOH/g or more and waste glycerin produced as a by-product in a process of producing a fatty acid alkyl ester.

7. The method according to any one of claims 1 to 6, wherein the inorganic acid is used in the first separation step, and the inorganic acid is concentrated sulfuric acid.

8. The method according to any one of claims 1 to 7, wherein the inorganic acid is used in the first separation step, and a mixed liquid of the raw material and the inorganic acid has a pH of 3 or less.

9. The method according to any one of claims 1 to 8, wherein the catalyst in the catalytic cracking step contains magnesium oxide.

10. The method according to any one of claims 1 to 9, wherein the catalytic cracking step includes performing a reaction in a rotating drum that is arranged in a state in which its axis of rotation is inclined with respect to a horizontal plane.

11. The method according to any one of claims 1 to 10, wherein a reaction temperature in the catalytic cracking step is 200°C to 600°C.

12. The method according to claim 11, wherein the reaction temperature is adjusted by electromagnetic induction heating.

13. A method for producing a fatty acid alkyl ester,

comprising:

a first separation step of mixing a raw material containing at least one of a free fatty acid and a fatty acid glycerin ester with an inorganic acid or enzyme to separate a first oil component and a first glycerin liquid; and

an esterification step of reacting the first oil component with a monohydric alcohol to obtain a fatty acid alkyl ester by using a method other than an alkali catalyst method, the method being at least one method selected from a group consisting of an acid catalyst method, an acid-alkali catalyst method, a biocatalyst method, an ion-exchange resin method, a supercritical method, a subcritical method, and a solid catalyst method.

14. A method for purifying glycerin from a raw material that contains at least one of glycerin and a fatty acid glycerin ester, the method comprising:

a first separation step of mixing the raw material with an inorganic acid to separate a first oil component and a first glycerin liquid;

a neutralization step of neutralizing the obtained first glycerin liquid with an alkaline substance; and

a second separation step of separating a second oil component and a precipitated inorganic salt from the neutralized glycerin liquid to obtain a purified glycerin.