CLAIMS

What is claimed is:

1. A method for co-production of an alkylbenzene product (12) and a biofuel (13) from a natural oil (14) comprising:

deoxygenating the natural oil to form paraffins (20);

hydrocracking a first portion (23) of the paraffins to form a first stream (25) of normal or lightly branched paraffins in the C_9 to C_{14} range and a second stream (26) of isoparaffins;

dehydrogenating the first stream to provide mono-olefins (52);

alkylating benzene (54) with the mono-olefins under alkylation conditions to provide an alkylation effluent (60) comprising alkylbenzenes and benzene;

isolating the alkylbenzenes to provide the alkylbenzene product; and

processing a second portion (21) of the paraffins and the second stream of isoparaffins to form biofuel.

2. The method of claim 1 wherein the second stream of isoparaffins is in the naphtha range, and wherein during processing of the second stream of isoparaffins, hydrogen (86) is produced and is recycled to support deoxygenating the natural oil.

3. The method of claim 1 wherein a hydrogen stream (36) results from dehydrogenating the first stream, and wherein the method further comprises recycling the hydrogen stream to support the deoxygenating step.

4. The method of claim 1 wherein processing the second portion of the paraffins and the second stream of isoparaffins includes isomerizing the second portion of the paraffins to form additional isoparaffins.

5. The method of claim 1 wherein di-olefins are provided by dehydrogenating the first stream, and wherein the method further comprises selectively hydrogenating the di-olefins to form additional mono-olefins.

6. The method of claim 5 further comprising removing aromatics from the mono-olefins before alkylating.

7. The method of claim 1 wherein the natural oil comprises a first plurality of fatty acids having a first range of chain lengths and a second plurality of fatty acids having a second range of chain lengths; wherein first chain length paraffins and second chain length paraffins are formed by deoxygenating the natural oils; wherein the first portion of the paraffins comprises the first chain length paraffins; and wherein the second portion of the paraffins comprises the second chain length paraffins; the method further comprising:

fractionating the paraffins to separate the first portion of paraffins from the second portion of paraffins before hydrocracking.

8. The method of claim 1 wherein the natural oil comprises C_{22} fatty acids, and wherein deoxygenating the natural oil causes cleaving and provides the portion of the paraffins and the second portion of the paraffins.

9. A method for co-production of an alkylbenzene product (12) and a biofuel (13) from natural oil source triglycerides (14) comprising:

deoxygenating the triglycerides to form a deoxygenated product (20) comprising water, carbon dioxide, propane, and paraffins;

fractionating the deoxygenated product to separate a first stream of paraffins (23) and a second stream of paraffins (21);

hydrocracking the first stream of paraffins to form a normal paraffin stream (25) and an isoparaffin stream (26);

dehydrogenating the normal paraffin stream to provide mono-olefins (52);

alkylating benzene (54) with the mono-olefins under alkylation conditions to provide an alkylation effluent (60) comprising alkylbenzenes and benzene;

isolating the alkylbenzenes to provide the alkylbenzene product; and

processing the second stream of paraffins and the isoparaffin stream to form biofuel.

10. A method for co-production of an alkylbenzene product (12) and biofuel (13) from a natural oil (14) comprising:

deoxygenating the natural oil with hydrogen (18) to form a stream comprising paraffins (20);

hydrocracking the paraffins to form a normal paraffin stream (25) and an isoparaffin stream (26);

dehydrogenating the normal paraffin stream to provide mono-olefins (52) and hydrogen;

recycling the hydrogen to support deoxygenation of the natural oil;

alkylating benzene (54) with the mono-olefins under alkylation conditions to provide an alkylation effluent (60) comprising alkylbenzenes and benzene;

isolating the alkylbenzenes to provide the alkylbenzene product; and

processing the isoparaffin stream to form biofuel.

CLAIMS

1. A method for co-production of an alkylbenzene product and a biofuel from a natural oil comprising:

deoxygenating the natural oil to form paraffins;

hydrocracking a first portion of the paraffins to form a first stream of normal or lightly branched paraffins in the C_9 to C_{14} range and a second stream of isoparaffins;

dehydrogenating the first stream to provide mono-olefins;

alkylating benzene with the mono-olefins under alkylation conditions to provide an alkylation effluent comprising alkylbenzenes and benzene;

isolating the alkylbenzenes to provide the alkylbenzene product; and

isomerizing a second portion of the paraffins and the second stream of isoparaffins to form biofuel.

2. The method of claim 1 wherein the second stream of isoparaffins is in the naphtha range, and wherein during processing of the second stream of isoparaffins, hydrogen is produced and is recycled to support deoxygenating the natural oil.

3. The method of claim 1 wherein a hydrogen stream results from dehydrogenating the first stream, and wherein the method further comprises recycling the hydrogen stream to support the deoxygenating step.

4. The method of claim 1 wherein di-olefins are also produced by dehydrogenating the first stream, and wherein the method further comprises selectively hydrogenating the di-olefins to form additional mono-olefins.

5. The method of claim 4 further comprising removing aromatics produced by the dehydrogenating step from the mono-olefins before alkylating.

6. The method of claim 1 wherein the natural oil comprises a first plurality of fatty acids having a first range of chain lengths and a second plurality of fatty acids having a second

range of chain lengths; wherein first chain length paraffins and second chain length paraffins are formed by deoxygenating the natural oils; wherein the first portion of the paraffins comprises the first chain length paraffins; and wherein the second portion of the paraffins comprises the second chain length paraffins; the method further comprising:

fractionating the paraffins to separate the first portion of paraffins from the second portion of paraffins before hydrocracking.

7. The method of claim 1 wherein isolating provides the alkylbenzene product comprising alkylbenzenes having C_8 to C_{28} chains.

8. The method of claim 1 wherein the natural oil comprises C_{22} fatty acids, and wherein deoxygenating the natural oil causes cleaving and provides the portion of the paraffins and the second portion of the paraffins.

9. A method for co-production of an alkylbenzene product and a biofuel from natural oil source triglycerides comprising:

deoxygenating the triglycerides to form a deoxygenated product comprising water, carbon dioxide, propane, a first portion of paraffins, and a second portion of paraffins;

fractionating the deoxygenated product to separate a first stream of paraffins and a second stream of paraffins;

hydrocracking the first stream of paraffins to form a normal paraffin stream and an isoparaffin stream;

dehydrogenating the normal paraffin stream to provide mono-olefins;

alkylating benzene with the mono-olefins under alkylation conditions to provide an alkylation effluent comprising alkylbenzenes and benzene;

isolating the alkylbenzenes to provide the alkylbenzene product; and

isomerizing the second stream of paraffins and the isoparaffin stream to form biofuel.

10. The method of claim 9 wherein the biofuel is synthetic paraffinic kerosene.

11. The method of claim 9 wherein a hydrogen stream results from dehydrogenating the normal paraffin stream, and wherein the method further comprises recycling the hydrogen stream to support the deoxygenating step.

12. The method of claim 9 wherein di-olefins are also produced by dehydrogenating the normal paraffin stream, the method further comprising selectively hydrogenating the di-olefins to form additional mono-olefins for alkylating the benzene.

13. The method of claim 9 further comprising removing aromatics produced by the dehydrogenating step from the mono-olefins before alkylating.

14. The method of claim 9 wherein:

the natural oil source is castor oil;

the triglycerides consist essentially of C_{18} fatty acids with hydroxyl groups at the carbon-12 position; and

deoxygenating the triglycerides causes cleaving and provides the first stream of paraffins and the second stream of paraffins.

15. The method of claim 14 wherein the first stream of paraffins have C_{10} to C_{11} chains.

16. The method of claim 15 wherein the second stream of paraffins have C_{17} to C_{18} chains.

17. A method for co-production of an alkylbenzene product and biofuel from a natural oil comprising:

deoxygenating the natural oil with hydrogen to form a stream comprising paraffins;

hydrocracking the paraffins to form a normal paraffin stream and an isoparaffin stream;

dehydrogenating the normal paraffin stream to provide mono-olefins and hydrogen;

recycling the hydrogen to support deoxygenation of the natural oil;

alkylating benzene with the mono-olefins under alkylation conditions to provide an alkylation effluent comprising alkylbenzenes and benzene;

isolating the alkylbenzenes to provide the alkylbenzene product; and

isomerizing the isoparaffin stream to form biofuel.

18. The method of claim 17 wherein the biofuel is synthetic paraffinic kerosene.

19. The method of claim 17 wherein a hydrogen stream results from dehydrogenating the normal paraffin stream, and wherein the method further comprises recycling the hydrogen stream to support the deoxygenating step.