Claims

12205PC/B3023PC/ Amended claims 25 Jan 2016 (clean)

1. An integrated process for producing hydrocarbons, said process comprising the steps of subjecting feedstock originating from renewable sources to catalytic hydroprocessing in a hydroprocessing system in the presence of hydrogen under hydrogen partial pressure in the range from 25 to 250 bar, followed by separation of an aqueous component, a heavy component comprising hydrocarbons having carbon number more than 5, and a light component comprising gases and hydrocarbons having carbon number from 1 to 5, directing said light component to separation for removal of carbon dioxide and hydrogen sulfide to obtain a recycle stream comprising hydrogen and hydrocarbons having carbon number from 1 to 5, followed by dividing the recycle stream to a first recycle stream and a second recycle stream, directing the first recycle stream to the hydroprocessing system, and the second recycle stream to a hydrogen plant comprising a steam reformer unit, a desulfurization unit upstream the steam reformer unit, and water gas shift unit, converting said hydrocarbons having carbon number from 1 to 5 in said hydrogen plant to hydrogen, and directing a hydrogen stream comprising said hydrogen to the hydroprocessing system.

2. The integrated process for producing hydrocarbons according to claim 1, wherein natural gas, LPG, naphta, biogas, methane, ethane, propane, butane or a combination thereof is used as starting material to the hydrogen plant.

3. The integrated process for producing hydrocarbons according to claim 2, wherein the second recycle stream is directed to the desulfurization unit of the hydrogen plant and sulfur compounds are removed from the starting material.

4. The integrated process for producing hydrocarbons according to any one claims 1 - 3, wherein the hydrogen plant comprises additionally a carbon dioxide/carbon monoxide/water separator unit.

5. The integrated process for producing hydrocarbons according to any one of claims 1-4, wherein the first recycle stream is combined with the hydrogen stream to obtain a combined stream, and the amount of hydrocarbons having carbon number from 1 to 5 in the combined stream is adjusted to the range not more than 30 % by mole, calculated from the total amount of feedstock to the hydroprocessing system.

6. The integrated process for producing hydrocarbons according to claim 5, wherein the hydrocarbons having carbon number from 1 to 5 comprise methane.

7. The integrated process for producing hydrocarbons according to any one of claims 1-6, wherein the light component is subjected to separation using one or more amine scrubbers capable of removing hydrogen sulfide and carbon dioxide.

8. The integrated process for producing hydrocarbons according to any one of claims 1-7, wherein the separation of the aqueous component, the heavy component, and the light component is carried out using a cold separator.

9. The integrated process for producing hydrocarbons according to any one of claims 1-8, wherein the heavy component is subjected to separation and/or fractionation to obtain hydrocarbons boiling in the transportation fuel range.

10. The integrated process for producing hydrocarbons according to any one of claims 1-9, wherein the feedstock originating from renewable source is selected from feedstock originating from plants, animals, algae, fish, microbiological processes, side streams and waste streams originating from processing said feedstocks, and sewage sludge.

11. The integrated process for producing hydrocarbons according to any one of claims 1-10, wherein the feedstock comprises plant oil, or plant derived compounds which are obtained as a by-product from the forest industry, and combinations thereof.

12. The integrated process for producing hydrocarbons according to any one of claims 1-11, wherein the hydrogen partial pressure in the catalytic hydroprocessing is in the range from 25 to 250 bar, preferably from 60 to 200 bar, particularly preferably from 80 to 150 bar.

13. The integrated process for producing hydrocarbons according to any one of claims 1-12, wherein the total pressure in the catalytic hydroprocessing is from 25 to 250 bar, preferably from 80 to 160 bar.

14. The integrated process for producing hydrocarbons according to any one of claims 1-13, wherein the catalytic hydroprocessing is carried out at a temperature from 280 to 450°C.

15. A hydrocarbon product obtained by the process according to any one of claims 1-14.

16. An integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen, wherein said process comprises the steps where feedstock originating from renewable sources is subjected to catalytic hydroprocessing in a hydroprocessing system in the presence of hydrogen under hydrogen partial pressure in the range from 25 to 250 bar, followed by separation of an aqueous component, a heavy component

comprising hydrocarbons having carbon number more than 5, and a light component comprising gases and hydrocarbons having carbon number from 1 to 5, directing said light component to separation for removal of carbon dioxide and hydrogen sulfide to obtain a recycle stream comprising hydrogen and hydrocarbons having carbon number from 1 to 5, followed by dividing the recycle stream to a first recycle stream and a second recycle stream, directing the first recycle stream to the hydroprocessing system, and the second recycle stream to a hydrogen plant comprising a steam reformer unit, a desulfurization unit upstream the steam reformer unit, and water gas shift unit, and converting said hydrocarbons having carbon number from 1 to 5 in said hydrogen plant to hydrogen.

17. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to claim 16, wherein hydrogen stream comprising said hydrogen converted in said hydrogen plant is directed to the hydroprocessing system.

18. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to claim 16 or 17, wherein natural gas, LPG, naphta, biogas, methane, ethane, propane, butane or a combination thereof is used as starting material to the hydrogen plant.

19. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to claim 18, wherein the second recycle stream is directed to the desulfurization unit of the hydrogen plant and sulfur compounds are removed from the starting material.

20. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 19, wherein the hydrogen plant comprises additionally carbon dioxide/carbon monoxide/water separator unit.

21. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 20, wherein the light component is subjected to separation using one or more amine scrubbers capable of removing hydrogen sulfide and carbon dioxide.

22. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 21, wherein the feedstock originating from renewable source is selected from feedstock originating from plants, animals, algae, fish, microbiological processes, side streams and waste streams originating from processing said feedstocks, and sewage sludge.

23. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 22, wherein the feedstock comprises plant oil, or plant derived compounds which are obtained as a by-product from the forest industry, and combinations thereof.

Claims

1. An integrated process for producing hydrocarbons, said process comprising the steps of subjecting feedstock originating from renewable sources to catalytic hydroprocessing in a hydroprocessing system in the presence of hydrogen, followed by separation of an aqueous component, a heavy component comprising hydrocarbons having carbon number more than 5, and a light component comprising gases and hydrocarbons having carbon number from 1 to 5, directing said light component to separation for removal of carbon dioxide and hydrogen sulfide to obtain a recycle stream comprising hydrogen and hydrocarbons having carbon number from 1 to 5, followed by dividing the recycle stream to a first recycle stream and a second recycle stream, directing the first recycle stream to the hydroprocessing system, and the second recycle stream to a hydrogen plant comprising a steam reformer unit, a desulfurization unit upstream the steam reformer unit, and water gas shift unit, converting said hydrocarbons having carbon number from 1 to 5 in said hydrogen plant to hydrogen, and directing a hydrogen stream comprising said hydrogen to the hydroprocessing system.

2. The integrated process for producing hydrocarbons according to claim 1, wherein natural gas, LPG, naphta, biogas, methane, ethane, propane, butane or a combination thereof is used as starting material to the hydrogen plant.

3. The integrated process for producing hydrocarbons according to claim 2, wherein the second recycle stream is directed to the desulfurization unit of the hydrogen plant and sulfur compounds are removed from the starting material.

4. The integrated process for producing hydrocarbons according to any one claims 1 - 3, wherein the hydrogen plant comprises additionally a carbon dioxide/carbon monoxide/water separator unit.

5. The integrated process for producing hydrocarbons according to any one of claims 1-4, wherein the first recycle stream is combined with the hydrogen stream to obtain a combined stream, and the amount of hydrocarbons having carbon number from 1 to 5 in the combined stream is adjusted to the range not more than 30 % by mole, calculated from the total amount of feedstock to the hydroprocessing system.

6. The integrated process for producing hydrocarbons according to claim 5, wherein the hydrocarbons having carbon number from 1 to 5 comprise methane.

7. The integrated process for producing hydrocarbons according to any one of claims 1-6, wherein the light component is subjected to separation using one or more amine scrubbers capable of removing hydrogen sulfide and carbon dioxide.

8. The integrated process for producing hydrocarbons according to any one of claims 1-7, wherein the separation of the aqueous component, the heavy component, and the light component is carried out using a cold separator.

9. The integrated process for producing hydrocarbons according to any one of claims 1-8, wherein the heavy component is subjected to separation and/or fractionation to obtain hydrocarbons boiling in the transportation fuel range.

10. The integrated process for producing hydrocarbons according to any one of claims 1-9, wherein the feedstock originating from renewable source is selected from feedstock originating from plants, animals, algae, fish, microbiological processes, side streams and waste streams originating from processing said feedstocks, and sewage sludge.

11. The integrated process for producing hydrocarbons according to any one of claims 1-10, wherein the feedstock comprises plant oil, or ~~plant derived~~ compounds which are obtained as a by-product from the forest industry, and combinations thereof.

12. The integrated process for producing hydrocarbons according to any one of claims 1-11, wherein the hydrogen partial pressure in the catalytic hydroprocessing is in the range from 25 to 250 bar, preferably from 60 to 200 bar, particularly preferably from 80 to 150 bar.

13. The integrated process for producing hydrocarbons according to any one of claims 1-12, wherein the total pressure in the catalytic hydroprocessing is from 25 to 250 bar, preferably from 80 to 160 bar.

14. The integrated process for producing hydrocarbons according to any one of claims 1-13, wherein the catalytic hydroprocessing is carried out at a temperature from 280 to 450°C.

15. A hydrocarbon product obtainable by the process according to any one of claims 1-14.

16. An integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen, wherein said process comprises the steps where feedstock originating from renewable sources is subjected to catalytic hydroprocessing in a hydroprocessing system in the presence of hydrogen, followed by separation of an aqueous component, a heavy component comprising hydrocarbons having carbon number more than 5, and a light component comprising gases and hydrocarbons having carbon number from 1 to 5, directing said light component to separation for removal of carbon dioxide and hydrogen sulfide to obtain a recycle stream comprising hydrogen and hydrocarbons having carbon number from 1 to 5, followed by dividing the recycle stream to a first recycle stream and a second recycle stream, directing the first recycle stream to the hydroprocessing system, and the second recycle stream to a hydrogen plant comprising a steam reformer unit, a desulfurization unit upstream the steam reformer unit, and water gas shift unit, and converting said hydrocarbons having carbon number from 1 to 5 in said hydrogen plant to hydrogen.

17. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to claim 16, wherein hydrogen stream comprising said hydrogen converted in said hydrogen plant is directed to the hydroprocessing system.

18. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to claim 16 or 17, wherein natural gas, LPG, naphta, biogas, methane, ethane, propane, butane or a combination thereof is used as starting material to the hydrogen plant.

19. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to claim 18, wherein the second recycle stream is directed to the desulfurization unit of the hydrogen plant and sulfur compounds are removed from the starting material.

20. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 19, wherein the hydrogen plant comprises additionally carbon dioxide/carbon monoxide/water separator unit.

21. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 20, wherein the light component is subjected to separation using one or more amine scrubbers capable of removing hydrogen sulfide and carbon dioxide.

22. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 21, wherein the feedstock originating from renewable source is selected from feedstock originating from plants, animals, algae, fish, microbiological processes, side streams and waste streams originating from processing said feedstocks, and sewage sludge.

23. The integrated process for converting hydrocarbons having carbon number from 1 to 5 to hydrogen according to any one of claims 16 - 22, wherein the feedstock comprises plant oil, or compounds which are obtained as a by-product from the forest industry, and combinations thereof.