CLAIMS

1. A method for treating a gaseous composition, comprising:

(i) providing a gaseous composition comprising H_2, methane, ethane, propane, and hydrocarbons having a carbon number of at least C4, wherein the total amount of H_2, methane, ethane, propane, and hydrocarbons having a carbon number of at least C4 is at least 80 wt-%, preferably at least 85 wt-%, more preferably at least 90 wt-% of the total weight of the gaseous composition; and

(ii) subjecting the gaseous composition to distillation in a thermally coupled distillation system comprising n distillation columns and at least one and at most n-1 condenser(s) and at least one and at most n-1 reboiler(s), n being an integer ≥ 2, to recover a propane composition.

2. The method according to claim 1, wherein the thermally coupled distillation system comprises at least a first distillation column connected to a condenser without being connected to a reboiler, and a second distillation column connected to a reboiler without being connected to a condenser, and the gaseous composition is fed to the first distillation column and the propane composition is recovered from the second distillation column.

3. The method according to claim 1 or 2, wherein a liquid feed and a liquid reflux are provided from the first distillation column to the second distillation column of the thermally coupled distillation system, and a vapour feed and a vapour boilup are provided from the second distillation column to the first distillation column of the thermally coupled distillation system.

4. The method according to claim 3, wherein the first column bottom is provided as the liquid feed to the bottom section of the second column, and the second column overhead is provided as the vapour feed to the top section of the first column, and the liquid reflux is provided from the top section of the first column, below the inlet of the vapour feed, to the top section of the second column, and the vapour boilup is provided from the bottom section of the second column, above the inlet of the liquid feed, to the bottom section of the first column.

5. The method according to any one of the preceding claims, wherein the first distillation column of the thermally coupled distillation system is configured to separate compounds lighter than propane, such as H_2, methane and ethane, and the second distillation column of the thermally coupled distillation system is configured to separate compounds heavier than propane, such as hydrocarbons having a carbon number of at least C4.

6. The method according to any one of the preceding claims, wherein the gaseous composition has a content ratio of hydrocarbons having a carbon number of at least C4 to propane of at least 0.05, preferably within a range from 0.05 to 0.40, more preferably from 0.07 to 0.35, even more preferably from 0.09 to 0.30, most preferably from 0.10 to 0.20.

7. The method according to any one of the preceding claims, wherein the gaseous composition comprises hydrocarbons having a carbon number of at least C5, and has a content ratio of hydrocarbons having a carbon number of at least C5 to propane of at least 0.01, preferably within a range from 0.01 to 0.35, more preferably from 0.02 to 0.30, even more preferably from 0.03 to 0.25, most preferably from 0.04 to 0.15.

8. The method according to any one of the preceding claims, wherein the gaseous composition comprises hydrocarbons having a carbon number of at least C4 at most 18.5 wt-%, preferably at most 18.0 wt-%, more preferably at most 17.0 wt-%, even more preferably at most 16.0 wt-%, most preferably at most 10.5 wt-%, and/or at least 5.0 wt-%, preferably at least 7.0, more preferably at least 9.0 wt-%, such as from 5.0 to 18.5 wt-%, or from 7.0 to 17.0 wt-%, or from 9.0 to 16.0 wt-%, based on the total weight of the gaseous composition; and/or hydrocarbons having a carbon number of at least C5 at most 15.0 wt-%, preferably at most 10.0 wt-%, more preferably at most 8.0 wt-%, even more preferably at most 6.0 wt-%, and/or at least 1.5 wt-%, preferably at least 2.0 wt-%, more preferably at least 3.0 wt-%, such as from 1.5 to 15.0 wt-%, or from 2.0 to 10.0 wt-%, or from 3.0 to 8.0 wt-%, based on the total weight of the gaseous composition.

9. The method according to any one of the preceding claims, wherein the gaseous composition comprises propane at least 60 wt-%, preferably at least 65 wt-%, more

preferably at least 70 wt-%, such as from 60 to 85 wt-%, or from 65 to 80 wt-%, or from 70 to 75 wt-%, based on the total weight of the gaseous composition.

10. The method according to any one of the preceding claims, wherein the gaseous composition comprises compounds lighter than propane, such as H_2, methane and ethane, at most 35 wt-%, preferably from 5 to 30 wt-%, more preferably from 10 to 25 wt-%, based on the total weight of the gaseous composition, and/or H_2 from 1 to 10 wt-%, preferably from 2 to 9 wt-%, more preferably from 3 to 8 wt-%, based on the total weight of the gaseous composition.

11. The method according to any one of the preceding claims, wherein the propane composition comprises, based on the total weight of the propane composition, at least 95 wt-%, preferably at least 96 wt-% propane, and at most 5.0 wt-%, preferably at most 3.0 wt-% hydrocarbons having a carbon number of at least C4, and at most 0.20 wt-%, preferably at most 0.18 wt-%, more preferably at most 0.13 wt-% hydrocarbons having a carbon number of at least C5.

12. The method according to any one of the preceding claims, wherein the gaseous composition has a biogenic carbon content of at least 50 wt-%, preferably at least 75 wt-%, more preferably at least 90 wt-%, even more preferably at least 95 wt-%, based on the total weight of carbon (TC) in the gaseous composition, and/or the propane composition has a biogenic carbon content of at least 50 wt-%, preferably at least 75 wt-%, more preferably at least 90 wt-%, even more preferably at least 95 wt-%, based on the total weight of carbon (TC) in the propane composition.

13. The method according to any one of the preceding claims, wherein the thermally coupled distillation system is operated at pressures above 1500 kPa, preferably above 1900 kPa, such as pressures within a range from 1500 kPa to 5000 kPa, or from 1900 kPa to 4500 kPa, or from 2400 kPa to 3900 kPa, and/or at temperatures above -70 °C, preferably within the range from -70 °C to 250 °C, more preferably from -70 °C to 200 °C, even more preferably from -70 °C to 180 °C.

14. The method according to any one of the preceding claims, wherein the combination of the first distillation column and the condenser is operated at pressures within a range from 1500 kPa to 5000 kPa, or from 1900 kPa to 4500

kPa, or from 2400 kPa to 3900 kPa, and at temperatures within the range from -70 °C to 120 °C, preferably from -70 °C to 100 °C.

15. The method according to any one of the preceding claims, wherein

the lowest pressure in the combination of the second distillation column and the reboiler is higher than the highest pressure in the combination of the first distillation column and the condenser, the lowest pressure in the combination of the second distillation column and the reboiler preferably being from 20 kPa to 150 kPa higher, more preferably from 30 kPa to 120 kPa higher, than the highest pressure in the combination of the first distillation column and the condenser.

16. The method according to any one of the preceding claims, wherein

the lowest temperature in the combination of the first distillation column and the condenser is below 0 °C and the highest temperature in the combination of the second distillation column and the reboiler is higher, preferably from 30 °C to 150 °C higher, more preferably from 50 °C to 120 °C higher, than the highest temperature in the combination of the first distillation column and the condenser, preferably the lowest temperature in the combination of the second distillation column and the reboiler being at most as high as the highest temperature in the combination of the first distillation column and the condenser.

17. The method according to any one of the preceding claims, wherein (i) providing the gaseous composition comprises subjecting a hydrotreatment effluent to gas-liquid separation to obtain at least a gaseous stream, and subjecting the gaseous stream to a pretreatment to obtain the gaseous composition.

18. The method according to any one of the preceding claims, wherein (i) providing the gaseous composition comprises:

subjecting a hydrotreatment feed comprising vegetable oils, animal fats, microbial oils, crude oil, thermally and/or enzymatically liquefied organic waste and residues, such as biomass waste and residues, municipal solid waste and/or waste plastics, or a combination thereof, optionally with a hydrocarbon diluent, to a catalytic hydrotreatment comprising hydrodeoxygenation, hydrocracking, hydroisomerization, hydropyrolysis, hydrodesulphurization, hydrodenitrogenation,

hydrodehalogenisation, hydrodearomatization, hydrodemetallation and/or hydrogenation, to obtain a hydrotreatment effluent,

subjecting the hydrotreatment effluent to gas-liquid separation to obtain at least a gaseous stream, and

subjecting the gaseous stream to a pretreatment to obtain the gaseous composition.

19. The method according to any one of the preceding claims,

wherein (i) providing the gaseous composition comprises:

subjecting a hydrotreatment feed comprising vegetable oils, animal fats and/or microbial oils, optionally with a hydrocarbon diluent, to a catalytic hydrotreatment comprising at least hydrodeoxygenation using a sulphided HDO catalyst, to obtain a hydrotreatment effluent;

subjecting the hydrotreatment effluent to gas-liquid separation to obtain at least a gaseous stream comprising H_2, H_2S, CO, CO_2, H_2O, methane, ethane, propane and hydrocarbons having a carbon number of at least C4, and a liquid hydrotreated stream comprising C6-C30 hydrocarbons; and

subjecting the gaseous stream to a pretreatment comprising at least purification to remove H_2S and CO_2, H_2 separation and drying, to obtain dried H_2S, CO_2 and H_2 depleted gaseous stream as the gaseous composition; and

wherein the method further comprises subjecting the liquid hydrotreated stream comprising C6-C30 hydrocarbons, optionally after a further catalytic hydrotreatment comprising at least hydroisomerisation, to a fractionation to recover one or more of a gasoline fuel component, an aviation fuel component, and/or a diesel fuel component.

20. A method for co-producing a propane composition and a fuel component comprising:

(i) subjecting a hydrotreatment feed comprising vegetable oils, animal fats and/or microbial oils, optionally with a hydrocarbon diluent, to a catalytic hydrotreatment comprising at least hydrodeoxygenation using a sulphided hydrotreatment catalyst, to obtain a hydrotreatment effluent;

subjecting the hydrotreatment effluent to gas-liquid separation to obtain at least a gaseous stream comprising H_2, H_2S, CO, CO_2, H_2O, methane, ethane,

propane and hydrocarbons having a carbon number of at least C4, and a liquid hydrotreated stream comprising C6-C30 hydrocarbons;

subjecting the gaseous stream to a pretreatment comprising at least purification to remove H_2S and CO_2, H_2 separation and drying to obtain a gaseous composition comprising H_2, methane, ethane, propane, and hydrocarbons having a carbon number of at least C4, wherein the total amount of H_2, methane, ethane, propane, and hydrocarbons having a carbon number of at least C4 is at least 80 wt-%, preferably at least 85 wt-%, more preferably at least 90 wt-% of the total weight of the gaseous composition; and

(ii) subjecting the gaseous composition to distillation in a thermally coupled distillation system comprising at least a first distillation column connected to a condenser without being connected to a reboiler, and a second distillation column connected to a reboiler without being connected to a condenser, by feeding the gaseous composition to the first distillation column, and recovering a propane composition from the second distillation column; and

wherein the method further comprises subjecting the liquid hydrotreated stream comprising C6-C30 hydrocarbons, optionally after a further catalytic hydrotreatment comprising at least hydroisomerisation, to a fractionation to recover one or more of a gasoline fuel component, an aviation fuel component, and/or a diesel fuel component.