Claims

1. A method for converting biomass to renewable fuels, comprising:

providing a device containing a programmable number of processing stations (N) and a series of catalysts;

subjecting biomass within the stations to at least one programmable starting temperature (Tstart);

incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non-volatile component; and

subjecting the volatile components generated in each station through the series of catalysts to produce at least one renewable fuel.

2. The method of claim 1, further comprising contacting the volatile component from a lipid-rich biomass with a dehydration catalyst to produce a product which on cooling to a temperature range of 1- 20°C produces a second volatile component, a first renewable fuel and water.

3. The method of claim 1, further comprising contacting a volatile component from a hemicellulose-rich biomass directly with an aromatization catalyst to produce a product which on cooling to a temperature of 0-5°C produces a second volatile component, a first renewable fuel and water.

4. The method of claim 1, further comprising contacting a volatile component from a lignin-rich biomass with a dehydration catalyst to produce a product which on cooling to 2-20°C produces a second volatile component, a renewable fuel and water.

5. A method for converting biomass to renewable fuels, comprising:

providing a device containing a programmable number of processing stations (N) and a series of catalysts;

subjecting biomass within the stations to at least one programmable starting temperature (Tstart); and

incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non-volatile component.

6. The method of claim 5, further comprising subjecting the volatile components generated in each station through the series of catalysts to produce at least one renewable fuel.

7. The method of claim 6, further comprising contacting the volatile component with a dehydration catalyst to produce a first product which on cooling to a temperature range of 1- 20°C produces a second volatile component, a first renewable fuel and water.

8. The method of claim 7, further comprising contacting the second volatile component with an aromatization catalyst to produce a second product which on cooling to a temperature of 1-20°C produces a third volatile component, a second renewable fuel and water, and recovering the second renewable fuel.

9. A system for the conversion of biomass to combustible fuels, comprising:

a device containing a programmable number of processing stations (N) and a series of catalysts;

means for subjecting biomass within the stations to at least one programmable starting temperature (Tstart);

means for incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non-volatile component; and

means for subjecting the volatile components generated in each station through the series of catalysts to produce at least one renewable fuel.

10. The system of claim 9, wherein the series of catalysts are selected from the group consisting of catalytic dehydration, catalytic aromatization and catalytic gas-upgrading.

11. The system of claim 9, further comprising means for incrementing the non-volatile component temperature by ΔT to produce additional volatile and non-volatile components.

12. The system of claim 9, wherein N ranges from 2 to 1000, and wherein Tstart ranges from 100°C to 1000°C.

13. The system of claim 9, wherein the temperature increment (ΔT) ranges from 0°C to 200°C, and wherein biomass moisture content is less than 15%.

14. The system of claim 1, wherein a co-solvent is added to volatile components or added to at least one of the processing stations, wherein the co-solvent is selected from the group consisting of alcohols, aldehydes, ketones, ethers, carboxylic acids, and hydrocarbons, and wherein the co-solvent is generated via a syngas conversion catalyst.

15. The system of claim 1, wherein biomass is selected from the group consisting of lipids, hemicellulose, cellulose and lignins.

16. A system for converting biomass to a renewable fuel, comprising:

a device containing a programmable number of processing stations (N) and a series of catalysts selected from the group consisting of catalytic dehydration, catalytic aromatization and catalytic gas-upgrading;

means for subjecting biomass within the stations to at least one programmable starting temperature (Tstart);

means for incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non-volatile component; and

means for subjecting the volatile components generated in each station through the series of catalysts to produce at least one renewable fuel.

17. The system of claim 16, wherein the dehydration catalyst comprises any acid catalyst or combination of acid catalysts.

18. The system of claim 16, wherein the aromatization catalyst is selected from the group consisting of MFI type zeolites and metal modified MFI-type zeolites including one or more metals selected from the group consisting of: Group VIB metals, Group VIIB metals, Group VIII metals, Group IB metals, Group IIB metals, Ga, and In.

19. The system of claim 16, wherein the gas-upgrading catalyst comprises one or more metal modified MFI type zeolites including one or more metals selected from the group consisting of: Ga, Zn, In, Mo, W, Cr, Pt, Pd, Rh, Ru, Au, and Ir.

20. The system of claim 16, wherein a sequence of catalysts is determined by renewable fuel yield or by temperature of devolatization of biomass components, and wherein one or more biomass source serve as feedstock for each processing station.

Claims

1. A method for converting biomass to renewable fuels, comprising:

providing a system containing a number of processing stations (N) in communication with a series of catalysts;

heating a biomass within the stations at a starting temperature (Tstart) to produce a volatile and a non-volatile component, said biomass and said heating selected to provide volatile components of a predetermined composition; and

subjecting the volatile components of a predetermined composition generated in at least one station through the series of catalysts to produce at least one renewable fuel.

2. The method of claim 1, wherein said series of catalysts is selected based on said starting temperature.

3. The method of claim 1, wherein said series of catalyst is based on the biomass composition.

4. The method of claim 3, wherein the biomass is a lipid-rich biomass and the volatile components from the lipid-rich biomass is contacted with a dehydration catalyst to produce a product which on cooling to a temperature range of 1 - 20°C produces a second volatile component, a first renewable fuel and water.

5. The method of claim 3, wherein the biomass is a hemicellulose-rich biomass and a volatile components from the hemicellulose-rich biomass is contacted directly with an aromatization catalyst to produce a product which on cooling to a temperature of 0-5°C produces a second volatile component, a first renewable fuel and water.

6. The method of claim 3, wherein the biomass is a lignin-rich biomass and the volatile component from the lignin-rich biomass is contacted with a dehydration catalyst to produce a product which on cooling to 2-20°C produces a second volatile component, a renewable fuel and water.

7. The method of claim 1, further comprising incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non-volatile component, said biomass and said incremental heating selected to provide incremental volatile components of a predetermined composition.

8. The method of claim 7, wherein the programmable increment is in the range of 0°C to 200°C.

9. A method for converting biomass to renewable fuels, comprising:

providing a device containing a programmable number of processing stations (N) and a series of catalysts;

subjecting biomass within the stations to at least one programmable starting temperature (Tstart); and

incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non- volatile component.

10. The method of claim 9, further comprising subjecting the volatile components generated in each station through a sequence of catalysts to produce at least one-renewable fuel.

11. The method of claim 9, further comprising:

identifying the temperature of an individual processing station after a temperature increment;

routing the volatile components generated at the individual processing station through a series of catalysts, said series of catalysts determined by the incremented temperature.

12. The method of claim 10, wherein the sequence of catalyst contact is determined by renewable fuel yield or by temperature of devolatization of biomass components.

13. The method of claim 1 or 9, wherein a co-solvent is added to volatile components or added to at least one of the processing stations, and preferably the co-solvent is selected from the

group consisting of alcohols, aldehydes, ketones, ethers, carboxylic acids, and hydrocarbons, and wherein the co-solvent is generated via a syngas conversion catalyst.

14. The method of claim 1 or 9, wherein biomass is selected from the group consisting of lipids, hemicellulose, cellulose and lignins.

15. A system for the conversion of biomass to combustible fuels, comprising: a device containing a programmable number of processing stations (N) and a series of catalysts;

a heater for subjecting biomass within the stations to at least one programmable starting temperature (Tstart);

a controller for incrementing an individual processing station temperature by programmable increments (ΔT) to produce a volatile and a non-volatile component;

series of catalysts for contacting the volatile components generated in each station to produce at least one renewable fuel; and

a processor for receiving data related to one or more of renewable fuel yield or temperature of devolatization of biomass components and determining a sequence of catalyst contacts.

16. A system for converting biomass to a renewable fuel, comprising:

a device containing a programmable number of processing stations (N) and a series of catalysts selected from the group consisting of catalytic dehydration, catalytic aromatization and catalytic gas-upgrading;

means for subjecting biomass within the stations to at least one programmable starting temperature (Tstart);

means for incrementing an individual processing station temperature by programmable increments (AT) to produce a volatile and a non- volatile component; and

means for subjecting the volatile components generated in each station through the series of catalysts to produce at least one renewable fuel.

17. The system of claim 15 or 16, wherein the series of catalysts are selected from the group consisting of catalytic dehydration, catalytic aromatization and catalytic gas-upgrading.

18. The system of claim 15 or 16, wherein N ranges from 2 to 1000, and wherein Tstart ranges from 100°C to 1000°C.

19. The system of claim 15 or 16, wherein the temperature increment (ΔT) ranges from 0°C to 200°C, and wherein biomass moisture content is less than 15%.

20. The system of claim 17, wherein

the dehydration catalyst comprises any acid catalyst or combination of acid catalysts, or

the aromatization catalyst is selected from the group consisting of MFI type zeolites and metal modified MFI-type zeolites including one or more metals selected from the group consisting of: Group VIB metals, Group VIIB metals, Group VIII metals, Group IB metals, Group IIB metals, Ga, and In, or

the gas-upgrading catalyst comprises one or more metal modified MFI type zeolites including one or more metals selected from the group consisting of: Ga, Zn, In, Mo, W, Cr, Pt, Pd, Rh, Ru, Au, and Ir.

21. The system of claim 16, wherein a sequence of catalysts is determined by renewable fuel yield or by temperature of devolatization of biomass components, and wherein one or more biomass source serve as feedstock for each processing station.