CLAIMS

1. A method for thermal hydrolysis of a liquid substrate, having a dry solids content of between 2 and 30 %, and a temperature below about 50 ºC, which liquid substrate is subsequently to be used in an anaerobic fermentation, digestion or another process aimed at producing or extracting methane or other valuable substances in one or more reactors, wherein;

- the same number of flashtanks and pulpers are used;
- at least a first and a second pulperin series and at least a first and a second flashtankin series are used for step-wise pre-heating and pressure reduction, respectively,

wherein:

a) said liquid substrate is transferred to and preheated and mixed in said first pulper, which is operated at a temperature of 40 ºC to 90 ºC and at a pressure of 0.2 to 0.9 barA, by injection of flash steam below liquid level from said downstream second flashtank, which is operated at a higher pressure than said first pulper

b) said pressure of 0.2 to 0.9 barA, under which said first pulper is being operated, is being maintained by a vacuum system working to maximize the condensation of any condensable vapors that are not condensed when passing through said liquid substrate in said first pulper

c) said preheated liquid substrate is transferred from said first pulper to said second pulper, which is operated at a temperature of 90 ºC to 135 ºC and at a pressure of 0.7 to 3.3 barA, and wherein said liquid substrate is subjected to further mixing and pre-heating, by injection of flash steam below liquid level from said downstream flashtank, which is operated at a higher pressure than said second pulper

d) said further preheated liquid substrate is transferred from said second pulper to said one or more reactors working in parallel or series wherein said liquid substrate is heated to temperatures in the range of 140 ºC to 220 ºC, and at a pressure of 3.6 to 10 barA

e) said liquid substrate is transferred from said one or more reactors working in series or parallel to said first flashtank operated at a temperature of 100 ºC to 140 ºC and at a pressure of 1 to 3.6 barA whereby a pressure reduction occurs, and wherefrom flash steam resulting from said pressure reduction is transferred to said second pulper operated at a temperature of 90 ºC to 135 ºC and at a pressure of 0.7 to 3.3 barA

f) said liquid material is transferred from said first flashtank to said second flashtank operated at a temperature of 70 °C to 100 °C and at a pressure of 0.35 to 1 barA, whereby a further pressure reduction occurs, and wherefrom flash steam resulting from said further pressure reduction in said second fiashtank is transferred to said first pulper operated at a temperature of 40 °C to 90 °C and at a pressure of 0.2 to 0.9 barA by means of said vacuum system.

g) optionally transferring said liquid material from said second flashtank to an optional third flashtank whereby a further pressure reduction occurs, and wherefrom flash steam resulting from said further pressure reduction is transferred to said optional additional third pulper.

2. A method for thermal hydrolysis of a liquid substrate, having a dry solids content of between 2 and 30 % and a temperature below about 50 °C, which liquid substrate is subsequently to be used in an anaerobic fermentation, digestion or another process aimed at producing or extracting methane or other valuable substances, in one or more reactors, wherein:

- the number of flashtanks used is one less the number of pulpers used;
- at least a first and a second pulper in series and at least one flashtank F are used for step-wise pre-heating and pressure reduction, respectively;

and wherein:

a) said liquid substrate is transferred, e.g. from an optional additional third pulper, to and preheated and mixed in a first pulper, which is operated at a temperature of 40 °C to 90 °C and at a pressure of 0.2 to 0.9 barA, by injection of flash steam below liquid level from said downstream flashtank , which is operated at a higher pressure than said first pulper

b) said pressure of 0.2 to 0.9 barA, under which said first pulper is being operated, is being maintained by a vacuum system working to maximize the

condensation of any condensable vapors that are not condensed when passing through said liquid substrate in said first pulper

c) said preheated liquid substrate is transferred from said first pulper to said second pulper, which is operated at a temperature of 90 ºC to 135 ºC and at a pressure of 0.7 to 3.3 barA, and wherein said liquid substrate is subjected to further mixing and pre-heating, by injection of flash steam below liquid level from said one or more downstream reactors, which are operated at a higher pressure than said second pulper

d) said further preheated liquid substrate is transferred from said second pulper to said one or more reactorsworking in parallel or series wherein said liquid substrate is heated to temperatures in the range of 140 °C to 220 °C, and at a pressure of 3.6 to 10 barA

e) said one or more reactors working in parallel or series is depressurized by transferring steam from the reactor headspace to said second pulper until the pressures of said one or more reactors working in parallel or series and said second pulper are in equilibrium following which said liquid substrate is transferred from said one or more reactors working in parallel or series to said downstream flashtank.

f) optionally transferring said liquid material from said flashtank to an optional additional flashtank whereby a further pressure reduction occurs, and wherefrom flash steam resulting from said further pressure reduction is transferred to said optional additional third pulper.

3. A method according to either of claims 1 or 2, further comprising a vapor cooler, which is interconnected between said first pulper and said vacuum system , works to condense and remove any vapors condensable below the temperature under which said first pulper is being operated.

4. A method according to claim 3, further comprising steps aimed at compressing the remaining non-condensable vapors from the headspace of said first pulper, which are neither condensed in said first pulper nor in said interconnected vapor cooler and steps aimed at injecting said compressed non-condensable vapors into an anaerobic digester or any other means for gas treatment.

5. A method according to any one of the preceding claims, wherein the transfer of said liquid substrate between pulpers, reactors, flashtanks etc. is achieved at least partly by barometrical pumping.

6. A plant for thermal hydrolysis of a liquid substrate, having a dry solids content of between 2 and 30 %, and a temperature of below about 50 °C, which liquid substrate is subsequently to be used in an anaerobic fermentation, digestion or another process aimed at producing or extracting methane or other valuable substances, said plant comprising:

- the same number of flashtanks and pulpers,

- at least a first and a second pulper being interconnected either directly or indirectly in series,

- a vacuum system interconnected by piping to said first pulper,

- one or more reactors working in parallel or series and being interconnected by piping to said second pulper, which is not interconnected to said vacuum system,

- at least a first and a second flashtank:

    - being interconnected either directly or indirectly in series,

    - of which the first flashtank is interconnected by piping to said one or more reactors working in parallel or series,

    - of which the second flashtank is individually interconnected by piping to first pulper, and the first flashtank is individually interconnected by piping to the second pulper, and

    - of which each is individually capable of being operated at a higher pressure than the one of the at least two pulpers with which it is individually interconnected by piping

and wherein:

a) said first pulper can be operated at a temperature of 40 ºC to 115 ºC and at a pressure of 0.2 to 1.8 barA, by injection of flash steam below liquid level from said downstream second flashtank to which it is individually interconnected,

b) said vacuum system can maintain said pressure of 0.2 to 0.9 barA, when said first pulper is to be operated below ambient pressure and can be worked to maximize the condensation of any condensable vapors that are not condensed when passing through said liquid substrate in said first pulper

c) said second pulper can be operated at a temperature of 90 ºC to 174 ºC and at a pressure of 0.7 to 8.7 barA, by injection of flash steam below liquid level from said downstream first flashtanks to which it is individually interconnected

d) said one or more reactors working in parallel or series can be operated at temperatures in the range of 140 ºC to 220 ºC and at a pressure of 3.6 to 23.2 barA

e) said liquid substrate can be transferred from said one or more reactors working in series or parallel to said first flashtank operated at a temperature of 100 ºC to 176 ºC and at a pressure of 1 to 9 barA whereby a pressure reduction occurs, and wherefrom flash steam resulting from said pressure reduction can be transferred to said second pulper operated at a temperature of 90 ºC to 174 ºC and at a pressure of 0.7 to 8.7 barA

f) said liquid material can be transferred from said first flashtank to said second flashtank operated at a temperature of 70 ºC to 119 ºC and at a pressure of 0.35 to 2 barA, whereby a further pressure reduction occurs, and wherefrom flash steam resulting from said further pressure reduction in said second flashtank can be transferred to said first pulper operated at a temperature of 40 ºC to 115 ºC and at a pressure of 0.2 to 1.8 barA, if below ambient pressure by means of said vacuum system.

7. A plant for thermal hydrolysis of a liquid substrate, having a dry solids content of between 2 and 30 %, and a temperature of below about 50 ºC, which liquid substrate is to be used in an anaerobic fermentation, digestion or another process aimed at producing or extracting methane or other valuable substances, said plant comprising:

- one more pulper(s) than flashtank(s),

- at least a first and a second pulper being interconnected either directly or indirectly in series,

- a vacuum system interconnected by piping to said first pulper,

- one or more reactors working in parallel or series and being interconnected by piping to said second pulper, which is not interconnected to said vacuum system,

- at least one flashtank:

    - being interconnected by piping to said one or more reactors working in parallel or series,

    - being interconnected by piping to first pulper, and

    - being capable of being operated at a higher pressure than the one of the at least two pulpers (P1 (a)) with which it is individually interconnected by piping

and wherein:

a) said first pulper can be operated at a temperature of 40 ºC to 115 ºC and at a pressure of 0.2 to 1.8 barA, by injection of flash steam below liquid level from said downstream flashtank to which it is interconnected

b) said vacuum system can maintain a pressure of 0.2 to 0.9 barA, when said first pulper is to be operated below ambient pressure and can be worked to maximize the condensation of any condensable vapors that are not condensed when passing through said liquid substrate in said first pulper

c) said second pulper, can be operated at a temperature of 90 ºC to 174 ºC and at a pressure of 0.7 to 8.7 barA

e) said one or more reactors working in parallel or series can be operated at temperatures in the range of 140 C to 220 C, and at a pressure of 3.6 to 23.2 barA

f) said liquid substrate can be transferred from said one or more reactors working in series or parallel to said flashtank by depressurizing said one or more reactors working in parallel or series by transferring steam from the reactor headspace to said second pulper until the pressures of said one or more reactors working in parallel or series and said second pulper are in equilibrium following which said liquid substrate can be transferred from said one or more reactors working in parallel or series to said flashtank.

8. A plant according to either of claims 6 or 7, further comprising a vapor cooler interconnected between said first pulper and said vacuum system, which can be operated at a temperature below the working temperature of said first pulper, thereby enabling the removal of condensable vapors that are not condensed in said first pulper.

9. A plant according to claim 8, further comprising means for compressing remaining non-condensable vapors from the headspace of said first pulper, which are neither condensed in said first pulper nor in said interconnected vapor cooler and means for injecting said compressed non-condensable vapors into an anaerobic digester or any other means for gas treatment.

10. A plant according to any one of claims 6-9, further comprising vessels to be used for at least the partial transfer of said liquid substrates by barometrical pumping.

11. A plant according to any one of claims 6-9 further comprising:

- piping allowing for the transfer of said liquid substrate, having a dry solids content of between 2 and 30 % and a temperature below about 50 ºC, directly to any of said at least two pulpers, said piping being equipped with one or more closing valve(s) enabling the selection of to which of said at least two pulpers said liquid substrate, having a dry solids content of between 2 and 30 % and a temperature below about 50 ºC, is to be transferred;
- connections by piping that enables the transfer of said liquid substrate from any of said at least two pulper(s) to any of said one or more reactors;
- connections by piping that enables ventilation from any of said one or more reactors to any of said at least two pulpers;
- connections by piping that enables the transfer of said liquid substrate from any of said one or more reactors to any of said one or more flash tank(s);
- connections by piping that enables the by-passing of said vacuum system.

12. A method for retrofitting an existing plant for hydrolysis of a liquid substrate, having a dry solids content of between 2 and 30 %, and a temperature below about 50 ºC which liquid substrate is to be used in an anaerobic fermentation, digestion or another process aimed at producing or extracting methane or other valuable substances, whereby said retrofitting ensures that said plant comprises at least the features of a plant according to claim 6.

13. A method for retrofitting an existing plant for hydrolysis of a liquid substrate, having a dry solids content of between 2 and 30 %, and a temperature of below about 50 ºC which liquid substrate is to be used in an anaerobic fermentation, digestion or another process aimed at producing or extracting methane or other valuable substances, whereby said retrofitting ensures that said plant comprises at least the features of a plant according to claim 7.

14. A method for retrofitting according to either of claims 12 or 13 further, comprising ensuring that said plant comprises a vapor cooler interconnected between said first pulper and said vacuum system, which can be operated at a temperature below the working temperature of said first pulper, thereby enabling the removal of condensable vapors that are not condensed in said first pulper .

15. A method for retrofitting according to claim 14, further comprising ensuring that said plant comprises means for compressing remaining non-condensable vapors from the headspace of said first pulper, which are neither condensed in said first pulper nor in said interconnected

vapor cooler and means for injecting said compressed non-condensable vapors into an anaerobic digester or any other means for gas treatment.

16. A method for retrofitting according to any one of claims 12-15 wherein the transfer of said liquid substrate is achieved at least partly by barometrical pumping by a thermal transfer and mixing unit, connected to a live steam system pressurizing the vessel of said unit, and possibly connected to a system to generate a vacuum to increase the filling rate of said vessel of said unit, and wherein said vessel of said unit is equipped to either discharge said liquid substrate to a reactor or return the substrate to a pre-heating vessel.

17. A method for retrofitting according to claim 16, wherein the volume of said thermal transfer and mixing unit is equal to the desired reactor fill volume.

18. A method for retrofitting according to claim 17, wherein said thermal transfer and mixing unit is used to measure reactor filling.

19. A method for retrofitting according to any one of claims 12-18, further comprising ensuring that said plant comprises:

- piping allowing for the transfer of said liquid substrate, having a dry solids content of between 2 and 30 % and a temperature below about 50 ºC, directly to any of said at least two pulpers, said piping being equipped with one or more closing valve(s) enabling the selection of to which of said at least two pulpers said liquid substrate, having a dry solids content of between 2 and 30 % and a temperature below about 50 ºC, is to be transferred;
- connections by piping that enables the transfer of said liquid substrate from any of said at least two pulper(s) to any of said one or more reactors;
- connections by piping that enables ventilation from any of said one or more reactors to any of said at least two pulpers;
- connections by piping that enables the transfer of said liquid substrate from any of said one or more reactors to any of said one or more flash tank(s);
- connections by piping that enables the by-passing of said vacuum system.