CLAIMS

1. Method for treating a non-Newtonian biomass material having:

- a dry-matter content (DS%) of at least 12%,
- a ratio between the chemical oxygen demand (COD) and volatile solids content (VS), COD/VS-ratio, of less than 2.0, and
- a static yield stress, τ_o, of between 150 and 2500 Pa, such as above 200, such as above 250 Pa, such as above 300 Pa, such as above 350 Pa, such as above 400 Pa, such as above 500 Pa, such as below 2400 Pa, such as below 2200 Pa, such as below 2000 Pa, such as below 1800 Pa, such as below 1600 Pa, such as between 300 and 1700 Pa, such as between 400 and 1700 Pa, such as between 500 and 1700 Pa, such as between 600 and 1700 Pa and/or a dynamic yield stress, τ_y, of between 50 and 500, such as above 100, such as above 150 Pa, such as above 200 Pa, such as below 450 Pa, such as below 400 Pa, such as below 350 Pa, such as below 300 Pa, such as below 250 Pa, such as between 50 and 400 Pa, such as between 50 and 300 Pa

said method comprising the steps of:

a) feeding said non-Newtonian biomass material to one or more pulpers by one or more pulper feed lines at a controlled DS% and/or COD loading rate,

b) homogenizing and pre-heating said non-Newtonian biomass material in said one or more pulpers resulting in a pre-heated biomass material,

c) discharging said pre-heated biomass material from said one or more pulpers,

d) feeding said pre-heated biomass material to a thermal hydrolysis system, operated at a higher temperature than the temperature of said pre-heated biomass material, by one or more feed lines at a controlled DS% and/or COD loading rate,

e) thermally hydrolysing said pre-heated biomass material in said thermal hydrolysis system resulting in a hydrolysed biomass material, and

f) subsequently processing at least part of said hydrolysed biomass material in one or more subsequent processing systems by transferring said hydrolysed biomass material to said one or more subsequent processing systems, by one or more feed lines at a controlled DS% and/or COD loading rate,

wherein said method is further characterized in that:

- said controlled DS% and/or COD loading rate of said non-Newtonian biomass material through said one or more pulper feed lines and pulpers of steps a) - c), and/or
- said controlled DS% and/or COD loading rate of said pre-heated biomass material through said one or more thermal hydrolysis system feed lines and said thermal hydrolysis system of steps d) and e), and/or
- said controlled DS% and/or COD loading rate of said hydrolysed biomass material through said one or more feed lines of step f),

is controlled based on:

- monitoring the static yield stress, τ_o, and/or dynamic yield stress, τ_y, of said non-Newtonian biomass material, said pre-heated biomass material and/or said hydrolysed biomass material, by continuously or semi-continuously measuring pressure drop, temperature and flowrate in:
  - said feed line(s) for said one or more pulpers of step a), and/or
  - said feed line(s) for said thermal hydrolysis system of step d), and/or
  - said feed line(s) for said one or more subsequent processing system of steps f), and/or
  - one or more thermal hydrolysis discharge or recirculation lines of said thermal hydrolysis system of step d) and e), and/or
  - one or more circulation lines of said one or more pulpers of steps a) – c),

and

- continuously or semi-continuously measuring one or more parameters of said one or more subsequent processing systems of step f)

thereby establishing, which controlled DS% and/or COD loading rate;

- of said non-Newtonian biomass material, at said determined static yield stress, τ_o, and/or dynamic yield stress, τ_y, through said one or more pulper feed lines and pulpers of step a); and/or
- of said pre-heated biomass material, at said determined static yield strees, τ_o, and/or dynamic yield stress, τ_y, through said thermal hydrolysis feed lines and thermal hydrolysis system of step d); and/or
- of said hydrolysed biomass material, at said determined static yield stress, τ_o, and/or dynamic yield stress, τ_y, through said feed lines for said one or more subsequent processing system of step f)

is characteristic of at least one of said one or more of parameters of said subsequent processing systems of steps f).

2. A method according to claim 1, wherein said non-Newtonian biomass material displays:

- a static yield stress, τ_o, of at least 500 Pa, such as at least 1000 Pa, such as at least 1500 Pa, and/or
- a dynamic yield stress, τ_y, of at least 80 Pa, such as at least 100 Pa, such as at least 120 Pa.

3. A method according to any of claims 1 or 2, wherein said thermal hydrolysis system of steps d) and e) includes:
- one or more reactors working in parallel or series in which said pre-heated biomass is subjected to heating and elevated pressures, and
- one or more flashtanks to which said biomass is transferred from said one or more reactors, whereby a pressure reduction occurs in one or more stages wherefrom flash steam results,
and wherein
- said pre-heating of said biomass material in said one or more pulpers of steps a) - c), which may work in parallel or series, is achieved by injection of flash steam recovered from said thermal hydrolysis system of steps d) and e).

4. A method according to any of claims 1 to 3, wherein said non-Newtonian biomass material has a dry-matter content (DS%) above 20% and wherein:
- at least 50% of said resulting hydrolyzed biomass material is recirculated by transport from i) downstream said hydrolysis system of steps d) and e), to ii) upstream said hydrolysis system of steps d) and e), and/or
- the biomass material is pre-heated in said pulpers of steps a) to c) and thermally hydrolysed in said thermal hydrolysis system of steps d) and e) by subjecting said biomass material to multiple steps involving stepwise heating and cooling
in one or more pulpers for heating, one or more reactors for treatment at a pre-selected temperature of above 150°C, more preferably above 160°C, or even more preferably above 180°C, and one or more flashtanks for pressure reduction and/or cooling.

5. A method according to any of claims 1 to 3, wherein said non-Newtonian biomass material has a dry-matter content (DS%) above 20% and wherein said one or more subsequent processing systems of step f) includes:

f1) a separation step to produce at least two fractions, of which one is rich in liquid compared to said hydrolysed biomass material and one is rich in solids compared to said hydrolysed biomass material,
and,
f2) transferring, by one or more feed lines, said hydrolysed biomass material, parts of, or all of, one or all of said at least two fractions produced in said separation step of step f1) to one or more processing units for anaerobic fermentation,
and,
f3) transferring, by one or more feed lines, said hydrolysed biomass material, parts of, or all of, one or all of said at least two fractions produced in said separation step of step f1) to one or more processing units for thermal reduction of organic compounds,

and wherein:

- at least part of a material resulting from said anaerobic fermentation of step f2) is at least partly dewatered and the resulting dewatered material is transferred by one or more feed lines, to said one or more processing units for thermal reduction of organic compounds of step f3).

6. A method according to any of claims 4 or 5, wherein said resulting hydrolyzed biomass material of step e) is recirculated by transport, by use of one or more mixing augers and pumps, preferably progressive cavity pumps, and preferably one or more augers with a conveying capacity of at least 1.5 times that of the pumps, from i) downstream said hydrolysis system of steps d) and e), to ii) upstream one or more of said pulpers of steps a) - c) and mixed with said non-Newtonian biomass material thereby acting to reduce the static yield stress, τ_o, and/or dynamic yield stress, τ_y, of the material fed to said pulpers

7. A method according to any of claims 1-6, wherein preheated biomass material from one or more pulpers of steps a) – c) is recirculated by transport, by use of one or more mixing augers and pumps, preferably progressive cavity pumps, and preferably one or more augers with a conveying capacity of at least 1.5 times that of the pumps, to upstream said one or more pulpers of steps a) – c) and mixed with said non-

Newtonian biomass material thereby acting to reduce the static yield stress, τ_o, and/or dynamic yield stress, τ_y, of the material fed to said pulpers.

8. A method according to any preceding claims, further characterized in that:
- heat-exchangers are employed to recover heat from the cooling of said hydrolyzed biomass material of step e) prior to said hydrolyzed biomass material being subjected to said subsequent processing in said one or more subsequent processing steps f), preferably by cooling said hydrolyzed biomass of step e) by subjecting said hydrolyzed biomass material to heat-exchange with water in a heat-exchanger, and subsequently injecting said water into said non Newtonian biomass material of step a) said pre-heated biomass material of step b). or preheating polymer/water in upstream pre-dewatering or thickening processes.

9. A method according to any preceding claims, further characterized in that said non-Newtonian biomass material of step a) displays:

- a static yield stress, τ_o,of above 2000 Pa, such as above 2200 Pa, such as above 2300 Pa and
- a dynamic yield stress, τ_y, above 300 Pa, such as above 350 Pa, such as above 400 Pa,

and

- the static yield stress, τ_o, of the material fed to said pulpers is reduced to a value below 1700 Pa such as below 1500 Pa, and/or
- the dynamic yield stress, τ_y, of the material fed to said pulpers is reduced to a value below 250 Pa, such as below 200 Pa

10. A method according to claim 9, further characterized in that inorganic particles and/or undissolved material is continuously separated from said hydrolyzed biomass material of step e) by degritting prior to said subsequent processing of step f).

11. A method according to claim 5 where at least part of the at least one fraction of step f1) rich in liquid compared to said hydrolyzed biomass material is recirculated by transport to
- upstream one or more of said pulpers of steps a) - c) and mixed with said non-Newtonian biomass material thereby acting to reduce the static yield stress, τ_o, and/or the dynamic yield stress, τ_y, of the material fed to said pulpers,

- upstream said hydrolysis system steps d) - e) and mixed with said pre-heated biomass material thereby acting to reduce the static yield stress, τ_o, and/or the dynamic yield stress, τ_y, of the material fed to said hydrolysis system, and/or
- upstream said separation step f1) and mixed with said hydrolyzed biomass material thereby acting to reduce the static yield stress, τ_o, and/or the dynamic yield stress, τ_y, of the material fed to said separation step f1).

12. A system for processing a biomass material having a dry-matter content (DS%) above 12%, said system comprising:
- a pulper for homogenizing and pre-heating said biomass material having a dry-matter content (DS%) above 12%,
- a a thermal hydrolysis reactor for subjecting said homogenized and pre-heated biomass material to thermal hydrolysis,

said system being characterized in that:
- the total volume of said pulper is > 2.6 times and < 20 times, preferably 2.6 to 6 times, the average filling volume of said thermal hydrolysis reactor
- said pulper comprises an outlet nozzle, for discharging said pre-heated material from said pulper, which is placed in such a way that:
    - the part of the total -volume of said pulper below said outlet nozzle is ≥ 1.6 times the average filling volume of said thermal hydrolysis reactor, and
    - the part of the total volume of said pulper not below the outlet nozzle is > 1 times the average filling volume of the thermal hydrolysis reactor.

13. A system according to claim 12 further characterized in that said pre-heating in said pulper is at least partly achieved by injection of flash steam from a thermal hydrolysis system.

14. A system according to any of claims 12 or 13, further characterized in:
a) that:
- the part of the total volume of said pulper below said outlet nozzle, and
- the part of the total volume of said pulper not below the outlet nozzle,

are provided in the form of at least two separate interconnected chambers or tanks,
b) that said outlet nozzle is in the form of an overflow edge, knife or similar outlet fitted on the first of said at least two separate interconnected chambers or tanks, which ensures that a volume

corresponding to ≥ 1.6 the average filling volume of said thermal hydrolysis reactor is continuously present below said edge, knife or similar outlet in said first of said at least two separate interconnected chambers or tanks, and

c) that said pulper includes a biomass material distributer, preferably designed as an extruder, acting to split incoming cold biomass material into smaller segments before the biomass material enters the pulper.

15. A system according to any of the preceding claims further characterized in that said pulper includes a recirculation loop capable of recycling an amount of preheated biomass material from said pulper equivalent to at least 0.5 times, preferably more than 1 times, and even more preferably more than 2 times the amount of cold biomass material feed and mixing said preheated biomass material with cold biomass material prior to its entry into or inside said biomass material distributer.