method and related apparatus (and stack of (parallel) systems), which allow obtaining (or producing) (valuable) cellular substances from suspended biomass material, with a high throughput (compared to prior art methods and apparatuses).

[0019] Aspects of the present invention envisage providing such method for disrupting suspended biomass material and related apparatus (and stack of (parallel) systems), which allow for integration with a solubilization and/or subsequent selective extraction or separation of the obtained (valuable) cellular substances.

[0020] More particularly, it is envisaged to provide a subsequent solubilization of cellular substances from suspended biomass material and minimization of contaminating load by tuning the extraction ratio of the preferred product or biochemical. After solubilization, a subsequent selective extraction or separation of the obtained cellular substances is also envisaged.

[0021] Aspects of the present invention envisage providing such method (and related apparatus and stack of (parallel) systems) for disrupting suspended biomass material with (optionally) a solubilization and/or subsequent selective extraction or separation of the obtained cellular substances, which allow decreasing the total operational expenditure (OPEX) (or total cost) (compared to prior art methods and apparatuses) and being applicable on industrial scale.

Summary of the Invention

[0022] According to one aspects of the invention, there is therefore provided a method for disrupting suspended biomass material, ~~as set out in the appended claims.~~ comprising the steps of: providing a suspension of biomass material in a first vessel (1), said suspension having a dry cell weight being comprised between 0.1% and 15% (w/w); pressurizing said suspension to a first pressure (p1) being comprised between 7500 kPa and 450000 kPa by using a first high-pressure pump (10); providing a pressurized gas disruption agent and/or a pressurized liquid disruption agent in a second vessel (2); pressurizing said gas and/or liquid disruption agent to a second pressure (p2) being comprised between 7500 kPa and 450000 kPa by using a second high-pressure pump (20), said second pressure (p2) being higher than said first pressure (p1); injecting a stream of said pressurized disruption agent into a stream of said pressurized suspension of biomass material and forming a micro-emulsion; passing said micro-emulsion; passing said micro-emulsion sequentially through a hydrodynamic agitation system (11) and a relief valve (13).

[0023] According to ~~other~~another aspects of the invention, there is provided an apparatus for disrupting suspended biomass material, ~~as set out in the appended claims.~~comprising: at least one first vessel (1) for holding a suspension of biomass material connected to at least one first high-pressure pump (10), said first high-pressure pump (10) being adapted for pressurizing the suspension of biomass material supplied by said first vessel (1); at least one second vessel (2) for holding a gas disruption agent and/or liquid disruption agent connected to at least one second high-pressure pump (20), said second high-pressure pump (20) being adapted for pressurizing the gas and/or liquid disruption agent supplied by said second vessel (2); wherein each of said first and second high-pressure pump (10,20) is connected to at least one sparger system (7), said sparger system (7) being adapted for injecting a first stream of the

pressurized disruption agent into a second stream of the pressurized suspension of biomass material and for forming a micro-emulsion, wherein said sparger system (7) is further connected to a tubing system (8) for mixing said first and second streams, said tubing system (8) comprising a primary tube (15) and at least one hydrodynamic agitation system (11), and said tubing system (8) being further connected to a relief valve (13). According to another aspect of the invention, there is provided a sparger system, comprising: a first tube (21) comprising a first inlet (24) for supplying a stream of disruption agent into the tube (21); a second tube (22) comprising a second inlet (34) for supplying a stream of a suspension of biomass material through the tube (22), the second tube (22) comprising an outlet (28), wherein the second tube (22) traverses the first tube (21) and comprises at least one set (23) of first openings (29-32) through a wall of the tube (22), the first openings (29-32) being in fluid communication with the first tube (21) such that an emulsion is formed by forcing the stream of disruption agent through the first openings (29-32) into the second tube (22), wherein the first openings (29-32) have a third diameter (d3) between 0.01 mm and 1 mm.

[0024] According to another ~~aspect~~example of the ~~invention~~disclosure, there is provided a stack of (parallel) systems for disrupting suspended biomass material, based on the apparatus of the present invention.

[0025] According to other ~~aspects~~examples of the ~~invention~~diclosure, there is provided the use of the apparatus of the invention~~, as set out in the appended claims~~.

[0026] Advantageous aspects of the present invention are set out in the dependent claims.

Short Description of the Drawings

[0027] Aspects of the invention will be described in more detail with reference to the appended drawings, wherein same reference numerals illustrate same features. In the drawings, not all alternatives and options are shown and therefore the invention is not limited to the content of the given drawings.

[0028] **Figure 1a** schematically represents an apparatus according to an aspect of the present invention, for disrupting suspended biomass material and, optionally, solubilizing the (valuable) cellular substances.

[0029] **Figure 1b** schematically represents an apparatus according to an aspect of the present invention, for disrupting suspended biomass material and, optionally, solubilizing the (valuable) cellular substances, said apparatus further comprising a pressure oscillation system (9).

[0030] **Figure 2** schematically represents a sparger system (7) used in the apparatus of **figures 1a** and **1b**.

[0031] **Figure 3** depicts the comparison of the solubilization ratios (%) of different