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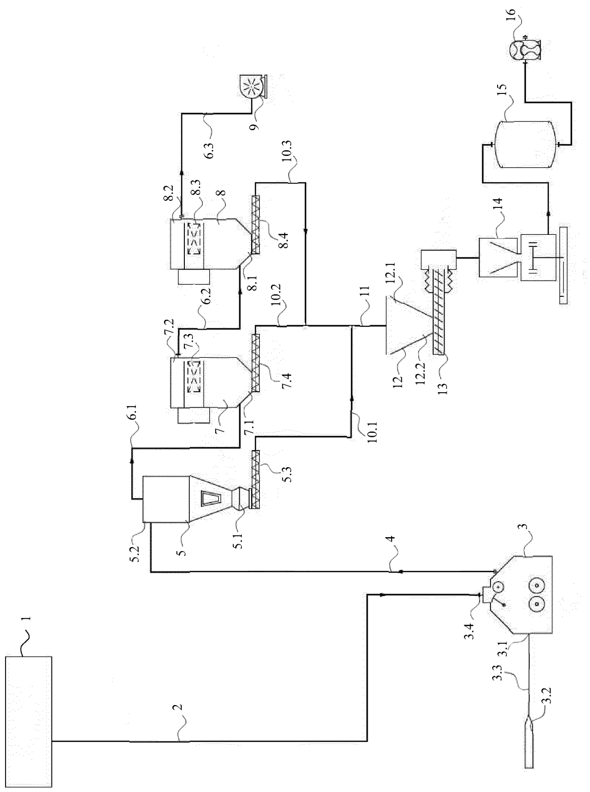
(54) INSTALLATION FOR DISSOLVING WATER-SOLUBLE POLYMERS IN POWDER FORM

(57) Installation for dissolving water-soluble polymers in powder form, in particular for enhanced oil and/or gas recovery operations or for fracking operations, comprising a device (1) for transporting polymer in powder form, a grinding device (3), a cyclone (5), a filter (7), an air extraction means (9), a hopper (12), a metering device (13), a hydration device (14).

Method for producing a water-soluble polymer solution implementing the installation. Enhanced oil and/or gas recovery method. Method for tracking an oil or gas reservoir.



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Description

Technical field

[0001] The present invention relates to an installation for dissolving water-soluble polymers being presented in powder form. It also relates to a method for producing a water-soluble polymer solution implementing the installation.

[0002] It also relates to enhanced oil and/or gas recovery or fracking or water transport network methods, implementing water-soluble polymer solutions prepared by means of this installation.

Prior art

[0003] Water-soluble polymers and, in particular, polyacrylamides are commonly used in large quantities in enhanced oil recovery (EOR) or for fracking operations or as an agent for reducing load loss for water transport networks.

[0004] Initially, large installations intended for the dissolution of polyacrylamides treated a few tens of kilos per hour. The problem of the initial wetting of the powder, which has a high tendency to agglomerate, was solved by simple means (ejectors, wetting shovels, nozzles in a tube). These means make it possible to obtain low flow rates at low concentrations (0.5%) and long dissolution times (1 to 2 hours for standard powders with a particle size of less than 1mm).

[0005] Document WO 2011/107683 describes a device (PSU - Polymer Slicing Unit) making it possible to both grind and disperse the polymer in powder form in dissolution water. This device comprises a rotor with cutting blades and a stator with fine slots. Depending on their thickness, these slots allow the powder to be ground more or less finely. With slots of 200 microns, the dissolution is almost immediate, but the flow rate is low. Slots of around 700 microns make it possible to reduce the dissolution time by 30 minutes and to obtain very high concentrations, of around 20g/litre. These high concentrations make it possible to greatly reduce the size of the dissolution tanks positioned downstream from the PSU (also called maturation tanks) and metering pumps, and offer an advantage of a significant reduction in the corresponding investments.

[0006] Document WO2016/156320 describes a PSU device, the slots of the stator and/or the cutters of the rotor of which are inclined by an angle of between 20° and 80° with respect to the horizontal plane of the stator. Thus, the vibrations are reduced and even greater quantities of water-soluble polymers are dispersed in a reduced time.

[0007] When the particle size of the polymer powders introduced into the wetting cone and therefore into the PSU grinding chamber described above is, on average, of 800μm, the powders are easily dispersed. Furthermore, upstream, these powders can be transported (for example, Big Bag) and easily stored (for example, silo).

[0008] When this relates to handling finer powders (particle size generally less than 350μm), their metering is a lot more difficult than for powders of a greater particle size, as they are, in particular, a lot more sensitive to hydroscopy which induces flowability (caking) problems, and also filter clogging. This is all the more problematic in an off-shore situation. In addition, these fine powders are more difficult to handle and tend to more easily disperse in a cloud in the working atmosphere. Due to this, operators must wear more complex safety equipment than a simple dust mask. Furthermore, a significant quantity of powder diffuses into polyacrylamide solution preparation units.

[0009] To save space and reduce costs, not only in onshore application, but also and particular in off-shore application, it is necessary to limit, as much as possible, the implementation of dissolution tanks. Nevertheless, the dissolution of the powders must be as complete as possible in order to prevent injectivity problems in wells. These objectives are all the more difficult to achieve than the powder comprises a particle population of small particle size, generally less than 350μm.

[0010] Document FR3063229 describes the use of a device for grinding water-soluble polymers in powder form, said grinding device being directly connected to the inlet of the wetting cone of a PSU device. In this configuration, the grinding device is subjected to a rapid heating of its constitutive elements which generates technical damage and leads to a thermal degradation of the polymer.

[0011] As a result, the problem that is proposed to solve by the invention is that of developing an installation for dissolving water-soluble polymers in powder form, a part of which is particularly fine, in practice less than 350 micrometres, not having the disadvantages mentioned above, in particular relating to the bulk, the safety of operators and the maintenance.

[0012] The problem of bulk is all the more significant than the installation is, in particular, intended to be used for enhanced oil and/or gas recovery operations or for off-shore fracking operations.

Summary of the invention

[0013] Thus, in order to guarantee an optimal water-soluble polymer powder dissolution yield, to reduce the impact of humidity and to handle these powders in total safety, the Applicant has developed an installation for dissolving water-soluble polymers in powder form, in a closed circuit, advantageously operating in a dry atmosphere, involving a grinding device, a cyclone and filter assembly, positioned upstream from a water-soluble polymer particle hydration device.

[0014] In practice, the polymer in powder form is ground before entering into the hydration device, in a closed environment, without the operator being confronted with the handling of small particle size powders. More specifically, the installation according to the invention guarantees that the finest particles obtained after grinding the powder are not disseminated into the atmosphere, while ensuring an optimal dissolution of the rest of the particles, this all without requiring a maturation tank. Because the dissolution installation according to the invention has the advantage of not requiring the use of a maturation tank, the footprint is reduced, in particular for offshore operations. The installation duly ventilated does not lead to exothermal phenomena within the grinding device, which prevents mechanical breakdowns and degradation of the polymer.

[0015] The invention also relates to a method for producing a water-soluble polymer solution implementing the installation described above.

[0016] Finally, two other last aspects of the invention relate to an enhanced oil and/or gas recovery method and a method for fracking an oil or gas reservoir, these two methods comprising a step of dissolving water-soluble polymers in the installation of the invention.

[0017] More specifically, the invention relates to an installation for dissolving water-soluble polymers in powder form, in particular for enhanced oil and/or gas recovery operations, or for fracking operations comprising:

- a device for transporting polymer in powder form,
- a device for grinding polymer into powder provided with an air inlet and a means for connection to the transport device, said grinding device being configured to grind the polymer powder into particles of different sizes,
- a cyclone, having a bottom part and a top part, which is provided with a means for connection to the grinding device, the cyclone being capable of separating the polymer particles, such that the finest particles are located in the top part of the cyclone, while the coarsest particles are located in the bottom part of the cyclone,
- a filter having a top part and a bottom part, the bottom part being connected to the top part of the cyclone, the filter being capable of performing a second separation of the polymer particles coming from the top part of the cyclone, such that the finest particles are located in the top part of the filter, while the coarsest particles are located in the bottom part of the filter,
- an air extraction means connected to the top part of the filter, said extraction means being capable of suctioning air entering from the air inlet of the grinding device and circulating successively in the cyclone then in the filter,
- a hopper having a bottom part and the top part, the top part having means for connection to the bottom parts respectively of the cyclone and of the filter,
- a metering device having means for connection to the bottom part of the hopper,
- a hydration device capable of receiving the polymer from the metering device.

[0018] According to the present invention, the term "polymers" used in the plural means a homopolymer or a copolymer or a homopolymer and/or copolymer mixture, a copolymer meaning a polymer prepared from at least two different monomers. This is therefore a copolymer (i) of at least one anionic monomer and/or (ii) of at least one other cationic monomer and/or (iii) of at least one non-ionic monomer and/or (iv) of at least one zwitterionic monomer.

[0019] The preferred non-ionic monomer is acrylamide. The preferred anionic polymer is acrylic acid or acrylamido-tertiary butyl sulphonic (ATBS) acid and their salts. The preferred cationic monomer is quaternised or salified dimethylaminoethyl acrylate (ADAME).

[0020] By "water-soluble polymers", this means a polymer or a polymer mixture which gives an aqueous solution without insoluble particles when it is dissolved while stirring for 4 hours at 25°C and with a concentration of 5 $g.l^{-1}$ in deionised water.

[0021] In practice, the water-soluble polymer has an average molecular weight by weight greater than 500000 Daltons, more preferably greater than 1 million Daltons. The water-soluble polymer, most often, has an average molecular weight by weight less than 40 million Daltons, preferably less than 30 million Daltons.

[0022] According to the invention, the water-soluble polymer in powder form before grinding has a particle size of between 150μm and 1500μm. Preferably, the average particle size is around 800μm.

[0023] After grinding and before introduction into the cyclone, the polymer particles have a particle size less than 500μm, more preferably between 1 μm and 500μm. The particles coming from the grinding of the powder therefore have a size varying between 1 and 500μm, which means that the particles are composed of particles of different sizes going from the finest to the coarsest.

[0024] To separate the finest particles from the coarsest particles after grinding and before dissolution, the installation comprises at least 2 cyclones positioned in series. In this case, the bottom part of the filter is connected to the top part of the last cyclone, such that the filter performs a second separation of the particles previously separated by the last cyclone.

[0025] To further also optimise the separation of the finest particles, the installation has at least two filters positioned in series. In this case, the bottom part of the first filter is connected to the top part of the last cyclone. In other words, the installation can comprise a succession of filters in series, the first of which is positioned downstream from the only cyclone or from the last cyclone, when these are mounted in series.

[0026] According to the number of cyclones and filters, the installation can comprise several hoppers. These hoppers are configured to receive the polymer particles coming from the bottom parts of the cyclone(s) and of the filter(s). Such a configuration makes it possible to dissolve the total polymer quantity implemented at the start, except for the finest particles retained by the filters.

[0027] The installation according to the invention comprises as many metering devices as hoppers and each hopper is connected to one single metering device. However, the metering devices feed in their assembly, one single and unique hydration device. In other words, the installation therefore preferably comprises one single hydration device, whatever the number of metering devices.

[0028] To enable the transfer of the polymer from the bottom part of the cyclone(s) and of the filter(s) to the means for connection to the hopper, the bottom parts of the cyclone(s) and of the filter(s) are advantageously each equipped with a transfer means, in practice, in the form of a transfer screw.

[0029] To reduce the bulk of the installation, the cyclone(s), the filter(s) and the suctioning means are positioned above the assembly formed by the transport device, the grinding device, the hopper, the metering device and the hydration device.

[0030] In practice, the cyclone(s), the filter(s) and the suctioning means are arranged on a platform positioned above the assembly formed by the transport device, the grinding device, the hopper, the metering device and the hydration device. The platform is accessible by a staircase or a ladder. It has openings configured to enable the passage of the means for connection of the top part of the cyclone to the grinding device and of the means for connection of the bottom parts respectively of the cyclone(s) and of the filter(s) to the hopper.

[0031] To make the installation adjustable, dismountable, and easily transportable, said installation comprises:

- a container **A** of general parallelepiped shape comprising side walls forming the large and small sides, a bottom and a roof, said container **A** comprising:
    - the transport device,
    - the grinding device,
    - the hopper,
    - the metering device(s),
    - the hydration device,
- a container **B** of general parallelepiped shape comprising side walls forming the large and small sides, a bottom and a roof, said container **B** being positioned on the container **A,** and comprising the cyclone(s), the filter(s) and the air extraction means,
- the roof of the container **A** and the bottom of the container **B** having openings configured to enable the passage of the means for connection of the top part of the cyclone to the grinding device and of the means for connection of the bottom parts respectively of the cyclone(s) and of the filter(s) to the hopper(s). This modularity makes it possible to be able to meet the different needs of tankers.

[0032] The containers **A** and **B** and generally all containers to which the present invention makes reference, each being presented in the form of an intermodal container, corresponding to a standardised shipping container, designed and built for the intermodal transport of goods. This means that these containers can be used through different transport methods, ships, trains and lorries, without unloading and reloading their cargo.

[0033] Insofar as the containers are standardised, this implies that they are of the same size, i.e. the same volume, and therefore walls, each of the same surface area. It follows that the container **A** and the container **B** are superposed on one another over the whole surface, respectively of the roof of the container **A** and of the bottom of the container **B.**

[0034] The containers generally have standard dimensions and can carry a net weight of between 1 and 20 tonnes. The containers preferably have a dimension of 6 to 12 metres x 2.4 metres x 2.6 metres high, excluding frame, and a weight of between 4 and 25 tonnes in movement to satisfy the local requirements.

[0035] To facilitate the handling and the storage of polymer to be dissolved, the installation further comprises a container **C** configured for the storage of powder polymer, of general parallelepiped shape comprising side walls forming the large and small sides, a bottom and a roof, the container **C** being positioned on the container **B.** The powder polymer is thus stored loose inside the container **C.**

[0036] To ensure the passage of the polymer to be dissolved from the container **C** into the transport device:

- the transport device is arranged on either side of the roof of the container **A** and of the bottom of the container **B,**
- the roof of the container **A** and the bottom of the container **B** each have an opening configured to enable the passage of said transport device,
- the bottom of the container **C** and the roof of the container **B** each have an opening configured to enable the passage of the powder polymer in the transport device.

[0037] To ensure the movement of the polymer stored in the container **C** in the direction of the opening enabling the passage of the polymer into the transport device, the bottom of the container **C** comprises a means for moving the polymer, for example in the form of a horizontal screw.

[0038] According to another embodiment, the polymer is stored outside of the assembly formed by the container **A** and the container **B,** for example in Big Bags. In this case, the container **A** has a hatch arranged in one of its side walls configured to enable the passage of the transport device so as to transport the powder polymer from the outside.

[0039] In this case, the transport device is presented in the form of a mechanical or pneumatic device feeding the grinding device from the outside of the container **A** from a polymer in powder form container (container example: Big Bag).

[0040] The constitutive elements of the installation advantageously have the following features, taken individually or in combination.

[0041] Concerning the filters, the filter or the series of filters is presented advantageously in the form of a hopper provided with a particle filter arranged in its upper part.

[0042] Concerning the grinding device, this is presented in the form of a hammer- or cutter-type grinding chamber. Preferably, the grinding device is a hammer-type grinding chamber.

[0043] Concerning the hopper connected to the bottom parts respectively of the cyclone(s) and of the filter(s), this generally has a volume of between 20 and 100L, preferably between 30 and 50L.

[0044] As mentioned above, the bottom parts of the cyclones and filters are, in a particular embodiment, equipped with a transfer screw enabling the passage of the polymer from the cyclone to the hoppers via a connection means, which is presented generally in the form of a conduit.

[0045] Concerning the metering device, this is presented in the form of a metering screw. The metering screw preferably has a flow rate of between 120 and 2000kg/h and this can be adapted according to the size of the fields and of the quantity needs of water-soluble polymer to be injected according to the application.

[0046] Without a particular embodiment, the hydration device is connected at the outlet to a buffer tank which receives the aqueous water-soluble polymer solution coming from said hydration device. The buffer tank is connected downstream from the installation, which means that it does not form part of the installation.

[0047] Concerning the hydration device, this comprises: a cone for wetting the polymer connected to a primary water supply circuit,

- at the lower end of the cone, a chamber for grinding and draining the dispersed polymer, comprising:
    - a rotor driven by a motor and provided with cutters,
    - a fixed stator constituted of a cylinder provided with slots,
    - over all or some of the periphery of the chamber, a ring fed by a secondary water circuit, the ring communicating with the chamber, so as to spray pressurised water on the outside of the stator, this enabling the release of the water-soluble polymer particles hydrated on the surface of said stator.

[0048] In a particular embodiment of the invention, the wetting cone has a coating, giving it a surface tension of between 7.5 and 19.5mN.m^{-1}.

[0049] Generally, the hydration device has a dissolution capacity of between 5 and 3000kg/h of water-soluble polymer particles, adjustable according to the field and to the application, more commonly between 50 and 650kg/h of polymer particles.

[0050] As a device for dispersing by water-soluble polymer grinding , "PSU" (Polymer Slicing Unit) can be cited, that the Applicant has developed and which is described in document WO 2011/107683 or also WO 2016/156320.

[0051] According to another embodiment, the hydration device comprises:

- a wetting chamber comprising a cylindrical upper part of vertical axis of revolution extending by a conical lower part, said wetting chamber being further provided:
    - o with at least one opening formed in the thickness of the wall of the upper and/or lower parts, said opening laterally emerging into a means for connection to a primary water supply circuit,
    - o with a cover provided with an opening formed in the thickness of the wall of said cover,
- a chamber for grinding and discharging dispersed polymer of horizontal axis of revolution, said grinding chamber comprising:
    - o a rotor driven by a motor and provided with cutters,
    - o a fixed stator being presented in the form of a cylinder in the wall from which vertical slots are cut,
    - o over all or some of the periphery of the chamber, a crown fed by a secondary water circuit, the crown communicating with the grinding chamber, so as to spray pressurised water on the stator,
- a means for connection of the wetting chamber to the grinding chamber in the form of an L-shaped tube, an end of which connects the lower end of the wetting chamber and the other end connects the inlet of the grinding chamber,
- the upper and lower parts of the wetting chamber and the L-shaped tube having an internal surface having an identical surface tension (TS1) and the cover of the wetting chamber having an internal surface having a surface tension (TS2) greater than that of the internal surface of the upper and lower parts of the wetting chamber and of the L-shaped tube (TS1).

[0052] The Applicant has indeed discovered that the hydration device, when the inner walls of the wetting chamber have a surface tension which is a maximum of 4mN.m-1 lower to that of the inner surface of the cover helps effectively attenuate the polymer deposits on the internal or inner surface of the wetting chamber and the clogging of this wetting chamber. As a result, the number of mechanical breakdowns and service interruptions for cleaning and maintenance are reduced.

[0053] As a result and according to another feature, the difference between the surface tension of the internal face of the cover (TS2) and that of the lower face of the upper and lower parts of the wetting chamber and the L-shaped tube (TS1) is at most 4m N. m-' , advantageously equal to 4mN.m^{-1}.

[0054] In order to prevent powder from accumulating in the means for connection to the primary water supply circuit and in the opening of the wall of the wetting chamber leading thereto, the thickness of the wall in which the opening is formed emerging into the means for connection to the primary water supply circuit and the internal surface of said connection means have a surface tension equal to (TS1).

[0055] According to a particular embodiment, the surface tension (TS1) is between 7.5 and 19.5mN.m^{-1} and the surface tension (TS2) is between 11.5 and 23.5mN.m^{-1}.

[0056] In practice, the characteristic surface tensions of the invention are defined with the aid of a goniometer by measuring the contact angles of 3 solvents applied to the tested surface, the 3 solvents being water, diiodomethane and ethylene glycol at 25°C.

[0057] To ensure the dehydration of the air circulating through the grinder, the installation further comprises a dehydration device.

[0058] According to a first embodiment, the hydration device is arranged in the proximity of the air inlet of the grinder.

[0059] According to another embodiment, the hydration device is presented in the form of a closed circuit connecting the air extraction means to the air inlet of the grinder.

[0060] The invention also relates to a method for producing a water-soluble polymer solution implementing the installation described above and comprising the following steps:

- the air suctioning means are started,
- the transport device is fed with water-soluble polymer in powder form,
- the polymer present on the transport device is moved towards the grinding device,
- the polymer in powder form is ground in the grinding device to obtain polymer particles of different sizes,
- the polymer particles ground in the top part of the cyclone(s) are suctioned,
- the finest polymer particles with respect to the rest of the particles are separated in the top part of the cyclone(s),
- the particles coming from the top part of the cyclone are suctioned into the bottom part of the filter(s),
- a second separation of the particles is carried out in the filter,
- the polymer particles collected in the bottom parts of the cyclone(s) and of the filter(s) are directed into the top part of the hopper,
- the metering device is fed by the bottom part of the hopper(s),
- the polymer that is then injected into the hydration device is metered,
- the polymer is dissolved in the hydration device,
- the polymer solution is recovered.

[0061] The invention also relates to an enhanced oil and/or gas recovery method comprising the following steps:

- dissolution of a water-soluble polymer in the installation described above,
- preparation of an injection fluid comprising at least said water-soluble polymer and water or brine,
- injection of the injection fluid into an underground formation,
- sweeping of the underground formation with the aid of the injected fluid,
- recovery of the aqueous and hydrocarbon mixture.

[0062] A last aspect of the invention relates to a method for fracking an oil or gas reservoir comprising the following steps:

- dissolution of a water-soluble polymer in the installation described above,
- preparation of a fracking fluid comprising at least water-soluble polymer and water or brine,
- injection of the fracking fluid under pressure to create fractures distributed perpendicularly to the production well.
- recovery of an aqueous and hydrocarbon mixture.

Brief description of the drawings

[0063] Figure 1 is a schematic representation of the installation according to the invention.

Example of an embodiment

[0064] The installation will now be described more specifically in relation to figure 1.

[0065] The installation according to the invention is an installation for dissolving water-soluble polymers in powder form, in particular for oil and/or gas recovery operations or for fracking operations.

[0066] The installation first comprises a zone (1) for storing polymer in powder form feeding a transport device (2) represented in the form of a conduit. In the present example of an embodiment, the polymer is stored loose in the storage zone (1) and is transited there via a lorry, for example. In practice, the water-soluble polymer in powder form at the time of storing has an average particle size of around 800μm.

[0067] The installation then comprises a grinding device (3) provided with an air inlet (3.1), which, as represented in the embodiment of figure 1, is connected to a dehydration device (3.2) by way of pipework (3.3). The grinding device (3) is further provided with a means for connection (3.4) to the transport device (2), in practice in the form of a flange.

[0068] The grinding device in this example is a hammer-type grinding chamber and makes it possible to reduce the particle size of the polymer to a size less than 500μm.

[0069] The installation then comprises a cyclone (5), having a bottom part (5.1) and a top part (5.2). The top part (5.2) is connected by a means for connection, in the form of a conduit (4), to the grinding device (3). The installation can comprise one single cyclone (5) (as represented in figure 1) or several cyclones (not represented), which in this case, are mounted in series, the top part of a cyclone being connected to the bottom part of the following cyclone. The cyclones make it possible to separate the finer particles from the coarser particles after grinding and before passage into the filters.

[0070] Downstream from the cyclone (5), one or more filters (7, 8) are mounted (two filters as represented in figure 1). Each filter has, in the form of a tank provided with a bottom part (7.1, 8.1) and a top part (7.2, 8.2), the top part containing a filtering zone in the form of a dust filter (7.3, 8.3). The bottom part (7.1) of the filter (7) is connected by way of a conduit (6.1) to the top part (5.2) of the cyclone (5), while the bottom part (8.1) of the filter (8) is connected by way of a conduit (6.2) to the top part (7.2) of the filter (7). The filters make it possible to further optimise more the separation of the finest particles by retaining them in the dust filters (7.3, 8.3).

[0071] To make it possible to suction air from the air inlet of the grinding device (3.1) to the filters (7, 8) by passing through the cyclone (5), the installation further comprises an air extraction means (9) connected to the top part (8.2) of the last filter (8) by way of a conduit (6.3).

[0072] The cyclone (5), as well as the filters (7,8) have, connected to their bottom part, a screw for transferring the polymer, respectively (5.3, 7.4, 8.4). The transfer screws are connected by way of a conduit (10.1, 10 2, 10.3) to a conduit (11) feeding one single and unique hopper (12).

[0073] The hopper (12) has, in this example, a volume of between 30 and 50L, and receives all the polymer particles obtained after separation in the cyclone (5) and the filters (7, 8). In practice, the conduit (11) feeds the top part (12.1) of the hopper (12). The bottom part (12.2) of the hopper (12) is itself equipped with a polymer metering device (13), in the form of a screw also, as represented. The metering screw has, in practice, a flow rate of between 120 and 2000kg/h.

[0074] The installation then comprises one single and unique hydration device (14), fed with polymer by the metering device (13). The hydration device has a water-soluble polymer particle dissolution capacity adjustable according to the field and the application, in practice between 50 and 650kg/h of polymer particles.

[0075] The hydration device (14) is schematically represented in figure 1 and corresponds, in this example, to the PSU described in document WO 2011/107683 or also WO 2016/156320.

[0076] The hydration device (14) is connected at the outlet to a buffer tank (15), wherein the dissolved polymer is stored. The injection fluid is prepared comprising the water-soluble polymer dissolved in the installation of the invention by mixing it with water or brine, and it is injected into the field by means of an injection pump (16).

[0077] The invention and the advantages which arise from it emerge from the description above. Thus, the capacity of the installation is noted to ensure an optical dissolution yield of water-soluble polymer powders while guaranteeing a handling of these in total safety, it all without requiring a maturation tank.

Claims

1. Installation for the dissolution of water-soluble polymers in powder form, in particular for enhanced oil and/or gas recovery operations or for fracking operations comprising:

   - a device (2) for transporting polymer in powder form,
   - a device (3) for grinding polymer into powder provided with an air inlet (3.1) and a means (3.4) for connection to the transport device, said grinding device being configured to grind the polymer powder into particles of different sizes,
   - a cyclone (5), having a bottom part (5.1) and a top part (5.2), which is provided with a means (4) for connection to the grinding device (3), the cyclone (5) being capable of separating the polymer particles, such that the finest particles are located in the top part (5.2) of the cyclone (5), while the coarsest particles are located in the bottom part (5.1) of the cyclone (5),
   - a filter (7) having a top part (7.2) and a bottom part (7.1), the bottom part (7.1) being connected to the top part (5.2) of the cyclone (5), the filter (7) being capable of performing a second separation of the polymer particles coming from the top part (5.2) of the cyclone (5), such that the finest particles are located in the top part (7.2) of the filter (7), while the coarsest particles are located in the bottom part (7.1) of the filter (7),
   - an air extraction means (9) connected to the top part (7.2) of the filter (7), said extraction means (9) being capable of suctioning air entering from the air inlet (3.1) of the grinding device (3) and circulating successively in the cyclone (5) then in the filter (7),
   - a hopper (12) having a bottom part (12.2) and the top part (12.1), the top part (12.1) having means (11) for connection to the bottom parts (5.1, 7.1) respectively of the cyclone (5) and of

the filter (7),

- a metering device (13) having means for connection to the bottom part (12.2) of the hopper (12),
- a hydration device (14) capable of receiving the polymer from the metering device (13).

2. Installation according to claim 1, **characterised in that** it comprises at least 2 cyclones (5) positioned in series and **in that** the bottom part of the filter (7) is connected to the top part of the last cyclone (5).

3. Installation according to any one of the preceding claims, **characterised in that** it has at least two filters (7, 8) positioned in series and **in that** the bottom part (7.1) of the first filter (7) is connected to the top part (5.2) of the last cyclone (5).

4. Installation according to any one of the preceding claims, **characterised in that** it comprises several hoppers (12) configured to receive the polymer particles coming from the bottom parts (5.1) of the cyclone(s) and of the filter(s) (7.1, 8.1).

5. Installation according to claim 4, **characterised in that** it comprises as many metering devices (13) as hoppers (12), **in that** each hopper (12) is connected to one single metering device (13) and **in that** the assembly of the metering devices (13) is configured to feed one single and unique hydration device (14).

6. Installation according to one of the preceding claims, **characterised in that** the cyclone(s) (5), the filter(s) (7, 8) and the air suctioning means (9) are positioned above the assembly formed by the transport device (2), the grinding device (3), the hopper(s) (12), the metering device (13) and the hydration device (14).

7. Installation according to one of the preceding claims, **characterised in that** the cyclone(s) and the filter(s) are arranged on a platform, which has openings to enable the passage of the means for connection of the top part of the cyclone to the grinding device and means for connection of the bottom parts of the cyclone(s) and of the filter(s) to the hopper(s).

8. Installation according to one of the preceding claims, **characterised in that** it comprises:

- a container **A** of general parallelepiped shape comprising side walls forming large and small sides, a bottom and a roof, said container **A** comprising:
    - the transport device,
    - the grinding device,
    - the hopper(s),
    - the metering device(s),
    - the hydration device;
- a container **B** of general parallelepiped shape comprising side walls forming large and small sides, a bottom and a roof, said container **B** being positioned on the container **A,** and comprising the cyclone(s), the filter(s) and the air extraction means,
- the roof of the container **A** and the bottom of the container **B** having openings configured to enable the passage of the means for connection of the top part of the cyclone to the grinding device and of the means for connection of the bottom parts respectively of the cyclone(s) and of the filter(s) to the hopper(s).

9. Installation according to claim 8, **characterised in that** it further comprises a container **C** configured for the storage of powder polymer, of general parallelepiped shape comprising side walls forming the large and small sides, a bottom and a roof, the container **C** being positioned on the container **B.**

10. Installation according to claim 9, **characterised in that**

- the transport device is arranged on either side of the roof of the container **A** and of the bottom of the container **B,**
- the roof of the container **A** and the bottom of the container **B** each have an opening configured to enable the passage of said transport device,
- the bottom of the container **C** and the roof of the container **B** each have an opening configured to enable the passage of the powder polymer in the transport device.

11. Installation according to one of claims 1 to 9, **characterised in that** the container **A** has a hatch arranged in one of its side walls configured to enable the passage of the transport device, so as to transport the powder polymer from the outside.

12. Installation according to one of the preceding claims, **characterised in that** the hydration device comprises:

- a cone for wetting the polymer connected to a primary water supply circuit,
- at the lower end of the cone, a chamber for grinding and draining the dispersed polymer comprising:
    - a rotor driven by a motor and provided with cutters,
    - a fixed stator constituted of a cylinder provided with slots,

- over all or some of the periphery of the chamber, a ring fed by a secondary water circuit, the ring communicating with the chamber, so as to spray pressurised water on the outside of the stator.

13. Installation according to one of claims 1 to 11, **characterised in that** the hydration device comprises:

- a wetting chamber comprising a cylindrical upper part of vertical axis of revolution extending by a conical lower part, said wetting chamber being further provided:

o with at least one opening formed in the thickness of the wall of the upper and/or lower parts, said opening laterally emerging into a means for connection to a primary water supply circuit,
o with a cover provided with an opening formed in the thickness of the wall of said cover,

- a chamber for grinding and discharging dispersed polymer of horizontal axis of revolution, said grinding chamber comprising:

o a rotor driven by a motor and provided with cutters,
o a fixed stator being presented in the form of a cylinder in the wall from which vertical slots are cut,
o over all or some of the periphery of the chamber, a ring fed by a secondary water circuit, the ring communicating with the grinding chamber, so as to spray pressurised water on the stator,

- a means for connection of the wetting chamber to the grinding chamber in the form of an L-shaped tube, an end of which connects the lower end of the wetting chamber and the other end connects the inlet of the grinding chamber,
- the upper and lower parts of the wetting chamber and the L-shaped tube having an internal surface having an identical surface tension (TS1) and the cover of the wetting chamber having an internal surface having a surface tension (TS2) greater than that of the internal surface of the upper and lower parts of the wetting chamber and of the L-shaped tube (TS1).

14. Method for producing a water-soluble polymer solution implementing the installation which is the subject matter of any one of claims 1 to 12, comprising the following steps:

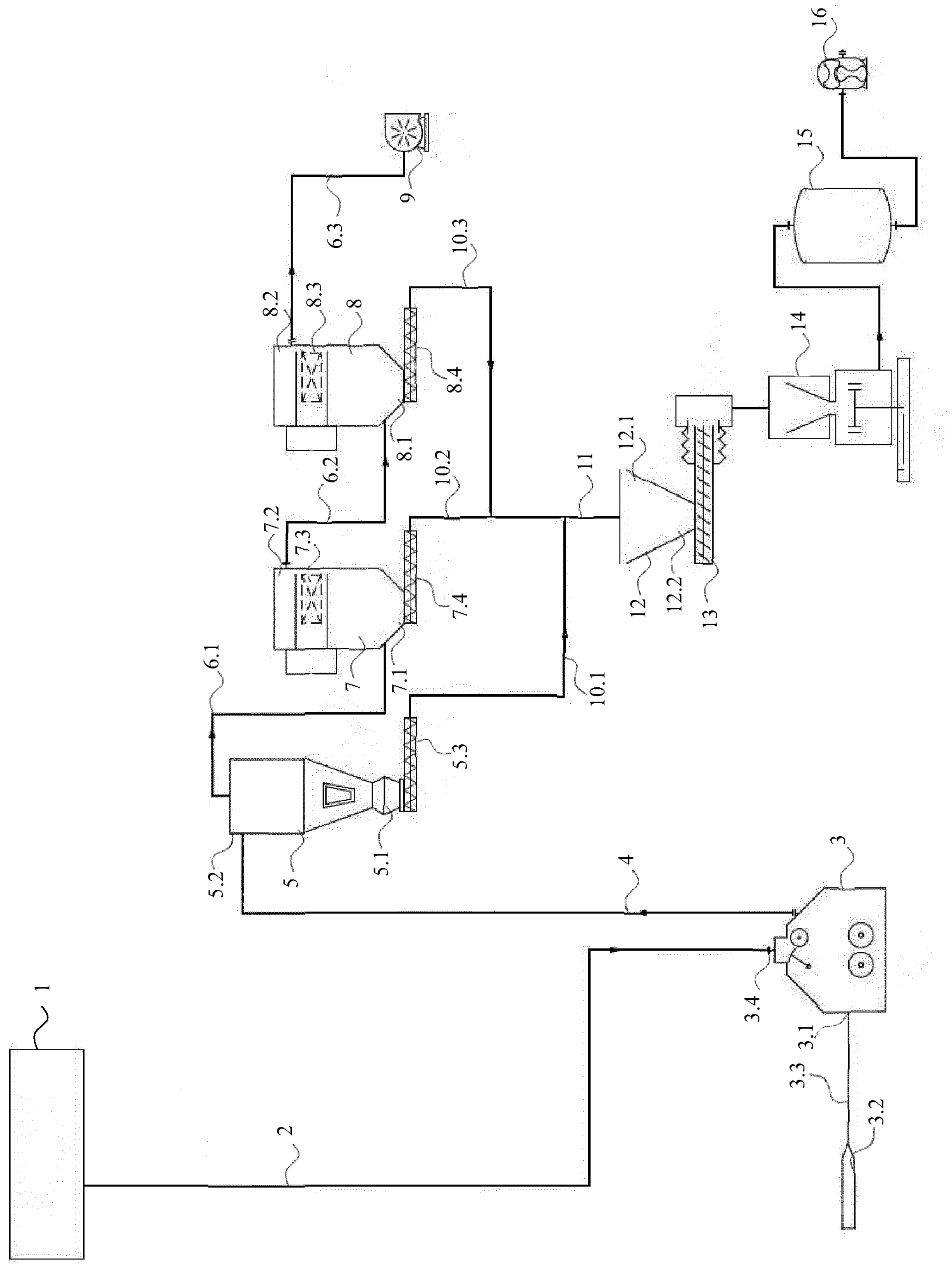
- the air suctioning means (9) are started,
- the transport device (2) is fed with water-soluble polymer in powder form,
- the polymer present on the transport device (2) is moved towards the grinding device (3),
- the polymer in powder form is ground in the grinding device (3) to obtain polymer particles of different sizes,
- the polymer particles ground in the top part (5.2) of the cyclone(s) (5) are suctioned,
- the finest polymer particles with respect to the rest of the particles are separated in the top part (5.2) of the cyclone(s) (5),
- the particles coming from the top part (5.2) of the cyclone (5) are suctioned into the bottom part (7.1) of the filter(s) (7),
- a second separation of the particles is carried out in the top part (7.2) of the filter (7),
- the polymer particles collected in the bottom parts (5.1, 7.1) of the cyclone(s) (5) and of the filter(s) (7) are directed into the top part (12.1) of the hopper (12),
- the metering device (13) is fed by the bottom part (12.2) of the hopper(s) (12),
- the polymer that is then injected into the hydration device (14) is metered,
- the polymer is dissolved in the hydration device (14),
- the polymer solution is recovered.

15. Enhanced oil and/or gas recovery method comprising the following steps:

- dissolution of a water-soluble polymer in the installation which is the subject matter of one of claims 1 to 13,
- preparation of an injection fluid comprising at least water-soluble polymer and water or brine,
- injection of the injection fluid in an underground formation,
- sweeping of the underground formation with the aid of the injected fluid,
- recovery of the aqueous and hydrocarbon mixture.

16. Method for fracking an oil or gas reservoir comprising the following steps:

- dissolution of a water-soluble polymer in the installation which is the subject matter of one of claims 1 to 13,
- preparation of a fracking fluid comprising at least said water-soluble polymer and water or brine,
- injection of the pressurised fracking fluid to create fractures distributed perpendicularly to the production well,
- recovery of an aqueous and hydrocarbon mixture.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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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