



- (51) International Patent Classification:
B65D 88/74 (2006.01) *B67D 7/80* (2010.01)
- (21) International Application Number:
PCT/FI2012/050028
- (22) International Filing Date:
13 January 2012 (13.01.2012)
- (25) Filing Language: Finnish
- (26) Publication Language: English
- (30) Priority Data:
20115039 14 January 2011 (14.01.2011) FI
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LI, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

[Continued on next page]

(54) Title: A METHOD AND AN APPARATUS FOR STORING AND TRANSFERRING SLUGGISH MATERIAL

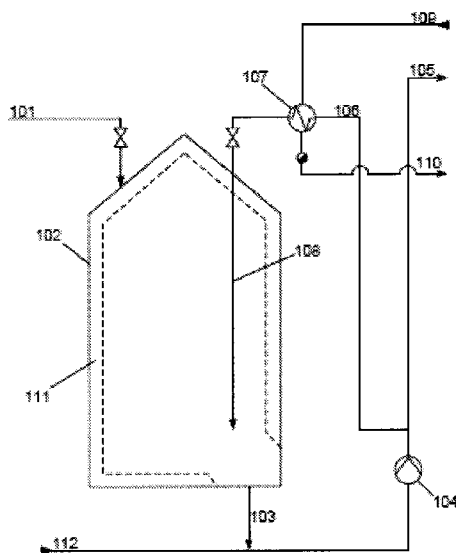


Figure 1

(57) Abstract: The present invention relates to a method and an apparatus for storing a viscous and detrimental material in a storage container (102, 202, 302, 402) and from taking it out of said storage container (102, 202, 302, 402) and directing it to a use. In the method, only that part of the material contained in said storage container (102, 202, 302, 402) which is located in the immediate vicinity of the outlet of the storage container (102, 202, 302, 402) is brought to a state suitable to be taken out and is directed to the use.



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- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A method and an apparatus for storing and transferring sluggish material

Field of the invention

The invention relates to a method and an apparatus for storing sluggish and detrimental material and for transferring it from its storage container to a use. In particular, the method relates to storing a concentrated solution and its use from a storage container which is emptied gradually over a longer period of time.

Prior art

Hydroxides, particularly alkali metal hydroxides, such as sodium or potassium hydroxide, are strong alkalis and thereby dangerous or detrimental compounds. They are characterized by an exothermic reaction when dissolved in water or diluting an aqueous solution. Similarly, their reactions with acids are vigorous and strongly heat generating. For example, sodium hydroxide binds carbon dioxide from the air, forming a solid white sodium carbonate precipitate. Alkali metal hydroxides also react with metals, such as aluminium, zinc, magnesium, tin, and lead, as well as their alloys, such as brass, discharging inflammable hydrogen gas. For example, the chemical classification of 50 wt-% sodium hydroxide is corrosive, class C.

For the reasons mentioned above, it is necessary to take particular caution when storing strong hydroxide solutions. Typically, hydroxide solutions are stored at high concentration and ambient temperature. For example, the solidification point of sodium hydroxide is +12 °C at a concentration of about 50 wt-%, and its viscosity is 50 cP at the temperature of 25 °C. When the temperature decreases, the viscosity increases, and the material will finally solidify. This creates a need either to heat the storage container, if the ambient temperature drops to the solidification point or below it, or to store the solution in a sufficiently warm space, to be usable. Depending on the size of the storage container, at least in industrial scale, keeping a liquid quantity sufficiently warm consumes a considerable amount of energy, or alternatively, it is difficult to place a large storage container in a sufficiently warm storage space. If the hydroxide solution is diluted, its solidification point will drop, but simultaneously, the volume for storing the same molar amount will increase accordingly.

As hydroxide solutions are strongly corrosive and reactive, particularly the properties of the walls of the container material must be taken into account. Aluminium, zinc or other corrodible or reactive metals or metal alloys formed of them are not suitable construction materials. The corrosive effect is intensified particularly when the temperature of the hydroxide solution increases.

Typically, hydroxide solutions are stored at high concentrations in large containers, from which a required amount of hydroxide solution is taken into use when needed, either by draining or by pumping. Thus, a requirement for the use is that the viscosity of the solution is not too high and that the desired material flow is obtained smoothly out of the storage container when needed.

It is an aim of the present invention to provide a method and an apparatus for reducing or eliminating the above described drawbacks.

Further, it is an aim of the invention to provide a simple and effective solution for taking hydroxide solution into use from a stock solution container.

Moreover, it is an aim of the invention to use the storage container as energy efficiently as possible.

Description of the invention

The method according to the invention is characterized in what will be presented in the characterizing part of claim 1. The apparatus to be used in the method according to the invention is characterized in what will be presented in the characterizing part of claim 14.

The inventors of the present invention have found that it is not necessary to heat the whole stock solution to a usable temperature, but it is sufficient that the point where the stock material is pumped out is at a temperature where the viscosity of the stock material can be decreased to a sufficiently low level to enable the removal of the material from the container.

An advantage of the present invention to the prior art is a significantly lower energy consumption due to the fact that the whole amount of stock solution does not need to be heated for taking out. Moreover, the container does not need to be separately insulated, wherein its mechanical construction, such as the structure of the wall, is simpler and more cost-effective to implement. Furthermore, the solution according to the invention reduces the corrosion of the wall of the container that is

exposed to the stock solution. Thus, less metal is dissolved from the wall into the chemical contained in the container, and a product is obtained for the outlet which product is freer from impurities, compared with a situation in which the material is kept in molten state at the outlet temperature for a long time.

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List of figures

Figure 1 shows schematically an advantageous embodiment of the apparatus according to the invention.

10 Figure 2 shows schematically an apparatus according to a comparative example 1.

Figure 3 shows schematically a second advantageous embodiment of the apparatus according to the invention.

Figure 4 shows schematically a third advantageous embodiment of the apparatus according to the invention.

15 Detailed description of the invention

According to the invention, the term "material" to be stored refers to a chemical that is detrimental to the environment, such as irritating, toxic, reactive, or corrosive. The pumping or draining properties of the material are problematic because of variations in the ambient storage conditions, such as the temperature.
20 Particularly in winter conditions or when the temperature drops sufficiently, the viscosity of the material, particularly a liquid material, may become so high that the material is difficult or impossible to get out of the container in liquid state by conventional methods. Eventually, this liquid may even solidify if the ambient temperature drops below the solidification point of the material.

25 The material according to the invention is advantageously a hydroxide solution, more advantageously a concentrated aqueous solution of an alkali metal hydroxide, most advantageously a sodium or potassium hydroxide solution. The concentration of the hydroxide solution is advantageously higher than 30 wt-%, more advantageously higher than 40 wt-%, such as higher than 45 wt-%. For
30 example, the viscosity of a 50 wt-% aqueous solution of sodium hydroxide typically becomes higher than 80 cP even at a temperature of 20°C and increases exponentially when the temperature drops further.

The present invention provides, according to its first aspect, a method in which only a part of the material stored in a storage container is heated to become a liquid suitable to be taken out, for example by pumping. This part of the material, to be heated, is placed in the immediate vicinity of the pumping point, *i.e.* the outlet
5 of the storage container, such as a vacuum pipe. When this part of the stock material has been made suitable to be taken out, it is led partly or completely to its use.

The heating of the material can be provided externally by means of a heat exchanger or internally by means of a local heating device in the immediate
10 vicinity of the outlet, or by applying both methods of heating simultaneously.

Advantageously, the quantity of stock material in the immediate vicinity of the outlet of the storage container is lower than 30%, more advantageously lower than 25%, most advantageously lower than 15%, such as lower than 10% of the total
15 volume of the stock material. The quantity in question will depend on the mass flow rate needed for the process, the ambient conditions, the efficiency of the heating applied, and the shape of the container.

Advantageously, when the ambient temperature ranges from 0 to 20°C, it will be sufficient that the heated part of the stock material is brought to a temperature of 20°C or higher, advantageously about 25 to 45°C, more advantageously between
20 30 and 40°C.

Advantageously, the quantity of the material to be circulated through the heat exchanger compared with the quantity of the material to be used is lower than 50%, more advantageously lower than 20%, most advantageously 10% or lower, of the material to be pumped out of the storage container in a situation of
25 continuous operation. Advantageously, the quantity of the material heated and pumped out continuously is higher than 5 tons per hour, more advantageously higher than 10 tons per hour.

The rest of said material in the storage container, excluding the material brought to liquid state in the immediate vicinity of the outlet, is at a low temperature, and it
30 may have such a high viscosity that it cannot be pumped or drained out of the container. When the temperature of the outer wall of the container drops below the solidification point of the material, the material in direct contact with the inner wall of the container is advantageously frozen and/or solidified. This reduces the properties of the material corroding the inner wall of the container, and an

autogenic lining of the container is provided by the freezing or solidifying material. Maintenance costs caused by corrosion monitoring and repair are reduced. This lining not only significantly reduces the corrosion of the container material, such as the solubility of iron in sodium hydroxide when the temperature drops and the liquid phase solidifies, but it also acts as a thermal insulator. Consequently, the storage container does not necessarily need to be equipped with a typical external insulating layer. In this way, significant savings are achieved in investment and operating costs. A separate thermal insulation will not be needed for maintaining the temperature inside the container, nor a supply of additional energy to compensate for thermal losses.

Advantageously, the thickness of the insulating lining formed of *e.g.* the stock material is at least one centimetre or greater, more advantageously several, such as 2 to 5 centimetres.

According to an advantageous embodiment, the stock material is heated outside the container by means of, for example, a heat exchanger, through which a liquid flow of the stock material is led into the storage container and to the vicinity of the outlet of the container. This heated liquid flow will keep the stock solution in the immediate vicinity of the outlet at a sufficiently high temperature so that material can be taken out of the container. Part of the outlet material flow is led to the use and part is recirculated via heating back to the storage container.

The ratio between the quantities of material to be taken out of the container and to be recirculated via heating in the container will depend on the quantity of material needed for use in the target and on the heating device used. Optimization of the heating and the material quantities is process optimization known to persons skilled in the art.

According to another advantageous embodiment, only that part of the material in said storage container which is placed in the immediate vicinity of the outlet of the storage container is made suitable to be taken out by heating said point locally by a heating device, advantageously by a local heating device at said point inside the container. The material that has in this way been made suitable to be taken out, is lead to the use.

Furthermore, according to an advantageous embodiment, only that part of the material in said storage container which is located in the immediate vicinity of the outlet of the storage container, is made suitable to be taken out, both by circulating part of said material through a heating device connected to a pipe system outside the storage container back to said point of the storage container, and by heating

said point locally with a heating device. The material that has in this way been made suitable to be taken out, is lead to the use. By applying both heating methods simultaneously, it is possible to make the heating more efficient, more steady and faster.

5 Figure 1 shows a schematic view of a particularly advantageous embodiment of the method according to the invention, in which a hydroxide solution, such as concentrated sodium hydroxide solution, is pumped through a heat exchanger 107 into a storage container 102. The heated hydroxide solution circulates via a pipe 108 extending inside the storage container to the immediate vicinity of an outlet
10 pipe 103 located at the bottom of the storage container, where it heats the surrounding stock solution. The temperature of this is increased, advantageously by the hydroxide solution, to 25 to 45°C, more advantageously to about 30 to 40°C, and the required quantity of the stock solution can thus be pumped by a pump 104 out of the bottom of the container. Part of the heated stock solution
15 taken out is led to use, for example to a pulping mill, whereas part is recirculated via reheating in a heat exchanger to the storage container.

Figure 3 shows a schematic view of another advantageous embodiment of the method according to the invention, in which a hydroxide solution, such as concentrated sodium hydroxide solution, is heated locally with a heating device
20 314. The material brought to the outlet temperature is pumped into the storage container 302.

Figure 4 shows a schematic view of a further advantageous embodiment of the method according to the invention, in which a hydroxide solution, such as concentrated sodium hydroxide solution, is pumped through a heat exchanger 407
25 into a storage container 402. The heated hydroxide solution circulates via a pipe 408 extending inside the storage container to the immediate vicinity of an outlet pipe 403 located at the bottom of the storage container, where it heats the surrounding stock solution. At the same time, the environment of the outlet pipe is heated locally with a heating device 414. The needed quantity of stock solution
30 can be pumped by a pump 404 out of the bottom of the container. Part of the heated stock solution taken out is led to use, whereas part is recirculated via reheating in a heat exchanger to the storage container. In a second aspect, the present invention provides an apparatus for implementing the method according to the invention.

The apparatus according to the invention comprises means for storing material in a storage container; means for making only that part of said material, which is located substantially in the immediate vicinity of the outlet of the storage container, suitable to be taken out of the storage container; means for heating; and means
5 for directing a given quantity of heated material to a use.

Advantageously, the apparatus according to the invention comprises a storage container for storing a material, advantageously a hydroxide solution. The storage container is equipped with an inlet pipe for supplying material into the container and an outlet pipe for taking stock solution out of the container. Furthermore, the
10 storage container is optionally equipped with a pipe, advantageously a substantially vertical pipe, which extends from the top of the container close to the bottom of the container, and through which the heated material is led to the vicinity of the bottom of the container and is discharged from the pipe. Thus, warm material is mixed with cooler material in the container, raising its temperature
15 locally. Furthermore, the apparatus comprises a pumping line connected to the outlet pipe at the bottom of the storage container, provided with a pump and optionally with a heating device for raising the temperature of the material to be circulated. The pumping line also comprises a material outlet line to the use, and optionally a recirculating line via the heating device to said vertical pipe.
20 Furthermore, the apparatus optionally comprises a heating device placed inside the container, in the immediate vicinity of the outlet.

The storage container is made of a corrosion proof material, advantageously steel, more advantageously carbon steel, nickel chromium steel, or stainless steel. Typically, limits have been defined for contents of sulphur and phosphorus in
25 carbon steel, depending on the operating temperature. The lower the operating temperatures remain, the more permissive the criteria for impurities in the materials become. The size of the container is advantageously in industrial scale, such as several cubic metres, advantageously 300 m^3 or greater, more advantageously greater than 500 m^3 , most advantageously greater than 1000 m^3 ,
30 such as greater than 2000 m^3 or even greater than 3000 m^3 . However, the solution according to the invention can also be implemented in a smaller scale.

The inlet pipe and/or the pipe leading to the inside of the storage container is equipped with valves which can be used to control the material flows in the apparatus.

If the stock solution is too sluggish to be pumped, for example after a stoppage, and the ambient temperature is low, pumping can be started by means of a bypass supply, advantageously the bypass supply 112 shown in Fig. 1, by first circulating a low quantity of the solution through the heating device to the storage container, to heat a required starting quantity of the solution. Alternatively, if the container is equipped with an internal heating device, it is possible to use it for heating first the starting quantity before starting the circulation.

An external heating device used in the apparatus is advantageously a heat exchanger. More advantageously, it is a heat exchanger, through which it is possible to recirculate and utilize, for example, waste or rejected heat from the use or from a process in its vicinity, for example heat generated in the process of a pulp mill, for heating the material to be recirculated.

An internal heating device used in the apparatus is advantageously a heating coil, a heating element, heating pipes, or another element suitable for said heating. More advantageously, it is a heating coil, through which it is possible to recirculate and utilize, for example, waste or rejected heat from the use or a process in its vicinity, for example heat generated in the process of a pulp mill, for heating said part of the material in the storage container.

In an advantageous embodiment, the apparatus according to the invention comprises a storage container 102 shown in Fig. 1 for storing a hydroxide solution. An inlet pipe 101 is connected to the storage container, for supplying hydroxide solution into the container through a valve. Furthermore, the container is equipped with an outlet pipe 103 or a vacuum pipe for taking out stock solution from the container to the use in a desired amount and at a desired moment of time. In the storage container, a substantially vertical pipe 108 equipped with a valve extends from the top of the container to the vicinity of the bottom of the container, through which pipe the heated hydroxide solution is led to the vicinity of the bottom of the storage container. The lower part of the pipe is open to the storage container. That location in the container to which heated hydroxide solution is introduced from the pipe 108, and the immediate vicinity of that location, will remain in liquid state when the temperature of the hydroxide solution is above the solidification point. Furthermore, the apparatus is equipped with a pumping line which is connected to the outlet pipe 103 at the bottom of the storage container and is equipped with a pump 104 for pumping hydroxide solution out of the container, and an outlet line 105 for conveying a given quantity of the hydroxide solution to the use. Part of the hydroxide solution is led to a recirculating line 106 with a heat exchanger 107. The

solution recirculating via the heat exchanger is heated and returned back to the pipe 108. In the heat exchanger, hot liquid is used, advantageously condensation water from the process, taken in from the outlet 109 of the process, recirculating through the heat exchanger and returned to the process 110. A solid lining layer
5 111 is formed in the storage container when the temperature of ambient air drops below the solidification point of the hydroxide solution used.

The apparatus according to the invention has the advantage that a less doped material can be used as the wall material of the container, because the corrosive properties of the stock solution reduce when the temperature drops. Furthermore,
10 no separate heat insulation will be needed for the outer surface of the container, because the freezing or solidifying hydroxide solution insulates the container from the inside. A considerable saving of energy is achieved, because only a small part of the hydroxide solution contained in the container needs to be in pumpable state, that is, heated. For example steam is not needed for heating the small volume of
15 hydroxide solution to be heated, but it can be heated sufficiently with hot condensation water from a nearby process.

The method and the apparatus according to the invention are suitable for use in an industry that applies a lot of alkali metal hydroxides, such as in the wood refining industry for preparing pulp, in the pulping itself and/or in the bleaching, or in
20 processes of the viscose fibre and technology industries.

In the following, the invention will be described with examples, however not limiting to them.

Examples

25 Example 1

A carbon steel storage container 102 of 4000 m³, shown in Fig. 1, was filled with concentrated 50 wt-% sodium hydroxide solution. The storage container was kept outdoors at ambient temperature of +9°C.

After a maintenance shutdown at a chlorate plant, supply of sodium hydroxide to
30 the process of the plant was restarted. First, liquid sodium hydroxide was pumped through a bypass supply 112 along a line 106 to a heat exchanger that operated with condensation water from another process, the temperature of the water being

85°C at the inlet 109 of the heat exchanger. The heated sodium hydroxide solution was led along a pipe 108 to a storage container where its temperature at the outlet of the pipe was about 35°C. The temperature of the hydroxide solution at the vicinity of the outlet increased sufficiently so that stock solution could be pumped to the use 105 and the bypass supply 112 could be stopped. Most of the hydroxide solution to be pumped, about 90 volume-%, was led to the use, and only a small part, about 10 volume-%, was led to recirculation through the heat exchanger to heat the sodium hydroxide in the storage container. A solid sodium hydroxide lining layer 111 with a thickness of a few centimetres was formed on the inner surface of the storage container.

No additional energy was needed to bring the sodium hydroxide solution contained in the storage container to a substantially pumpable state, but it was possible to use warm or hot liquid, such as water, that was already available for recirculating at the plant site.

After use of six months, no signs of corrosion of the wall material were detectable in the walls of the storage container.

Comparative example 2

Concentrated 50 weight-% sodium hydroxide solution was typically stored in a carbon steel storage container of 4000 m³, shown in Fig. 2, provided with an insulation outside the container to minimize heat loss from the container to ambient air.

When the temperature of ambient air was +9°C, the storage container 202 provided with the thermal insulation 213 shown in Fig. 2 was filled with concentrated sodium hydroxide solution along a line 201. After a maintenance shutdown at a chlorate plant, supply of sodium hydroxide to the process of the plant was restarted from a pipe 205. During the maintenance shutdown, after the filling of the container, the whole sodium hydroxide solution in the storage container had been kept in liquid state and well flowing by means of a steam coil 214. Hot water vapour at about 100°C was supplied along a line 209 to the steam coil 214, from which the steam was recirculated in condensed state along a line 210 to the heating device where it was reheated to its operating temperature. The temperature of the sodium hydroxide solution in the vicinity of the steam coil was typically between 90°C and 33°C, depending on the location. In the vicinity of the walls of the storage container, the temperature of the sodium hydroxide solution

was about 30 to 40°C. Stock solution of sodium hydroxide was pumped to the use 205 via a vacuum pipe 203 and a pump 204. If necessary, the supply to the use could be stopped or bypassed, and the sodium hydroxide solution could be pumped directly back to the storage container along the line 206.

- 5 Keeping the whole volume of the sodium hydroxide solution at a temperature higher than 30°C consumed a lot of energy in the form of hot steam.

Moreover, when examining the walls of the storage container after a use of six months, signs of corrosion of the wall material could be found particularly at the locations where the temperature of the sodium hydroxide solution was normally at
10 the highest in the container.

Example 3

Concentrated 50 weight-% sodium hydroxide solution was stored in a carbon steel storage container of 500 m³ shown in Fig. 3. When the temperature of ambient air was +10°C, the storage container 302 shown in Fig. 3 was filled with concentrated
15 sodium hydroxide solution along a line 301. After a maintenance shutdown of an industrial process, supply of sodium hydroxide to the test process of the plant was restarted from a pipe 305. During the maintenance shutdown, the sodium hydroxide solution in the storage container had been frozen and formed a solid-like lining with a thickness of about one and a half centimetres on the inner wall of
20 the container. Hot process water at about 90°C was supplied along a line 309 to a heating coil 314, from which the process water was returned in condensed state along a line 310. The temperature of the sodium hydroxide solution in the vicinity of the heating coil was typically between 70°C and 40°C, depending on the location. In the vicinity of the walls of the storage container, the temperature of the
25 sodium hydroxide was about 10 to 15°C. Stock solution of sodium hydroxide was pumped to the use 305 via a vacuum pipe 303 and a pump 304. If necessary, the supply to the use could be stopped or bypassed, and the sodium hydroxide solution could be pumped directly back to the storage container along the line 306.

No additional energy was needed to bring the sodium hydroxide solution contained
30 in the storage container to a substantially pumpable state, but it was possible to use hot process water that was already available for recirculation at the plant site.

After use of six months, no signs of corrosion of the wall material were detectable in the walls of the storage container.

Example 4

A carbon steel storage container 402 of 5000 m³, shown in Fig. 4, was filled with concentrated 50 wt-% sodium hydroxide solution. The storage container was kept outdoors at ambient temperature of +9°C.

- 5 After a maintenance shutdown at a pulp mill, supply of sodium hydroxide was restarted to a test process in the mill. First, liquid sodium hydroxide was pumped through a bypass inlet 412 along a line 406 to a heat exchanger operated with condensation water from another process of the mill, the temperature of the water being 85°C at the inlet 409 of the heat exchanger. The heated sodium hydroxide
10 solution was led along a pipe 408 to a storage container where its temperature was about 35°C at the outlet of the pipe. Furthermore, hot process water at about 90°C was supplied along a line 409b from another process of the pulp mill to a heating coil 414, from which this process water was returned in condensed state along a line 410b. The temperature of the hydroxide solution at the vicinity of the
15 outlet increased sufficiently so that stock solution could be pumped to the use 405 and the bypass supply 412 could be stopped. Most of the hydroxide solution to be pumped, about 85 volume-%, was led to the use, and only a small part, about 15 volume-%, was led to recirculation through the heat exchanger to further heat the sodium hydroxide in the storage container, together with the local heating coil.
20 A solid sodium hydroxide lining layer 411 with a thickness of a few centimetres was formed on the inner surface of the storage container.

No additional energy was needed to bring the sodium hydroxide solution contained in the storage container to a substantially pumpable state, but it was possible to use warm or hot liquid, such as water, from other processes at the mill site.

- 25 After use of six months, no signs of corrosion of the wall material were detectable in the walls of the storage container.

Claims

1. A method for storing viscose and detrimental material in a storage container (102, 202, 302, 402) and for taking it out of said storage container (102, 202, 302, 402) and directing it to a use, **characterized** in that only that part of the material in said storage container (102, 202, 302, 402) which is located substantially in the immediate vicinity of the outlet of the storage container (102, 202, 302, 402) is brought by heating to a state suitable to be taken out, and a given amount of material is led to the use.
2. The method according to claim 1, **characterized** in that the heating of the material to a state suitable to be taken out is implemented by recirculating part of said material via a heating device (107, 407) connected to a pipe system outside the storage container (102, 402) back to said location of the storage container (102, 402).
3. The method according to claim 1, **characterized** in that the heating of the material to a state suitable to be taken out is implemented by heating the location of the material outlet locally by a heating device (214, 314, 414).
4. The method according to claim 1, **characterized** in that the heating of the material to a state suitable to be taken out is implemented both by recirculating part of said material via a heating device (407) connected to a pipe (406) system outside the storage container (402) back to said location of the storage container (402), and by heating said location locally by a heating device (414).
5. The method according to any of the claims 1 to 4, **characterized** in that said material is a hydroxide solution, advantageously an alkali metal hydroxide solution, more advantageously a potassium or sodium hydroxide solution.
6. The method according to claim 5, **characterized** in that the concentration of the hydroxide solution is higher than 30 wt-%, more advantageously higher than 40 wt-%, most advantageously higher than 45 wt-%.
7. The method according to any of the claims 1 to 6, **characterized** in that a heat exchanger, a heating coil, a heating element, or a heating pipe system is used for the heating.

8. The method according to claim 7, **characterized** in that the amount of heat consumed by the heating device is taken in the form of waste or rejected heat from a process, from the use of said stock material or from its vicinity.
- 5 9. The method according to any of the claims 1 or 2 to 8, **characterized** in that the quantity of the stock material to be recirculated via the heating device (107, 407) compared with the quantity of material supplied to the use is lower than 50%, advantageously lower than 20%, more advantageously 10% or lower, of the material to be pumped out of the storage container (102, 402) in a situation of continuous operation.
- 10 10. The method according to any of the claims 1 to 9, **characterized** in that the material located in the immediate vicinity of the outlet is heated to a temperature of 25 to 45°C.
- 15 11. The method according to any of the claims 1 or 2 to 10, **characterized** in that the material to be recirculated through the heating device (107, 407) is led along a substantially vertical pipe (108, 408) to the immediate vicinity of the outlet.
- 20 12. The method according to any of the claims 1 to 11, **characterized** in that when the ambient temperature of the storage container (102, 402) is lower than the solidification point of the material to be stored, an insulating layer (111, 411) is formed on the inner surface of the storage container (102, 402).
- 25 13. The method according to claim 12, **characterized** in that the thickness of said insulating layer (111, 411) is greater than one centimetre.
- 30 14. An apparatus for use in a method according to any of the claims 1 to 13, **characterized** in that it comprises means for storing material in a storage container (102, 202, 302, 402); means for making only that part of said material, which is located substantially in the immediate vicinity of the outlet of the storage container (102, 202, 302, 402), suitable to be taken out of the storage container (102, 202, 302, 402); means for heating; and means for leading a given quantity of heated material to a use.
15. The apparatus according to claim 14, **characterized** in that it comprises
- i. a storage container (102, 202, 302, 402), which is provided with an inlet pipe (101, 201, 301, 401) for supplying material to be stored in the storage

container (102, 202, 302, 402) and an outlet pipe (103, 203, 303, 403) and a relating pipe system for leading the material out of the storage container (102, 202, 302, 402) to a use, and optionally means for recirculating the material to the storage container (102, 202, 302, 402), and

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ii. at least one heating device (107, 214, 314, 414, 407) placed outside the storage container (102, 202, 302, 402) and/or inside the storage container (102, 202, 302, 402) in the immediate vicinity of the outlet, and through which the temperature of the material to be directed to the use and to be possibly recirculated can be increased before the material is taken out of the storage container (102, 202, 302, 402), and

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iii. possibly a pipe (108, 408) leading to the bottom of the storage container (102, 402), from which the recirculated and heated material is discharged to the storage container (102, 402).

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16. The apparatus according to claim 15, **characterized** in that the material of the storage container (102, 202, 302, 402) is carbon steel or stainless steel.

17. The apparatus according to claim 15 or 16, **characterized** in that the pipe (108, 408) leading to the bottom of the storage container (102, 402) is substantially vertically inside the storage container (102, 402).

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18. The apparatus according to any of the claims 15 to 17, **characterized** in that the volume of the storage container (102, 202, 302, 402) is 300 m³ or greater, more advantageously 500 m³ or greater, most advantageously 1000 m³ or greater.

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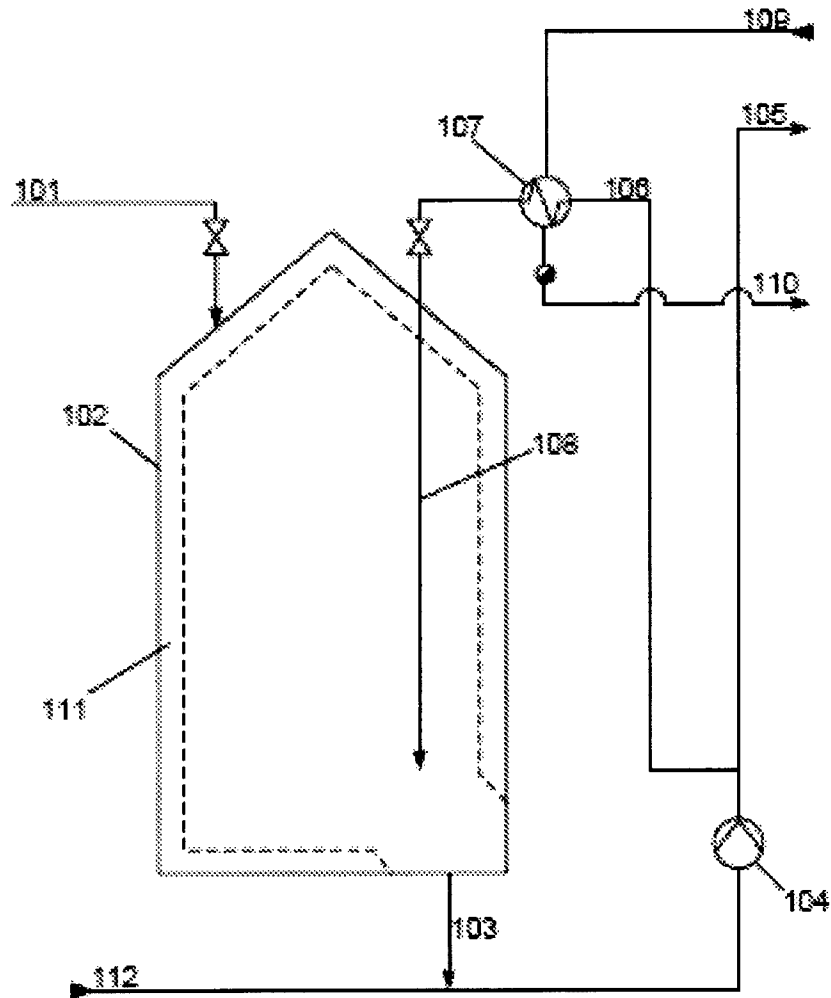


Figure 1

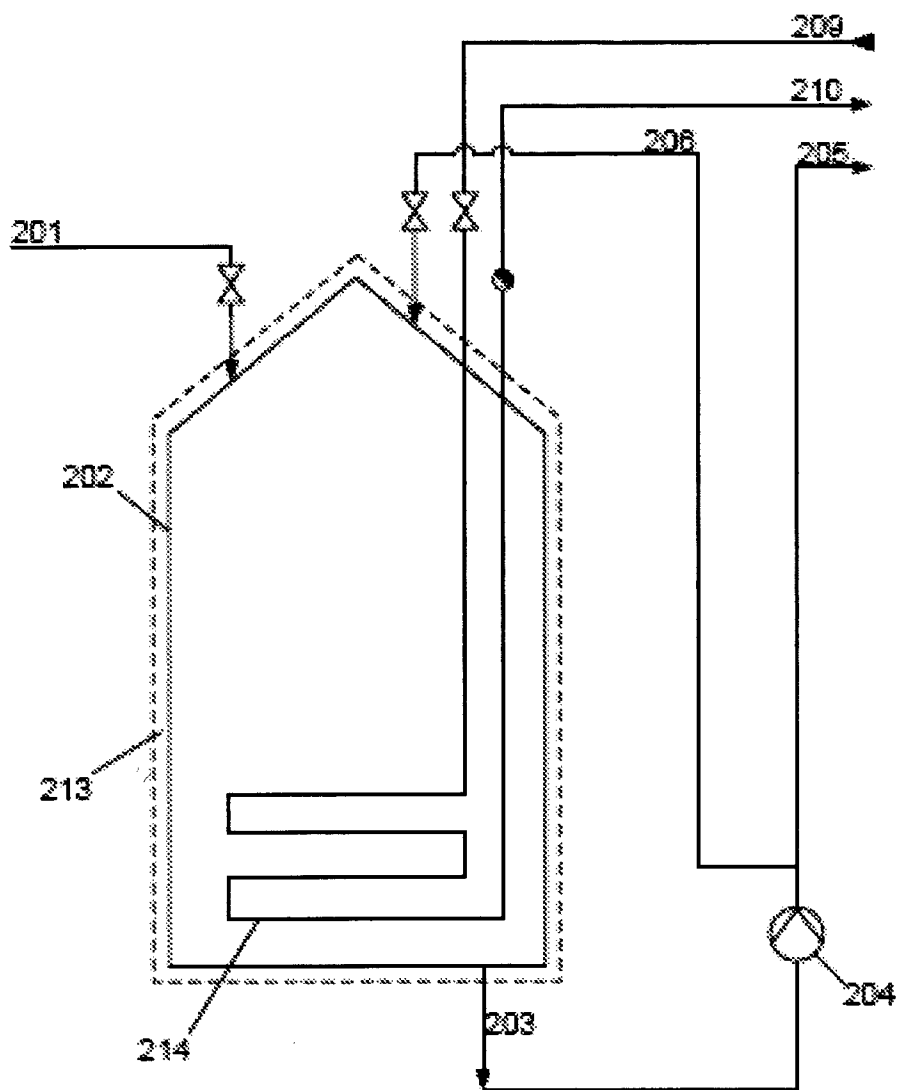


Figure 2

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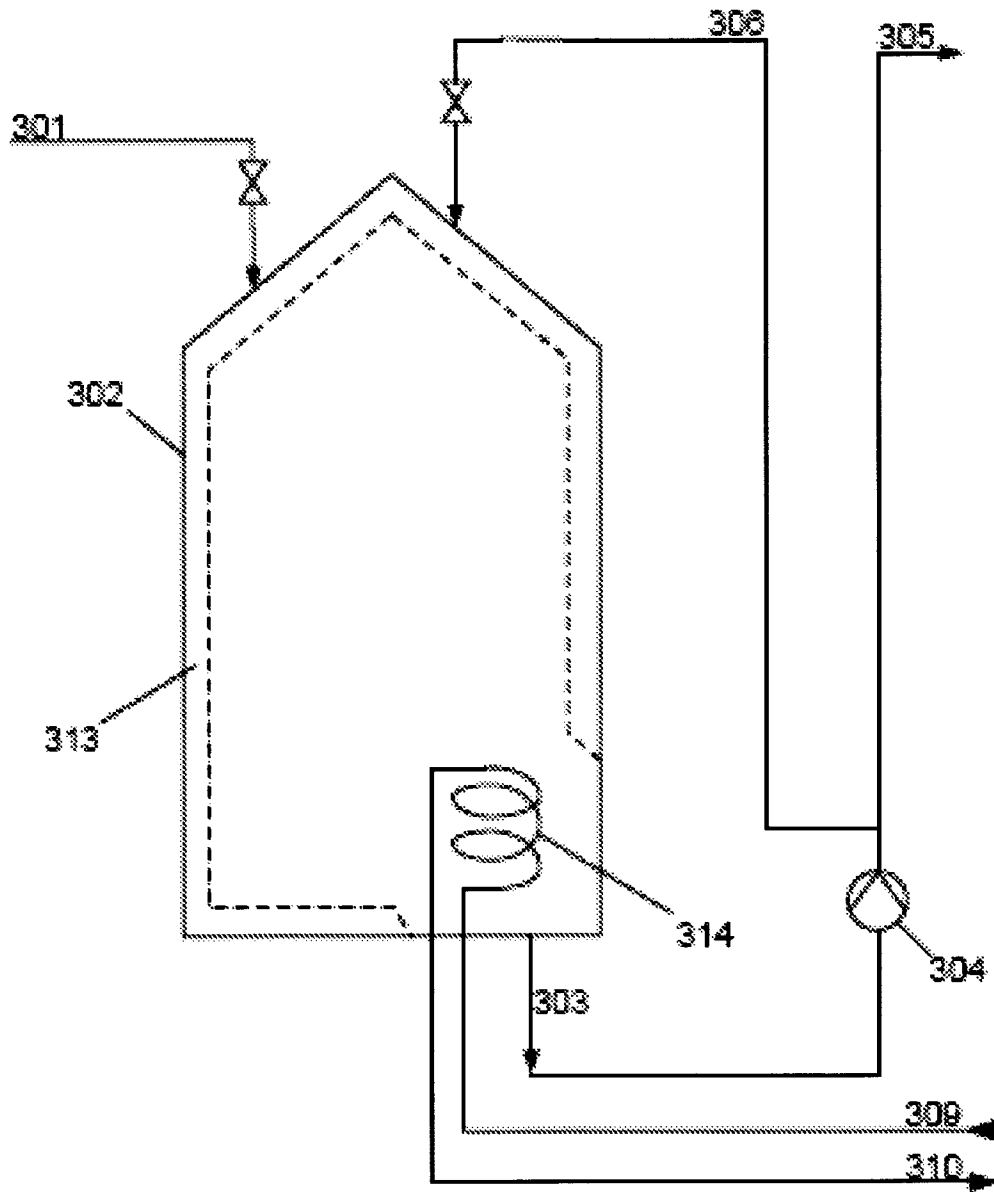


Figure 3

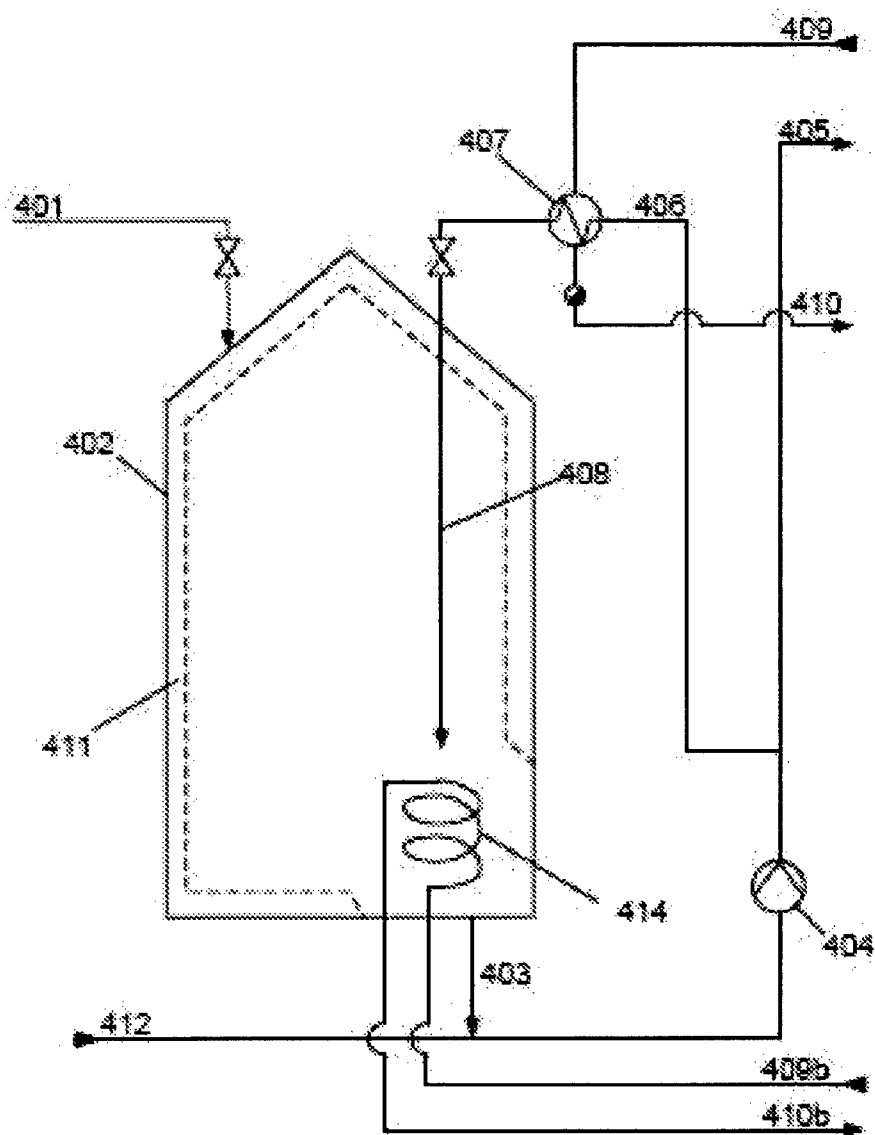


Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2012/050028

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65D88/74 B67D7/80
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65D B67D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/112677 A1 (CHADWICK THOMAS [CA]) 22 August 2002 (2002-08-22) paragraphs [0025] - [0028], [0036], [0042]; figures	1-18
X	DE 10 99 567 B (HANS G NISSEN) 16 February 1961 (1961-02-16) column 3, line 20 - column 4, line 2; figures	1,3,5-7, 10, 14-16,18
X	DE 11 33 744 B (HANS G NISSEN) 26 July 1962 (1962-07-26) the whole document	1,3,5-7, 10, 14-16,18
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

10 May 2012

Date of mailing of the international search report

25/05/2012

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Müller, Claus

INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2012/050028

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2012/050028

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