Title: METHOD AND APPARATUS FOR SUPPLYING FIBRE PULP TO A FORMATION SUPPORT

Abstract: In the method in order to supply fibre pulp to a formation support, fibre pulp is spread onto a wider area by guiding the flow coming from a supply pipe against a flow baffle (3c) located in closed space, which baffle guides and spreads the flow to a wide flow. The flow is directed towards a curved wall at the edge of the closed space, which wall directs the flow to be a substantially parallel flow to the other side of the flow baffle (3c) through a flow-through passage between the curved wall and the flow baffle (3c). The wide pulp flow coming from the other side of the flow baffle is kept fluidized by conveying the pulp flow to the flow channel (4) wherein energy is provided to the pulp flow for example via a wall limiting the flow channel after which the pulp is supplied from a wide slice (5) to a formation support (2).
ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). Published: Without international search report and to be republished upon receipt of that report (Rule 48.2(g)).
Method and apparatus for supplying fibre pulp to a formation support

The invention relates to an apparatus for supplying fibre pulp to a formation support according to the preamble of the appended claim 1. The invention also relates to an apparatus for implementing the method which is of the type presented in the preamble of the appended claim 8.

It is previously known a spreading apparatus that can be used to distributing fibre pulp supplied from a tube to a wider area. In this known apparatus the pulp is spread to a wider area with a flat casing placed perpendicularly to the tube and being parabolic in its outline. Inside the casing, a flow baffle is placed transversely to the supply direction to spread the pulp in a fan-like manner in the parabola shaped inner wall from which the pulp is directed to the other side of the flow baffle as a parallel flow and the pulp comes out from the gap in the straight edge of the casing as a wide front. Several of these kinds of units can be placed side by side. The structure is presented in detail i.e. in international patent application WO-03/016618 and Finnish patent FI-1 13671 and in the corresponding patent application WO-94/10380. The possibility to use the spreading device in forming i.a. wide webs is mentioned in the publications.

In the patent FI-1 13671 it is mentioned that the spreading apparatus produces homogenous web and with a high striking velocity to the flow baffle a higher consistency pulp having a concentration about 5 to 10% can be fluidized. In this case homogenous means the even basis weight of the web.

However, a sufficiently homogenous web-like or sheet shaped permanent product cannot be produced with apparatus having one or several above described spreading and distribution units. The problem is that fibre orientation in the web formed from the pulp is not even nor optimal, in other words the fibres are not sufficiently uniformly orientated in the travel direction of the web. Web formation requires
disintegration of fibre flocks in the pulp and control of fibre orientation in order to achieve sufficient web qualities. In addition, the dry matter profile of the pulp flow coming from the headbox must be controllable. The web must have a sufficient strength (MD, CD, and Z direction) in order to enable the supply through the whole machine, uniform, controllable fibre profile in MD, CD and Z directions as well as controllable moisture profile in MD and CD directions.

The arrangement according to the above-mentioned publications known as Paraformer headbox has only been used in pulp washers where the pulp being washed is supplied in between two wires or rolls, the web formed from the pulp travels supported all the time and it can be pressed to remove water. The web is made to suspension to form a pulp stock straight at the other end of the apparatus when a sufficient amount of water has been removed from it.

Quality problems arise especially if high-consistency pulp is to be used, in other words pulp having a fibre solids content as high as possible in order to minimize circulating water. The problem in supplying 4 to 20% high-consistency pulp to the product formation support is that fibres in these consistencies tend to very easily accumulate in a dense fibre network even if the pulp were successfully fluidized temporarily for example by letting the pulp strike the flow baffle in the above described spreading apparatus. The consistency of such pulps is, in fact, already in a range where a web tends to form when fibres are bound to each other. Thus the flaws occurring in the pulp remain in the final product weakening its qualities because the effect of the flaws cannot be removed anymore. Creating an uniform fibre orientation to a web formed from high-consistency pulp is especially difficult.

It is an aim of the invention to eliminate the drawbacks caused by processing high-consistency pulp and to present a method and apparatus which can be used to form wide, uniform quality and fibre orientation controlled webs. To achieve this aim, the method according to the invention is primarily characterized in what will be presented in the characterizing part of the appended claim 1.
The wide pulp flow coming from the spreading unit is kept fluidized by conveying the flow into a gap which is limited over the flow width by walls which form a flow channel ending in the slice of the headbox. Outside energy is provided in the pulp through the walls over a long distance and respectively through a long retention time of the pulp in which case the fibre pulp continuously stays fluidized, after which the pulp is supplied through a wide slice to the formation support. After drying phases product in the form of a web or sheet is created out of the web formed to the formation support. The web formed of the pulp can be dried with the help of heat up to a 90% dry matter content or even drier in the dryer section and thus sheets resistant to handling can be produced out of the dried web.

In the method high-consistency fibre pulp spread first into a wide front with the help of the spreading unit can be subjected to fluidization in which case the formation of flocks and the too early solidification of the fibre pulp is prevented. In addition, several spreading units can be used supplying each the pulp flow of a certain width at the respective location into the same gap tapering in the flow direction where the pulp is kept fluidized through the energy provided to the pulp. The energy is preferably brought with the help of the relative motion of the wall limiting the gap in the direction perpendicular to the flow direction and the pulp flow. The other wall can consist of for example a peripheral surface of a rotor wherein the rotor is arranged to rotate, and motion of its peripheral surface causes the said motion. The relative motion of the peripheral surface and the opposite motionless solid surface causes turbulence in the pulp flowing in the gap which prevents the formation of fibre network and flocks as well as breaks the already formed flocks.

According to an advantageous embodiment, the walls get closer to each other in the flow direction forming a flow channel tapering in a direction perpendicular to the width direction.
Turbulence can be increased by the design of the peripheral surface and solid surface whereby they can for example form successive local constrictions and expansions in the flow channel.

With the help of this method a water-based, high-consistency pulp can be distributed over a wide area in order to form a web-like product so that the water leaves the pulp through the formation support. Pulp can be kept homogenous and in addition to the basis weight distribution, its fibre orientation can be controlled at the same time so that the qualities of the finished product would be as desired.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 shows an apparatus according to the invention in a larger entity wherein the fibre pulp supplied by the apparatus is produced to a large-surface product,

Fig. 2 shows an apparatus according to the invention in a cross-section seen in a direction perpendicular to the main pulp flow direction,

Fig. 3 shows an isometric view of the apparatus, the end wall of the fluidization chamber removed, and

Fig. 4 shows, as seen in the travel direction of the formation support an apparatus which has several spreading units.

Figure 1 shows the principle of manufacturing a product in the form of a continuous web W by the method according to the invention. Water-based, high-consistency fibre suspension is supplied from a pulp container with the help of a pump (not shown) through a distribution pipe 9 and a supply pipe 7 to a headbox which consists of a spreading unit 3 and fluidization camber 1. From the fluidization chamber 1 the pulp is discharged through a slice to a formation support 2, such as a wire, that runs continuously forward and is permeable to water. The
fibre pulp has a consistency of 4 to 20%, in which range the fibre pulp can be called high-consistency pulp. The consistency of the pulp is preferably in the range from 5 to 15%. The fibre pulp carried along with the formation support 2 is gradually dewatered through the formation support 2, wherein its dry matter content is increased, and the fibrous product W starts to form into a cohesive texture in which the fibres are arranged in their fixed positions with respect to each other and are bound to each other. Since the water content of the pulp coming from the headbox to the formation support is relatively low, less water is removed at this step A of web formation than when using pulp of normal consistency, and the quantity of circulating water is small. The circulating water filtered through the wire is illustrated with an arrow in Fig. 1.

After the formation step, the web W that is already cohesive without support and is run forward as an unsupported web, is guided to a pressing step B, in which it is dewatered by mechanical pressing, and finally into a drying step C, in which water is removed by evaporating with heat. The web W formed in this way may be a pulp web, a cardboard web or a paper web.

The invention is particularly well suited for producing pulp products wherein the machine in Fig. 1 is a pulp drying machine. The pulp web formed by the machine can be reeled up to form a roll or cut in sheets.

The depiction of Fig. 1 is intended to be illustrative only, and the positions of the various parts and the runs of the formation support 2 and the other means conveying the web W may vary, depending on the machine and on the product to be manufactured.

Figure 2 shows the structure of the headbox according to the invention in more detail, in a vertical section taken in the direction of the pulp flow and the running direction of the web to be formed. High-consistency pulp is supplied to the headbox through the supply pipe 7. The pulp first enters the spreading unit 3 wherein the pulp is spread from the flow in the shape of the cross section of the supply pipe 7 to a wide,
thin flow which continues from the spreading unit to the inlet channel 8 of the fluidization chamber 1. The inlet chamber continues as a flow channel 4 gradually tapering towards a slice. The pulp is kept fluidized in the flow channel in the manner described herein below.

The pulp spreading unit 3 is a flat casing placed perpendicularly to the supply pipe 7. The outlines of the casing in the inlet direction of the pulp are best shown in the Fig. 3. The casing has a straight edge and a curved edge, wherein the supply pipe 7 is located at the level of the straight edge. The inside of the casing is divided by a flow baffle 3c to two chambers, an inlet chamber 3a at the side of the supply pipe 7, and an outlet chamber 3b leading to the fluidization chamber. Flow baffle 3c prevents the direct flow-through at the location of the straight edge but leaves a curved flow-through passage between chambers 3a and 3b which passage is limited by the curved edge of the casing and the edge of the flow baffle 3c complying with this shape.

The high-consistency pulp coming from the supply pipe 7 strikes the flow baffle 3c which forces the flow to spread radially in the inlet chamber 3a towards the curved edge. A wall forming the curved edge of the casing and extending in the direction of the flow baffle 3c forces the pulp spread to the edge to go via the flow-through passage to the outlet chamber 3b to the other side of the baffle 3c. In the outlet chamber 3b the pulp proceeds as flow front having the width of the straight edge and continues directly to the inlet channel 8 of corresponding width of the fluidization unit and onwards to the flow channel 4 of corresponding width. The shapes of the curved edge of the casing and the flow-through channel, respectively, can be a parabolic. In this case the term curved also means other shapes, also polygons that form curves. The structure and principle of the spreading unit is the same as in the above-mentioned publications illustrating the Paraformer headbox.

After the inlet channel 8 the flow continues in the fluidization chamber 1 to the flow channel 4 which is formed between a cylinder 6 arranged to rotate in a chamber and a curved wall 7 opposite to its peripheral
surface. The distance between the walls can remain constant or they may get closer to each other in the flow direction. In order to implement the latter the wall 7 has a larger radius of curvature than the cylinder, and it approaches the cylinder 6 in the direction of flow of the pulp, resulting in a tapering flow channel with a generally curved form. The wall 7 of the flow channel is immobile, even though it may be movable in the direction of radius of the cylinder 6, to adjust the "gap" between the cylinder 6 and the wall 7. The cylinder 6 can also be called "rotor", and the wall 7 immobile with respect to it can also be called "stator". In the flow channel 4, pulp is supplied along the whole length substantially over the machine width, and the terms "narrowing" and "tapering" refer in this context to the reduction of the dimensions in a direction perpendicular to the machine width and the flow direction, that is, in the direction of the radii of curvature of the cylinder and the wall. Fig. 2 illustrates the shape of the flow channel over the whole machine width.

In Fig. 2, the flow channel 4 extends in an angle of about 90 degrees with respect to the flow of the outlet chamber 3b and the inlet channel 8 but the above-mentioned angle may vary within a large range; that is, it may range from 0 to almost 180 degrees. The flow channel 4 may thus also start as a direct extension to the inlet channel 8, or it may extend in a sharper angle than 90 degrees.

The cylinder 6 does not substantially affect the pulp flow in the flow channel 4 towards the slice 5, but this is obtained by means of a feeding device placed before the spreading unit. Thanks to this, the rotary movement of the cylinder 6 effectively exerts energy to the pulp flowing towards the slice 5, fluidizing it and preventing the formation of fibre bundles and the fixation of fibres with respect to each other. To boost the shearing forces exerted on the pulp, the peripheral surface of the cylinder 6 may be provided with a three-dimensional surface pattern.

At the terminal end of the flow channel 4, the wall 7 may be provided with successive elevations or ridges in the direction of the axis of rotation of the cylinder 6, forming successive constriction or expansion
points in the cross-sectional area of the flow. In this area, the average distance of the wall 7 from the cylinder 6 may be constant, and the design of the wall surface may be used to effectively maintain turbulence also at the terminal end of the flow channel. The elevations or ridges may extend in similar configuration over the whole machine width, or they may be discontinuous and staggered. It is also possible that the wall 7 is provided with separate knobs which form a corresponding design to maintain turbulence.

As the cross-sectional area of the flow of the channel 4 is reduced in the flow direction of the pulp due to the fact that the wall 7 approaches the cylinder 6 in the direction of its radius, this means that with a constant volume flow rate, the linear flow velocity of the pulp is increased. It is a requirement for turbulence that the peripheral speed of the cylinder 6 based on a rotary movement differs from this linear flow velocity over the whole length of the flow channel. When the cylinder 6 rotates in the direction of the pulp flow (counter clockwise in Fig. 2), its peripheral speed should exceed the greatest linear velocity of the pulp based on the volume flow in channel 4. Turbulence is also generated, if the peripheral speed of the cylinder is slower than the linear velocity of the pulp in the same direction. It is also possible that the cylinder 6 rotates against the pulp flow direction (clockwise in Fig. 2), wherein it also effectively gives up energy to the pulp flowing through the flow channel 4.

The rotational speed of the cylinder 6 is dependent on the consistency of the pulp in such a way that the higher the consistency of the pulp to be supplied, the higher the rotational speed is to be adjusted. It can be shown that at a certain rotational speed, a fluidization point is achieved, at which the pulp at a given consistency starts to act like water. The cylinder 6 or rotor does not have an essential pumping effect, but its function is only to exert shearing forces on the pulp flowing in the channel 4. The high-consistency pulp supplied to the headbox does not flow by its own weight but is has to be introduced there by a feeding device providing forced flow. The actual volume flow through the spreading unit 3 and the fluidization chamber 1 is produced by a high-
consistency pump that supplies pulp into the headbox, which pump may be a displacement-type pump or a fluidizing pump. The pump supplies pulp into the headbox through the pipes 9, 7 without any buffer tank or the like in between.

Fig. 2 shows best how at the terminal end of the flow channel 4, there is a sharp turn where the short terminal part of the flow channel following the peripheral surface of the cylinder turns away from the cylinder, forming a short slice channel which ends in the slice 5. The terminal part of the channel is directed away from the cylinder in the direction of the radius of the cylinder, but the turn may be sharper or gentler, greater or smaller than 90°. This short terminal part of the flow channel 7 is also curved in the direction opposite to the curvature of the initial part, gradually into the direction of the formation support 2. The pulp is discharged from the slice 5 in a direction opposite to the direction of movement of the periphery of the cylinder 6. By means of the sharp turn at the end of the flow channel 4, a quick change of direction is obtained in the fibre pulp flowing therein. The quick turn causes shearing forces and frictional forces in the flowing pulp and thereby maintains fluidization. If the cylinder 6 rotates against the flow in the channel 4, the pulp will be discharged from the slice 5 in the direction of movement of the periphery of the cylinder 6.

Furthermore, it is possible that there is a gentler or smoother change of direction at the end of the flow channel, or that the direction is not changed at all. In this case, the direction of the terminal part 4a ending in the slice 5 deviates only a little or not at all from the direction of the flow channel 4. In these cases, the flow channel 4 may be arranged in a mirror-like manner with respect to the rotor 6 in Fig. 2, the position of the slice channel 4a and the running direction of the wire remaining unaltered.

The figure also shows the path of the formation support 2 that is permeable to water, past the head box. The lower surface of the fluidization chamber 1 forms a first sliding surface that guides the formation support towards the slice 5 and ends at the lower edge of the
slice 5. The upper edge of the slice extends as a second sliding surface in the running direction of the formation support 1. Above-mentioned surfaces, especially the first sliding surface, are preferably convexly curved in order to direct the formation support 2, as it is shown in the Fig. 1.

In Fig. 4 it is shown how one or several spreading units can be side-by-side in the width direction in the headbox of the machine, three of them in the case of the figure. The spreading units 3 have been connected to the same fluidization chamber 1, whose width and the width of the flow channel 4 correspond to the sum width of the parallel flows caused by the spreading units. Pulp is supplied to each unit 3 through an individual supply pipe. Supply pipes can be connected to the same distribution pipe 9 in to which pulp is supplied with a feeding device such as a high-consistency pump. Thus, the outlet chambers 3b of different units supply simultaneously parallel pulp flows to the fluidization chamber 1 to the common wide inlet channel 8 and flow channel 4 wherein the pulp flows combine to a pulp flow forming a full-width web W. Flows to different spreading units 3 can be adjusted independently for example with the flow control means arranged to the supply pipes 7 according to a principle that is known in the above-mentioned international patent application WO-94/10380.

One or several spreading unit 3 connected to the fluidization chamber 1 can locate in other positions than it has been shown in Fig. 2 and 3. The outlet chamber/s 3b can also be at an angle in relation to the outlet channel 8 of the fluidization chamber 1.
Claims:

1. A method for supplying fibre pulp to a formation support wherein the fibre pulp is spread to a wider area by guiding the flow coming from a supply pipe against a flow baffle (3c) located in a closed space, which baffle guides and spreads the flow to a wide flow which is directed towards a curved wall at the edge of the closed space, which wall directs the flow to be a substantially parallel flow to the other side of the flow baffle (3c) through a flow-through passage situated between the curved wall and the edge of the flow baffle (3c), characterized in that the wide pulp flow coming from the other side of the flow baffle is kept fluidized by conveying the pulp flow to a flow channel (4) wherein energy is provided to the pulp flow for example via a wall limiting the flow channel after which the pulp is supplied from a wide slice (5) to a formation support (2).

2. The method according to claim 1, characterized in that the pulp flow is introduced in a flow channel (4) tapering in a direction perpendicular to the width of the pulp flow.

3. The method according to claim 1 or 2, characterized in that energy is provided to the pulp flow with the help of motion one of the walls of the flow channel (4), the velocity of which motion differs from the pulp flow velocity in the flow channel (4).

4. The method according to claim 3, characterized in that the wall moving at a velocity different from the pulp flow velocity consists of the peripheral surface of a cylinder (6) rotating in a fluidization chamber.

5. The method according to any of the preceding claims, characterized in that energy is provided to the pulp flow with the help of the surface design of one or both walls.
6. The method according to any of the preceding claims, **characterized** in that the consistency of the fibre pulp to be supplied is 4 to 20%, advantageously 5 to 15%.

5. The method according to any of the preceding claims, **characterized** in that the pulp is supplied simultaneously as separate flows against two or several flow baffles (3c) creating spread flows which are combined and guided to the flow channel (4).

10. The method according to any of the preceding claims, **characterized** in that after drying phases, a web or sheet shaped product is manufactured out of the web (W) formed to the formation support (2).

9. An apparatus for supplying fibre pulp to the formation support which comprises a spreading unit (3) of the fibre pulp into which unit a supply pipe (7) of the fibre pulp is connected and which comprises a closed space, a flow baffle (3c) which limits inside the space an inlet chamber (3a) on the side of the supply pipe (7) and an outlet chamber (3b) on the outlet-side of the fibre pulp, wherein the inlet and the outlet chamber are connected to each other by a flow-through passage between the edge of the flow baffle (3c) and a curved wall limiting the space in order to guide the flow directed and spread by the flow baffle (3c) to the side of the outlet chamber (3b) to be a substantially parallel flow, **characterized** in that a fluidization chamber (1) follows the outlet chamber (3b) in the flow direction of the pulp flow, which fluidization chamber (1) comprises a flow channel (4) comprising means for providing energy to the pulp flow, said flow channel ending in a slice (5) in order to supply the pulp to the formation support (2).

10. An apparatus according to claim 8, **characterized** in that the flow channel (4) tapers towards the slice (5) in a direction perpendicular to the width direction of the pulp.
11. An apparatus according to claim 9 or 10, **characterized** in that the wall limiting the flow channel (4) is arranged to provide energy to the pulp flow.

12. An apparatus according to claim 11, **characterized** in that the wall limiting the flow channel (4), which is arranged to provide energy, is the peripheral surface of a cylinder (6) arranged to rotate in the fluidization chamber.

13. An apparatus according to claim 11 or 12, **characterized** in that the wall limiting the flow channel (4) has a surface design that is arranged to provide energy to the pulp flow.

14. An apparatus according to claim 13, **characterized** in that the surface of the wall limiting the flow channel (4) forms successive constriction or expansion points in the cross-sectional area of the flow.

15. An apparatus according to any of the preceding claim 9 to 14, **characterized** in that the terminal end of the flow channel (4) is provided with a sharp turn where the flow channel turns into a short terminal part ending in the slice (5).

16. An apparatus according to any of the preceding claim 9 to 15, **characterized** in that there are two or more spreading units (3) side-by-side that are connected to the same fluidization chamber (1).

17. An apparatus according to any of the preceding claims 9 to 16, **characterized** in that the supply pipe (7) of the spreading unit (3) is connected to a source of fibre pulp having the consistency of 4 to 20%, advantageously 5 to 15%.