Title: A METHOD AND A SYSTEM FOR MAKING A FIBRE-containing PRODUCT

Abstract: The present invention relates to a method and system for producing fibrous material. In the method, fibrous suspension is supplied onto a wire in such a way that a web is formed and the formed web is dried. Further in the method, after the web formation, the web is kept at least partly in contact with said long wire continuously until the dry matter content of the web exceeds a predetermined limit value, in any case at least to the press section. A system for producing fibrous material in a web forming machine comprises fastening members for placing a wire in said machine in such a way that the wire runs continuously from at least the web forming section substantially to the press section.
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A METHOD AND A SYSTEM FOR MAKING A FIBRE-CONTAINING PRODUCT

Field of the invention

The invention relates to a method for making a fibre-containing product. The invention also relates to a system for making a fibre-containing product.

Background of the invention

Fibre-containing sheets with a relatively large content of nanofibrillated cellulose (NFC) has been found to have properties of particular interest. The relative proportion of the surface of a piece with respect to the volume of the piece increases when the piece becomes smaller, for which reason the properties of nanoparticles often differ to a great extent from the properties of macroscopic pieces. Properties which can be achieved with nanofibrillated cellulose and are of interest to the industry, include, for example, particularly high tensile strength, very low porosity and partial translucency. Among other things, these properties make nanofibrillated cellulose a sought-after raw material, and products containing it would have a variety of industrial uses.

For the present, the application of nanofibrillated cellulose as a raw material for a fibrous product, such as paper or paperboard, is still limited by various problems in practice. Nanofibrillated cellulose is a gel-like material even at low consistencies, and the removal of water from fibre materials with a high content of nanofibrillated cellulose is often slow. Furthermore, nanofibrillated cellulose sticks easily to the wire used, because small particles of nanofibrillated cellulose adhere particularly strongly to the wire cloth, which may cause problems in the manufacturing process of the fibrous product containing nanofibrillated cellulose; due to the strong adherence of the particles, the detachment of the web from the wire requires a relatively great force. Problems caused by the adherence to the wire are often pronounced because wet nanofibrillated cellulose has a relatively low internal strength, for which reason the force required for detaching the web from the wire may be greater than the internal strength of said wet fibre suspension. Particularly in the case that the content of nanofibrillated cellulose in the pulp suspension is
relatively high, the internal wet strength of the web may easily remain so low in relation to the forces between the web and the wire that the detachment of the intact web from the wire is particularly problematic.

In papermaking processes of prior art, the web is normally detached from the wire at a very early stage when the web still has a low dry matter content, for which reason the addition of nanofibrillated cellulose into the pulp suspension in web forming machines may lead to particularly low running speeds of the web forming machines, which, in turn, may reduce substantially the cost efficiency of the grade to be run. Furthermore, this problem may be pronounced because dewatering of the web that contains nanofibrillated cellulose may be slower than normal.

In addition to the problems mentioned above, an additional problem in the use of nanofibrillated cellulose may be the fact that the present wires commonly used in production are normally relatively coarse for small particles, wherein the degree of retention of nanofibrillated cellulose may remain at a particularly low level when such wires are used.

Under laboratory conditions, said problem of detaching the pulp from the wire and the problem of the density of the wire have been resolved, among other things, by using a particular small mesh wire, a so-called fine mesh wire, whose density may be, for example, 200 mesh. In this way, a sufficiently high degree of retention of nanofibrillated cellulose is normally achieved. In addition to first making the fibre sheets with a high content of nanofibrillated cellulose on the fine mesh wire, said fibre sheets have also been dried, under laboratory conditions, on top of the fine mesh wire until the dry matter content of the sheets has increased. The dry strength of sheets that substantially contain nanofibrillated cellulose is considerably higher than their wet strength, so that a sheet dried to a sufficient degree can normally be detached from the long wire without problems.

The fibrous web tends to shrink when it dries. Because the web-like product is typically kept tight in the longitudinal direction of the web, problems in the drying shrinkage normally appear in the cross direction of the web. These problems may occur both in the manufacture of conventional fibrous products
and in the manufacture of fibrous products that contain substantially nanofibrillated cellulose. Because the drying shrinkage takes place when the web dries, it might be possible to overcome the problem by operating in such a way that the web would be longer than normally in contact with the wire cloth, on which the web is formed.

In large scale, for example in paper factories, there has been no practical solution to these problems mentioned above. Thus, there would be a need for solutions, by which a fibrous product could be made by better approaches in the product processes in various web forming machines or corresponding machines.

Brief summary of the invention

The aim of the present invention is to find a solution to the above-mentioned problem caused by the low dry matter content in such a way that the fibrous product is kept for a sufficiently long time in contact with the wire cloth, on which the web is formed. According to an advantageous embodiment, the aim is to alleviate the problem of detaching the fibrous web that contains nanofibrillated cellulose, from the wire in the manufacture of a web-like fibrous product by drying the web to a sufficient extent before the web is detached from said wire. In another advantageous embodiment, the aim is to reduce and/or to control the drying shrinkage of the web in the cross direction.

In the solution according to the invention, the detachment of the web from the wire can be performed at such a stage where the dry matter content of the web reaches a predetermined limit value. In an advantageous embodiment, this is achieved when the internal strength of the web is greater than the forces effective between the web and the wire. In this way, the web can remain intact when detached from the wire. According to an advantageous embodiment, considerable amounts of nanofibrillated cellulose can be included in the product in such a way that the web can still be detached from the wire without breaking the web. According to another advantageous embodiment, the web can be detached from the web forming wire when the
dry matter content of the web is such that the drying shrinkage of the web
in the cross direction has been reduced to a desired extent.

According to an embodiment of the invention, the web is supported on at
least one wire from the formation of the web to at least the press section, for—example past at least the first press nip of the press, preferably to the drying
section of the web forming machine. In this case, the web is supported by
the same at least one wire substantially continuously all the way from the web
formation to at least said stage. In one embodiment, the web to be made is
supported by at least one and the same wire substantially to at least half-way
of the press section. According to one embodiment, the web is supported by
the same wire from the formation of the web at least past the first drying
group in the drying section, preferably substantially to half-way of the drying
section. In one embodiment, the web is supported by the same wire past the
whole drying section, for example to the point where the web is close to the
first calender, the coating unit or the machine roll of the web forming
machine.

In one embodiment, the web is supported by only one long wire, that is, on
only one side of the web. In an advantageous embodiment, in which a long
wire is used, the mesh size of said long wire is advantageously selected in
such a way that it is possible to improve the retention of the fibre material that
contains nanofibrillated cellulose. In one embodiment of the invention, the
web is supported by wires that are denser than the wires commonly used in
papermaking, so-called fine mesh wires. In one embodiment example, these
fine mesh wires are provided on both sides of the web.

In one embodiment of the invention, the long wire in contact with the web is
supported by separate wires which may be coarser than the long wire. In this
case, the long wire is preferably placed between the pulp and the normal
wire. Several of these so-called normal wires can be placed along the whole
path travelled by the long wire, or they can be placed, for example, in the
drying section only. In an advantageous embodiment, the web is supported
by long wires on both sides at least all the way to the drying section, and
normal wires are either not applied at all or they are applied in the drying
section only.
The method for making a fibre product according to the present invention is primarily characterized in what will be presented in claim 1. The system for making a fibre product according to the present invention is primarily characterized in what will be presented in claim 6.

**Description of the drawings**

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

- Fig. 1: is a side view showing an example embodiment of a web forming machine with a wire solution according to an example, and
- Fig. 2: shows an advantageous detail of the wire solution according to the embodiment shown in Fig. 1.

**Detailed description of the invention**

In this application, a web forming machine refers to a machine for making a web that contains fibrous material. Such a machine may be, for example, a paper machine, a paperboard machine, or another corresponding machine.

A web refers to a planar product running in the form of a continuous web whose basic structure is a mesh formed at least partly of fibres or parts of fibres. At least some of the fibres contain cellulose. In addition, the web may contain various quantities of other substances, such as various fillers, surfactants and additives. Furthermore, water is normally used in the manufacturing process. The final product of the manufacturing process may be, for example, paper, paperboard, thin wood-plastic composite, or a corresponding product.

A fine mesh wire refers, in the present application, to a dense wire with a mesh number of at least 130, 140 or 150. The fine mesh wire may also be denser, such as, for example, a wire with a mesh number of at least 180, at least 200 or at least 220. A normal wire refers, in the present application, to a
wet wire or a drying wire of prior art, normally used in a web forming machine. The mesh number indicates the number of filaments in a filter, such as in a wire, per one inch.

A long wire refers, in the present application, to a wire that extends substantially from the web forming section (wire section) to at least the press section, preferably to the first press nip in the press section.

Normal wires 9 refer to commonly used wires, including both wet wires and dry wires. Normal wires 9 can also be called second wires 9 in the present application.

Nanofibrillated cellulose (NFC) refers to such fibrous material in which single microfibrils have been separated from each other. Nanofibrillated cellulose particles typically have a length not greater than 1 μm, and their diameter is smaller than 1 μm, typically from about 2 nm to 200 nm. The dimensions of nanofibrillated cellulose particles are dependent on the method of production of the nanofibrillated cellulose. Contrary to conventional grinding of cellulose, in the production of nanofibrillated cellulose the aim is to crush the cellulose fibres. In its appearance, nanofibrillated cellulose is typically transparent, gel-like material.

Figure 1 shows an advantageous embodiment of the invention. Figure 2 shows an advantageous detail of the wire solution according to the embodiment of Fig. 1. Figures 1 and 2 show a web forming machine 1, a headbox 2, a web forming section (wire section) 3, a press section 4, a drying section 5, a calender 6, a reel-up 7, a long wire 8, normal wires 9, and a web 10.

In the solution according to the invention, one or more normal wires 9 may be provided, but it is also possible that the solution according to the invention does not have any normal wires 9. The normal wires 9 can be left out particularly from those sections of the machine, in which there is at least one long wire 8. In an advantageous example, the long wire 8 is preferably a fine mesh wire. According to an advantageous example of the invention, normal wires 9 can be used in the web forming machine substantially in the same positions as the long wires 8, in such a way that the normal wire is placed at
least partly between the long wire 8 and the rolls of the web forming machine. In this way, the normal wire 9 may prevent the wear of the long wire 8 or long wires 8. This may be advantageous because the long wire 8 may be a relatively expensive wire, in which case it is often less expensive to replace the normal wires 9 than the long wires 8.

The web 10 is typically supplied from the headbox 2 to the web forming section 3. In the machine according to the invention, there is at least one long wire 8, and the suitable number of long wires is normally dependent on the type of the web 10 forming machine 1. Normally, the number of long wires 8 is exactly one or exactly two, depending on the type of the web forming machine 1. The long wire 8 can be supported by a normal wire 9(a) in the web forming section 3. In this case, the normal wire 9(a) can delay the wear of the long wire 8.

From the web forming section 3, the web 10 is carried, supported by at least one long wire 8, forward in the drying process typically to the press section 4, where the long wire 8 can be supported by normal wires 9b, 9c of the press section, in which case said normal wires 9b, 9c can delay the wear of the long wire 8. In the press section, one or both of the normal wires 9b, 9c can also be eliminated from the solution according to the invention, if they have been replaced by the long wire 8. In an advantageous embodiment, the long wire 8 is placed to support the web 10 from the web forming section 3 past the first press nip of the press section 4, after which the long wire is led to the web forming section again. According to another advantageous embodiment, the long wire 8 is placed to support the web past the second press nip and/or the third press nip in the press section 4, after which the web is detached from the long wire 8, which long wire 8 is then led to the web forming section 3.

From the press section 4, the web 10 is advantageousled further to the drying section 5. In an advantageous embodiment, the web 10 is led, supported by at least one and the same long wire 8, from the web forming section 3 to the drying section 5. In an advantageous embodiment, the long wire is placed in such a way that the web 10 is in contact with the same long wire 8 from the web forming section 3 all the way to the desired drying group in
the drying section 5, such as the first drying group, the second drying
5 group, the third drying group, the fourth drying group, or the fifth drying
group. The web 10 is then detached from the long wire 8, after which the web
is led forward in the process, wherein it can be, for example, in contact with
5 normal wires 9, as in conventional papermaking. The drying section 5 may be
provided with one or more normal wires 9d-9g in addition to the long wire 8.
At least some of the normal wires 9 may be provided substantially in the
same location as the long wire 8 in the drying section 5 of the web forming
10 machine 1, being placed between the long wire 8 and one or more rolls of the
web forming machine 1, wherein said normal wires 9 may delay the wear of
the long wire 8.

One long wire 8 may be provided, in which case the long wire 8 may be
placed on one side of the web 10, or, for example, two long wires 8 may be
15 provided in such a way that the first long wire 8 is placed on one side of the
web 10 and the other long wire is placed on the other side of the web. If two
long wires 8 are provided, normal wires 9 may be placed, for example, in
connection with one long wire 8, if desired, or in connection with both long
wires 8. In some cases, the placement of normal wires 9 in connection with
both long wires 8 may be preferable, for example to prevent the wear of the
long wire 8. If there are two long wires 8 in the machine, that is, preferably
20 one long wire 8 on each side of the web, the detachment of the web from the
long wires 8 may take place either substantially at the same time or substan-
tially at different times, that is, one by one in such a way that the web 10 is
first detached from one long wire 8 and then from the other long wire 8. In
25 many cases, if only possible in view of the functionality of the process, it is
more desirable to use only one long wire 8, to minimize the costs. In some
cases, however, it is necessary to use two long wires 8 on at least part of the
drying length of the web. This kind of a situation may come up, for example,
in connection with a so-called gap former.

The long wire 8 is placed in the web forming machine 1 advantageously in
30 such a way that the web 10 is in continuous contact with the long wire 8 at
least from the web 10 forming section 3 to the press section 4 of the web 10,
for example to half-way of the press section, or all the way to the drying sec-
35 tion 5. If the machine 1 is provided with normal wires 9 in contact with the
long wire 8, the long wire 8 is placed preferably in such a way that it is between at least one normal wire 9 and the web 10 on at least one side of the web 10. The long wire 8 and the web 10 are preferably kept in contact with each other until the web 10 is sufficiently dry to be detached from the long wire 8. The desired dry matter content of the web can be determined, for example, in such a way that the web is intact when detaching from the wire, and/or in such a way that the drying shrinkage in the cross direction of the web can be prevented. After this, the web 10 can be supported by normal wires 9, if necessary.

The number and locations of possible normal wires 9 may vary even to a great extent from some advantageous embodiments of the invention described above. An essential aspect is that the long wire 8 is placed in the web forming machine 1 in such a way that said long wire supports the web 10 in a continuous manner from at least the web forming section 3 to the press section 4, more preferably to the drying section, or, for example, all the way to a possible first calender or machine roll. Usually, inserting the long wire 8 through the calender 6 is not necessary for the desired final result, and in view of the desired final result it may be preferable not to convey the long wire 8 through the calender 6.

Preferably, the long wire 8 is provided with cleaning members for cleaning the long wire 8 or part of it during its each lap. This can be implemented, in practice, for example by installing suitable cleaning members of prior art, such as jets, for cleaning the long wire 8. Preferably, this cleaning of each point of the long wire 8 always takes place after the web 10 has been detached from the long wire 8 but before said point of the long wire 8 is at that point of the web forming machine again where the web 10 is supplied to the web forming section (wire section) of the web forming machine.

To secure the efficient drying of the web 10, it is often advantageous to provide the web forming section 3 and/or the press section 4 with some separate means or devices for accelerating the drying. These may be means or devices of prior art, such as, for example, suction boxes and/or suction rolls. Particularly in the case of two wires on top of each other, there may be a
need to provide more such devices than normally, and/or these devices may be more efficient than normally.

The web 10 can be detached from the long wire 8 at the stage where the dry matter content of the web 10 is sufficient. The dry matter content may be sufficient, for example, when it is at least 8 wt-%, 9 wt-%, 10 wt-%, 11 wt-%, 12 wt-%, 13 wt-%, or 14 wt-%, but e.g. due to the structure of the wire, it may also be advantageously at least 15 wt-%, 18 wt-%, 20 wt-%, 25 wt-%, 30 wt-%, 40 wt-%, or at least 60 wt-%. The suitable dry matter content is influenced, among other things, by the apparatus for drying the web and particularly by the properties of the wire in contact with the web.

In one example, thanks to the invention, the content of nanofibrillated cellulose in the pulp suspension can be set high, wherein it is possible to achieve, for example, the desired properties in the final product. Thus, by applying the long wire solution according to the invention, it is also possible to include relatively large quantities of nanofibrillated cellulose in the pulp, for example in such a way that at least 10 wt-%, at least 20 wt-%, at least 30 wt-%, at least 40 wt-%, at least 50 wt-%, at least 60 wt-%, or at least 70 wt-% of the dry matter of the web 10 consists of nanofibrillated cellulose. If necessary, for example when required by the properties of the final products, it is possible to include even so much nanofibrillated cellulose that at least 80 wt-% or even at least 90 wt-% of the dry matter of the web 10 consists of nanofibrillated cellulose. In some cases, the solution of the invention may be more useful when the content of nanofibrillated cellulose in the web increases, because in this case the detachment of the web from the wire may become more difficult than before. By the solution according to the invention, it may be possible to prevent partly or even totally a situation in which the machine technical properties would become a hindrance to increasing the quantity of nanofibrillated cellulose.

According to an example solution, supporting the web to the wire by significant forces may prevent the drying shrinkage of the web in the cross direction, when the supporting is continued for a sufficiently long time or even substantially along the whole drying path of the web. Particularly in this case, the invention may also be useful in the manufacture of a so-called normal
fibrous web, among other things for controlling the drying shrinkage in the cross direction. In the manufacture of a web that contains nanofibrillated cellulose, an additional advantage can be achieved in that the addition of nanofibrillated cellulose has often been found to have an effect that increases the drying shrinkage, particularly in the cross direction of the web. When solutions of prior art are used, the drying shrinkage of a web of said kind in the cross direction may thus even exceed 10%. Most of the drying shrinkage often takes place at the end of drying, in which case keeping the web on the long wire 8 may prevent the drying shrinkage substantially, particularly when it takes place from the web forming section substantially to the end of the drying section.

Even though the invention is particularly important for pulps that contain nanofibrillated cellulose, the invention can also be applied in connection with such fibrous pulps which do not contain nanofibrillated cellulose. In this way it may be possible to substantially reduce web breaks, for example in the press section. Furthermore, the control of the shrinkage of the web in the cross section may be facilitated. The invention is suitable for application in various web forming machines, and the above-presented examples are not intended to restrict the invention. Thus, the invention is not limited solely to the examples presented in Figs. 1 and 2 and in the above description, but the invention is characterized in what will be presented in the following claims.
Claims:

1. A method for producing paper, paperboard or corresponding fibre material, in which method
- a pulp suspension is supplied onto a first wire (8) in such a way that a web (10) is formed, and
- the formed web (10) is dried,
characterized in that further in the method,
- the web (10) is kept in contact with said same first wire (8) after the formation of the web (10) continuously from the web forming section (3) to the first press nip in the press section.

2. The method according to claim 1, characterized in that nanofibrillated cellulose is included in the web and that the content of nanofibrillated cellulose in the web, calculated in dry matter content, is at least 10 wt-%, at least 20 wt-%, at least 30 wt-%, or at least 40 wt-%.

3. The method according to claim 2, characterized in that the content of nanofibrillated cellulose in the web, calculated in dry matter content, is at least 50 wt-%, at least 60 wt-%, at least 70 wt-%, or at least 80 wt-%.

4. The method according to any of the preceding claims 1 to 3, characterized in that said first wire (8) is supported on at least part of its path on at least one side by means of a second wire (9).

5. The method according to claim 4, characterized in that in the method, said second wire (9) used is a wire whose mesh size is greater than the mesh size of said first wire (8), and/or a wire having a shorter total length than said first wire (8).

6. The method according to any of the preceding claims, characterized in that said web is kept in contact with said first wire continuously until the dry matter content of said web is at least 10 wt-%, 12 wt-%, 15 wt-%, 20 wt-%, 25 wt-%, 30 wt-%, 40 wt-%, or at least 50 wt-%.
7. A system for producing paper, paperboard or corresponding fibrous material, the system comprising a web forming machine (1) with at least the following parts:
   - a first wire (8),
   - a web forming section (3) equipped with means for supplying pulp suspension onto said first wire (8) for the formation of a web (10), and
   - a press section (4) equipped with means for reducing the moisture content of the web,

characterized in that said first wire (8) is placed in said machine (1) in such a way that it is arranged to run continuously from at least the web forming section (3) to the press section (4), wherein said first wire (8) supports the web to be formed continuously from the web forming section (3) to at least the first press nip in the press section.

8. The system according to claim 6 or 7, characterized in that the system further comprises at least a drying section (5) equipped with means for reducing the moisture content of the web substantially by the effect of temperature, and that said first wire (8) is placed in said web forming machine (1) in such a way that said same first wire (8) runs continuously from at least the web forming section (3) to the drying section (5).

9. The system according to claim 8, wherein the drying section (5) comprises a first drying group, a second drying group and a third drying group, characterized in that said first wire (8) is placed in such a way that it runs continuously from the web forming section (3) to at least the second drying group or the third drying group in the drying section (5).

10. The system according to any of the claims 6 to 9, characterized in that the system comprises not only said first wire (8) but also a second wire (9), which second wire (9) is placed in said web forming machine (1) to support the first wire (8) in such a way that said second wire (9) is at at least some stage in contact with the long wire (8).

11. The system according to any of the claims 6 to 10, characterized in that the system further comprises a third wire which is placed in said web forming machine (1) in such a way that also said third wire runs continuously from the
web forming section (3) to the press section (4) in such a way that also said third wire supports the web to be formed continuously from the web forming section (3) to at least the first press nip in the press section.
A. CLASSIFICATION OF SUBJECT MATTER

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)

IPC: D21 F

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

FI, SE, NO, DK

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

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search: 17 March 2011 (17.03.2011)

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Name and mailing address of the ISA/FI:
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## Classification of Subject Matter

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