The present invention relates to a method and a machine for making a fibre product. The invention also relates to a shaped body produced by the inventive method. According to the invention, a fibre product is formed on a first tool. The formed fibre product is then sandwiched between the first tool and a second tool and the surface of the second tool is heated to at least 220°C to evaporate water from the fibre product. The tools are permeable to air and water. When the fibre product has been dewatered to a dry solids content of at least 70%, the fibre product is subjected to microwave heating.
### Table: Comparison of Materials and Properties

<table>
<thead>
<tr>
<th></th>
<th>Moulded Pulp</th>
<th>Thermo formed (prior art)</th>
<th>Invention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grammage g/m²</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Roughness (sideA/sideB)</td>
<td>More then 5000/4000</td>
<td>900/1800</td>
<td>900/900</td>
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<tr>
<td>According to bendtsen ISO 8791-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile index kNm/kg</td>
<td>26</td>
<td>55</td>
<td>82</td>
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<tr>
<td>ISO1924-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density kg/m³</td>
<td>220</td>
<td>580</td>
<td>800</td>
</tr>
<tr>
<td>Tear index</td>
<td>5</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Air resistance (sek by Gurley method ISO 5636-5)</td>
<td>24</td>
<td>52</td>
<td>90</td>
</tr>
</tbody>
</table>

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**Fig. 15a**

**Fig. 15b**

**Fig. 15c**
METHOD AND MACHINE FOR MAKING FIBRE PRODUCTS FROM STOCK AND A NEW TYPE OF FIBRE PRODUCT

FIELD OF THE INVENTION

[0001] The invention relates to the production of fibre products from stock and especially to three-dimensional objects such as egg cartons, and other packaging products but also to objects such as drinking cups for beverages or trays, e.g. food trays.

BACKGROUND OF THE INVENTION

[0002] Fibre products such as for example egg boxes can be made from stock in a process where a fibre layer is created and shaped to a desired form whereas the so shaped fibre product is dewatered and possibly subjected to some form of post-processing operation.

[0003] U.S. Pat. No. 6,103,179 discloses a method for producing a fibre product which is where a first male mould is immersed in a moulding tank containing stock. By means of vacuum, a fibre layer of predetermined thickness for the fibre product is formed. The first male mould is then removed from the moulding tank. A cyclical sequence of movements is performed with a female mould in which, in a first pressing stage, the female mould is brought under force against the male mould so that a first expressing of stock water occurs, following which the fibre product is transferred to the female mould which is moved to a second position. The fibre product is then subjected to a second expressing whereafter the fibre product is subjected to final drying using microwave or IR radiation.

[0004] U.S. Pat. No. 6,451,235 discloses a method for forming a three dimensional fibre truss from a fibre slurry. In this method, a wet-forming station is used which comprises a substantially rigid moveable wet-forming die with a three-dimensional first forming surface and a substantially rigid fixed wet-forming die with a second forming surface. A deckle comprises a substantially rigid impermeable frame that surrounds a deckle interior space comprising a prismatic volume including a cross-sectional outline that encompasses a peripheral surface of the first die so that the moveable wet-forming die can traverse an axial length of the prismatic volume of the deckle interior space. Within the deckle interior space, above a predetermined area of the second forming surface, there is a slurry space. There are also filling means for adding fibre slurry to the slurry space and a pressing means for urging the moveable wet-forming die along the axial length of the prismatic volume. The method includes adding a predetermined quantity of fibre slurry to the slurry space and compressing at a pre-selected rate the fibre slurry contained in the slurry space. A pre-form fibre truss is then removed from the deckle interior space and moved to a truss finishing station. In the truss finishing station, the moist pre-form fibre truss is compacted further and dried under pressurized constraint between heated forming dies to produce the finished fibre truss. After treatment in the finishing station, a caul carries the finished fibre truss to a post-processing station. The post-processing is stated to include such operations as boxing to skins.

[0005] U.S. Pat. No. 6,582,562 discloses a method for producing moulded parts from a slurry by the use of first and second mating porous moulds. In this method, the first mould is moved into the slurry and a vacuum is supplied to the first mold to cause the slurry to form onto the first mold to a desired thickness. The second mold is heated by hot air from a hot air source and the first and second mold are mated and a vacuum is supplied to the first and second molds during mating of the first and second molds. After this, the molded part is ejected from the first mold and the molded part travels with the second mold. The second mold is moved and the vacuum on the second mold is released to permit the molded part to be separated from the second mold. This can be done in connection with a conveyer belt. It is stated that drying temperatures of 300° F. can be used (corresponding to about 149° C.).

[0006] U.S. Pat. No. 5,136,150 discloses a method and a device for achieving a flow of stock in a moulding tank. It is stated that the moulding tank is used to produce a fibre product such as an egg carton or other packaging product. In this patent, it is proposed that a flow of stock in the moulding tank is pumped into the bottom of the moulding tank and allowed to flow up over the rim of the tank. It is stated that this results in a flow that is directed upwards and that this should be important for forming a fibre layer of even thickness on a male tool used in the method.

[0007] During production of fibre products such as for example egg boxes and drinking cups, it is desirable that the shape of the final product can be controlled in a reliable way. For many applications, it is also desirable that the final product has substantially even strength properties so that the final product does not bend easier in one direction than in another. If heat is used to dewater the fibre product, it is also desirable that the heat does not burn the surface of the fibre product. It is also desirable that vaporized water can be evacuated efficiently.

[0008] It is an object of the present invention to provide an improved method and an improved machine for producing fibre products from stock. In preferred embodiments of the invention, the method is carried out in such a way and the machine is so designed that improved control of the shape of the final product is achieved. In advantageous embodiments of the invention, the final product also obtains substantially even properties of strength. Further objects of the invention include efficient dewatering and avoidance of burning of the surface of the final product.

DESCRIPTION OF THE INVENTION

[0009] The invention relates to a method for producing a fibre product from stock. The inventive method comprises providing a first tool that is permeable to air and water and providing a second tool. The second tool is heated to a surface temperature of at least 220° C. A moulding tank is provided and stock is fed to the moulding tank. The first tool is immersed in the stock in the tank and an embryonic fibre product is formed on the first tool by applying suction through the first tool. The first tool is then removed from the stock and the first tool is brought against a second tool such that the formed fibre product is sandwiched between the first and the second tool. The formed fibre product is heated by the second tool such that at least a part of the water in the formed fibre product is vaporized.

[0010] The formed fibre product may subsequently be subjected to at least one additional step of dewatering where the fibre product is sandwiched between a pair of opposed tools. Water is removed from the fibre product until it has reached a dry solids content of preferably at least 70%. When the fibre product has reached a dry solids content of at least 70%, it may be subjected to final drying by microwaves. Prior to final
drying by microwaves, the fibre product can be subjected to steam in order to achieve a more even moisture content.

[0011] The heating and vaporizing step that is carried out between the first tool and the second tool should preferably last for no more than 1 second. During the forming step, the fibre product is suitably dewatered to a dry solids content of 18-22% by weight, preferably 20% by weight.

[0012] The stock used can suitably have a dry solids content of 0.4-0.7% by weight. Preferably, the stock has a dry solids content of 0.5% by weight. A suitable stock can be made from chemithermochemical pulp (CTMP).

[0013] In preferred embodiments of the invention, no stock is fed to the moulding tank during the actual forming step. This can be achieved, for example, by means of causing stock from a machine vat to by-pass the moulding tank during the forming step. After the forming step, the stock from the machine vat can once again be fed to the moulding tank. The forming step preferably takes 1-2 seconds.

[0014] The first tool and the second tool should preferably be pressed against each other with a force that generates an overpressure of no more than 1 MPa and preferably no more than 900 KPa. In fact, it can be suitable in some cases to use a very low pressure and the pressure may be in the range of 10-900 KPa. It is also conceivable that no mechanical pressure at all is applied.

[0015] Suction should preferably be applied to the first tool also when the fibre product is sandwiched between the first tool and the heated second tool. In preferred embodiments, also the second tool is permeable to air and water. Suction is then applied also to the second tool when the fibre product is sandwiched between the tools so that steam and water is evacuated through both the first tool and the second tool.

[0016] The invention also relates to a machine for producing fibre products from stock. The machine comprises a moulding tank for holding stock and a first tool that is permeable to air and water. The machine further comprises a second tool that is permeable to air and water. The machine has means connected to the first tool for lowering the first tool into the tank and lifting the first tool out of the tank and for bringing the first tool against the second tool. A suction device, i.e. a source of underpressure is connected to the first tool. A source of heat, i.e. a heating device, arranged to heat the second tool and capable of heating the surface of the second tool to a temperature of at least 220°C in order to vaporize water in a wet fibre product when the wet fibre product is sandwiched between the first and the second tool.

[0017] The machine further comprises a microwave heater for additional removal of water from a fibre product that has previously been dewatered between the first and the second tool. There are also means for transferring a fibre product from the second tool to the microwave heater.

[0018] Preferably, a machine vat is arranged to supply stock to the moulding tank through a conduit. There may also be a by-pass conduit that can be used selectively such that stock from the machine vat can be either passed directly to the moulding tank or pumped around in a looped flow.

[0019] In advantageous embodiments, a steam shower can be arranged before the microwave heater so that a fibre product to be passed through the microwave heater can be showered with steam before it is treated by the microwave heater.

[0020] Preferably the first tool comprises particles that have been sintered together to form a porous body. In preferred embodiments, also the second tool comprises particles that have been sintered together to form a porous body. Of course, it should be understood that also other tools than sintered tools could be considered.

[0021] In advantageous embodiments, the first and second tools are mounted on holders that can be rotated between different angular positions.

[0022] In addition to the first and the second tool, additional tools may be arranged in a path from the pair of the first and second tool to the microwave heater, the additional tools forming cooperating pairs of tools where a fibre product may be subjected to additional dewatering and the additional tools further being arranged to convey a fibre product towards the microwave heater.

DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a schematic representation of the layout of the machine used in the inventive method.

[0024] FIGS. 2a-2h show a sequence where a forming tool is immersed in stock held in a tank.

[0025] FIG. 5 shows in greater detail a forming tool immersed in stock.

[0026] FIG. 6 shows the forming tool of FIG. 3 where a fibre product has been formed on the tool.

[0027] FIG. 7 shows how the first tool mates with the second tool and how a fibre product is sandwiched between the two tools.

[0028] FIG. 8 shows, in perspective, a group of tool holders arranged in a sequence.

[0029] FIG. 9 shows a side view of the tool holders shown in FIG. 6 and FIG. 7.

[0030] FIG. 9 shows how ready-dried fibre products are transferred to a conveyor belt.

[0031] FIG. 10 shows a part of the machine shown in FIG. 1.

[0032] FIG. 11 shows an exploded view of a tool pair used in the present invention.

[0033] FIG. 12 shows a cross section of the tool pair shown in FIG. 11.

[0034] FIG. 13 shows in greater detail the microstructure of the tools shown in FIG. 12.

[0035] FIG. 14 shows, in perspective, a tool holder provided with a plurality of tools.

[0036] FIGS. 15A-C show properties of moulded product produced according to the invention, in comparison with prior art.

[0037] FIG. 16 shows a detail of an advantageous embodiment of a tool used in the inventive method.

DETAILED DESCRIPTION OF THE INVENTION

[0038] Reference will now be made to FIG. 1. In FIG. 1, a machine for producing fibre products is shown. To the left in FIG. 1, a stock preparation section is indicated where pulp bales 20 can be disintegrated and dissolved into stock in a pulper 22 and subsequently passed to a machine vat 7. In the machine vat 7, the stock can be kept in motion by an agitation device 21 to avoid flocculation. From the machine vat 7, the stock can be fed through a conduit 8 to a tank 6 which is used in the process according to the present invention. In preferred embodiments of the invention, no stock is fed to the moulding tank 6 during the actual forming step. This can be achieved, for example, by means of causing stock from the machine vat 7 to by-pass the moulding tank 6 during the forming step.
After the forming step, the stock from the machine vat 7 can once again be fed to the moulding tank 6. The forming step can suitably take 1-2 seconds. When no pulp is passed to the moulding tank 6, the pulp 19 in the moulding tank 6 can be at rest. This entails the advantage that the fibre product that is formed obtains more uniform properties in all directions since the orientation of the fibres will be more stochastic. To avoid flocculation in the conduit(s) leading to the moulding tank 6, the stock can be sent through a by-pass conduit 9 during forming so that the stock is kept in motion. After the fibre product has been formed on a tool 1 that is immersed in the stock that is kept in the tank 6, the fibre product is dewatered between opposing pairs of tools and subsequently passed to a microwave heating device 17 for final drying. A conveyor belt 15 can be used to transport fibre products 10 to the microwave heater 17. At the end of the production line, there may be a pick-up unit 23 that is used to place the final products 10 in a stock 24. The pick-up unit 23 may have a suction device (not shown) in order to be able to pick up the ready-dried products 10.

[0039] The function of the process will now be explained with reference to FIGS. 2a-2h and FIGS. 3-5. In FIG. 2a, a first tool 1 is placed on a holder 14 which can pivot on an axle or pin 14. In FIG. 2b, the holder 13 has been pivoted or rotated to a position where the first tool 1 faces the stock 19 that is held in a tank 6. The first tool 1 is mounted on the holder 13 in such a way that it can be lowered into the stock 19. This can be done by special means for lowering and raising the first tool 1 in relation to the holder 13. Such means can include a telescoping hydraulically operated arm 18 which is indicated schematically in for example FIG. 2c. The first tool 1 is now lowered into the stock 19 until it reaches the position indicated in FIG. 2d. This position is shown in greater detail in FIG. 3. As can be seen in FIG. 3, the first tool 1 has a profiled surface 25 that corresponds to the shape of a fibre product to be formed. The first tool 1 is air and water permeable. It is also connected to a source of underpressure, i.e. a suction device 2 that can apply suction through the first tool 1 such that water and fibres are sucked towards the first tool 1. The water will pass through the first tool 1 and can be passed back into the stock 19 through a return conduit (not shown). However, the fibres will stay on the profiled surface 25 of the first tool 1 and form an embryonic fibre product 10 as indicated in FIG. 4. In this way, the first tool 1 serves as a forming tool for initial forming of the fibre products. The stock used is preferably based on chemithermomechanical pulp (CTMP) but also other pulp that CTMP can be contemplated. CTMP is a preferred pulp in this context since it is relatively easy to dewater stock based on CTMP. The consistency of the stock may be 0.5% by weight or about 0.5% by weight. However, other values for consistency may also be contemplated.

[0040] The initial forming step may take about 1-2 seconds. When the initial forming step is completed, the first tool 1 (the forming tool) is lifted from the stock 19 as indicated in FIG. 2e. The formed fibre product 10 now has a dry solids content of about 20% but dry solids content can also be somewhat lower or somewhat higher, realistically in the range of, for example, 18-22%. As indicated in FIGS. 2f-2h, the holder 13 may then be rotated and the first tool 1 once again moved by the arm 18 away from the body of the holder 13. In FIGS. 2f-2h, the first tool 1 is moved horizontally and to the right in the figures. However, it should be understood that other directions and patterns of movement are also possible. The first tool is moved in order to mate with a second tool 3 as indicated symbolically in FIG. 2i and in greater detail in FIG. 5. During this movement, the suction device 2 continues to be active so that the embryonic fibre product 10 is firmly held by the first tool 1. The second tool 3 has a profiled surface 26 that matches the profiled surface 25 of the first tool 1. When the first tool 1 meets the second tool 3, the formed fibre product 10 is held between the tools 1, 3. In the figures, the first tool 1 is shown as a male tool while the second tool 3 is shown as a female tool. This is believed to be the most suitable solution since it makes the forming process easier but the first tool 1 can also be a female tool. A heating device 5 is arranged to heat the second tool 3 such that the profiled surface 26 of the second tool 3 reaches a temperature of preferably at least 220° C. Also, temperatures considerably higher than 220° C. can be used. A realistic interval for the surface temperature of the second tool 3 may be 220° C.-400° C. Although the surface temperature for the second tool 3 should preferably be at least 220° C., in order to achieve effective dewatering, it should be understood that temperatures below 220° C. can be contemplated. For example, the temperature could be as low as 200° C. Hence, an interval for the temperature can be 200° C.-400° C. In preferred embodiments, the second tool 3 is also a permeable tool and a suction device 4 may also be connected to the second tool 3 to apply suction through the second tool 3 when the second tool 3 mates with the first tool 1. Due to the high temperature of the second tool 3, water in the fibre product 10 is vaporized. Since at least the first tool 1 is permeable, vapour can escape through the first tool 1. If the suction device 2 of the first tool is active, this will facilitate evacuation of vapour. If the second tool 3 is also permeable, vapour can also be evacuated through the second tool 3 and this is made more efficient if the suction device 4 of the second tool is active. The fibre product 10 is held between the tools 1, 3 during the vaporization. When water is vaporized at such high temperatures, the vaporization process will be violent and sudden. According to a wide-spread theory, the fibre product will be subjected to a process of so called “impulse drying”. This implies that vaporized water that leaves the fibre product will also force out such remaining water between the fibres that has not been vaporized. This results in a very effective dewatering. The invention is not bound by any particular theory of exactly what happens under such circumstances. However, practical experience has demonstrated that surface temperatures of 220° C. result in very effective dewatering. It has been observed that dryness levels of 50% and more can be obtained already in the first dewatering step between the tools 1, 3. The time in the nip between the tools 1, 3 should preferably be quite short and a time of no more than 1 second can be suitable. In some cases, a time which is less than 1 second can be suitable. The pressure in the nip between the tools 1, 3 should preferably not be higher than 1 MPa. Preferably, the mechanical pressure should not be higher than 900 KPa. For example, the mechanical pressure may be in the range of 10-900 MPa. In some cases, the pressure could actually be zero.

[0041] Reference will now be made to FIG. 6. In FIG. 6, it can be seen how several tool holders 13 are arranged in a row. As indicated in for example FIG. 8, each tool holder 13 is pivotable and has an axle 14 for this purpose. The axle 14 may be rotatable together with the tool holder or the tool holder 13 may pivot on the axle 14. On each of the tool holders 13, there are additional tools 11, 12 such as male tools 11 and female tools 12. Each of the tools 11, 12 can form a nip together with at least one other tool on an adjacent tool holder 13. Each of
the tools 11, 12 may be permeable and connected to a suction device just like the first tool 1 and the second tool 3. The tools 11, 12 can be mounted on one or several telescoping arms 18 or on some other actuator to move the tools 11, 12 away from or towards their respective holders 13. In this way, a tool 11 on one holder 13 may be moved horizontally towards a tool 12 on an adjacent holder 13 in order to dewater a fibre product held between the tools 11, 12. The tools 11, 12 and there tool holders 13 also serve as a conveyor for conveying the fibre product 10 towards the microwave heater 17. This function in the following way. A fibre product 10 is held on a male tool 1 or on a female tool 3, 12 by means of suction through the permeable tool 1, 3, 11, 12. As an example, reference will now be made to a case where the fibre product 10 is initially held on a male tool 1, 11. The arm 18 (or arms 18) moves the male tool 1, 11 towards the female tool 3, 12. The fibre product 10 is dewatered. The suction through the male tool 1, 11 is released, and the fibre product 10 is now held by suction through the female tool 3, 12. The male tool 1, 11 returns to its original position. The tool holder 13 of the female tool 3, 12 is now rotated 180° such that the fibre product will be facing a new male tool 12. It can now be understood that this process can be repeated in such a way that the fibre product 10 is transferred to the next male tool and further towards the microwave dryer. The tools 11, 12 and their holders 13 are thus arranged to convey a fibre product 10 towards the microwave heater. For additional clarification of the arrangement of the additional tools 11, 12, reference is also made to FIG. 7.

[0042] As can be seen most clearly in FIG. 14, each tool holder 13 can have a plurality of tools 12 arranged next to each other so that a plurality of fibre products 10 can be produced and finished simultaneously. It should be understood that each of the additional pairs of tools 11, 12 can function in the same way as the first tool 1 (the forming tool) and the second tool 3 and that further dewatering can take place in the nips formed between the pairs of additional tools 11, 12. The additional tools 11, 12 serve both the purpose of dewatering and the purpose of conveying the fibre product (s) 10. In advantageous embodiments of the invention, the pressure between the first tool 1 and the second tool 3 may be kept relatively low while a higher pressure and a lower temperature is used between following tool pairs 11, 12. For example, the higher pressure of up to 1 MPa can be used in a press nip between the last pair of tools 11, 12. It should be understood that, normally, additional dewatering takes place in press nips between the additional tools 11, 12. When more than two press nips are used, the pressure in the nips could increase from nip to nip such that the lowest pressure is used in the first nip, a higher pressure is used in following nips and the highest pressure in the last nip. The pressure may thus increase in steps from nip to nip.

[0043] With reference to FIG. 9e-9f, a conveyor belt 15 may be located at the end of the tool path. FIG. 9a shows how the last tool holder 13 is in a horizontal position. It should be understood that a fibre product 10 is held by suction to the male tool 11. The tool holder 13 is located above the conveyor belt 15. In FIG. 9b, the tool holder 13 has been rotated so that the tool 11 now faces the conveyor belt 15. The tool 11 moves downwards as indicated in FIG. 9a and the suction is deactivated causing the fibre product to be dropped on the conveyor belt 15. Possibly, air could also be blown through the tool 11 to help the fibre product 10 to leave the tool 11. The fibre product will then be transported towards the microwave heater while the tool 11 returns to its original position as indicated in FIG. 9e-9f.

[0044] In FIG. 10, it can be seen how the microwave heater 17 can be preceded by a steam shower 16 that blows steam on the fibre product 10. The purpose of this is to achieve a more even moisture distribution in the fibre product 10. It should be understood that the use of steam is an optional feature of the invention and it is possible to envisage embodiments of the invention where steam is not used. Preferably, the fibre product has been dewatered to a dry solids content of at least 70% before it reaches the microwave heater 17. However, it should be understood that it could reach the microwave heater with a dry solids content below 70%.

[0045] The design of the tools 1, 3, 11, 12 according to a possible embodiment of the invention shall now be explained in more detail with reference to FIGS. 11-13. FIG. 11 is an exploded view of the first tool 1 and the second tool 3. As indicated in FIG. 11, a heater 5 may be placed close to the second tool 3, possibly directly connected to the tool 3 or at a certain distance from the second tool 3. As can be seen in FIG. 12, both tools 1, 3 are provided with channels 27 through which water and air can pass. As indicated in FIG. 12, the tools 1, 3 may comprise different layers 28, 29, 30. These layers are parts of the tool structure that have different permeability. An inner layer 28 forms a base structure with a relatively high degree of permeability. An intermediate layer 29 has a relatively lower permeability and a thin surface layer 30 may have an even lower permeability. The tools may advantageously be made of small metal spheres that have been sintered together to form the different layers. As indicated in FIG. 13, the surface layer 30 may be formed of small spheres 31 while the intermediate layer 29 may be formed by somewhat larger metal spheres 32. The base structure 28 is formed by the largest spheres 33. The smallest particles 31 may have a diameter in the range of 0.01 mm-0.18 mm while the particles 32 in the intermediate layer 29 may have a diameter in the range of 0.18 mm-0.25 mm. The larger particles or spheres 33 in the base layer may have a diameter of 0.71 mm-1 mm. The particles 31, 32, 33 may be the kind of particles that are sold in the form of metal powder and can be obtained from CALLO AB, Poppelsdorfer 15, 57139 Neuss, Germany. CALLO AB sells a metal powder under the name Callo 25 which is a spherical metal powder with particles having a diameter of 0.09-0.18 mm. The chemical composition is 89% Cu and 11% Sn. Suitable particles can also be obtained from Makin Metal Powders Limited, Buckley Road, Rochdale, Lancashire OL12 9DT England.

[0046] The porosity of the tool 1 may be about 40%. The value of 40% porosity can apply to all layers. Embodiments of the invention can also be envisaged where different layers of the tool have different porosity.

[0047] The smaller spheres 31 form a fine surface layer that contributes to giving the fibre product a smooth surface while the interior layers 29, 28 improve permeability. The channels 27 that pass through the sintered structure may have pointed tips that reach the surface of the tool which improves permeability.

[0048] Reference will now be made to FIG. 16. In the embodiment of FIG. 16, a part 34 of the surface 25 of the first tool 1 has been covered or coated so as to be impermeable or substantially impermeable. On the impermeable spot 34, no layer of fibres will form. Hence, the fibre product will have a hole with a shape corresponding to the impermeable spot 34.
The impermeable spot 34 can be achieved by for example painting a part of the surface 25 or by covering a part of the surface 25 with a sheet of an impermeable material. It should be understood that this feature (an impermeable spot) is entirely optional and that the invention can be practiced without this optional feature. In terms of a method, it should be understood that the invention can be understood as including the (optional) step of using a tool with an impermeable spot 34. The idea of using a tool with an impermeable spot can be used independently of how the tool, the machine or the method is otherwise designed or performed.

[0049] The porous structure provided by the sintered metal particles 31, 32, 33 has the advantage that water and vapour can escape easily through the tools 1, 3, 11, 12. This reduces the risk of delamination during the vaporization process. The sintered structure also has the advantage that steam can escape in a very even way over the whole surface of the tool.

[0050] The high temperature entails the advantage that an efficient dewatering is achieved. Pressing with a relatively high pressure before the microwave heater (when the fibre product is wet) entails the advantage that good surface properties can be achieved before microwave drying. Therefore, it will not be necessary to press the fibre product after microwave drying which could be harmful to the fibre product. The microwave heating step entails the advantage of improved hygiene. The use of the high temperature also entails the advantage that the surface of the fibre product becomes more compact which is advantageous in view of bending stiffness.

[0051] It should be understood that, in certain embodiments, the microwave heating can be deleted or replaced by some other heating method, for example IR heating.

[0052] It should be understood that the idea of halting the feeding of stock to the mould 6 during forming can be used independently of how the process is otherwise performed.

[0053] The invention also relates to a fibre product that can be obtained by the above described method. In FIGS. 15A-15C there are shown properties of a moulded product produced in accordance with the invention. FIG. 15A demonstrates that quality aspects (being of importance in many fields where moulded fibre pulp products are used, e.g. the packaging industry) can be remarkably better for the invention in relation to prior art products, e.g. produced by thermo moulding or conventional pulp moulding. It is believed that one reason for the high quality of a product according to the invention is that a high density can be achieved, in the range of 600-900 kg/m³, without causing any weakness in the fibre net work. According to conventional prior art methods densities above 500 would rarely be achieved, without also obtaining at least on quality aspect below a desirable level. As can be seen in FIG. 15C thermo formed pulp products may obtain a level above 500 kg/m³. However when using thermo forming, which includes hot after pressing, the fibre net work will be partly disrupted that drastically decreases some quality aspects, e.g. tensile index. Especially corners and other areas of the body that presents sharp bends/curves will be negatively affected by such hot after pressing, whereas according to the invention corners and areas having a sharp radius also present substantially the same kind of continuous, homogeneous web structure as substantially flat areas of the body, which in turn provides equally good quality aspects in substantially all parts of the product. In advantageous embodiments, the fibre web of the product is of even thickness or substantially even thickness. However, it should be understood that fibre products obtained by the method described may, at least in certain cases, have a density lower than 600 kg/m³ or higher than 900 kg/m³.

[0054] A further major advantage according to the invention is that very smooth surfaces on both sides of the body may be produced. Products produced according to the invention may easily obtain a roughness in the range of about 750-1,000 ml/m². (ISO 8791-2, Bendtsen), whereas conventional moulded pulp products at least on one side normally have a roughness well above 1,500 ml/m². It may be mentioned that one of the reasons why conventional products normally present a higher roughness is that most conventional techniques do use a wire mesh to form the surface.

[0055] A further advantage according to the invention is that the product will achieve a high tensile index, normally in the range of 65-100 kN/m³, which indeed is a significant advantage compared to traditional moulded pulp products. (see FIG. 15 B) Moreover also a good tear index is achieved. Another advantage is the bonding strength of the surface layer will be somehow higher than the bonding strength of an intermediate layer near the centre portion of the web forming the body, since the inventive method will achieve a higher amount of bindings between the fibres in the surface layer. As a consequence there is achieved a similar function as with an I-beam, i.e. the stiffness and the bending resistance is improved.

[0056] Finally it is of course an advantageous aspect of a product according to the invention that it may be achieved without any after pressing which otherwise will increased production costs and as has been mentioned above also negatively effect the at least some or one quality aspects. In FIG. 15B it is shown that thanks to all of the advantages mentioned above the tensile index for a product produced according to the invention may have high values independent on the shape of the body, whereas according to conventional methods the products will present decreasing tensile index with increasing complexity of the shape of the body. In table 15C there are presented some empirically found average values for two prior art methods, i.e. conventional pulp moulding and thermo forming, in comparison with the invention. As is evident from this table, products according to the invention may have numerous advantages in relation to quality aspects compared with prior art products.

1-29. (canceled)
30. A method for producing a fibre product from stock, the method comprising the steps of:
   a) providing a first tool that is permeable to air and water;
   b) providing a second tool and heating the second tool to a temperature of at least 220° C.;
   c) providing a moulding tank and feeding stock to the moulding tank;
   d) immersing the first tool in the stock in the tank;
   e) forming an embryonic fibre product on the first tool by applying suction through the first tool;
   f) removing the first tool from the stock;
   g) bringing the first tool against the second tool such that the formed fibre product is sandwiched between the first and the second tool and heated by the second tool such that at least a part of the water in the formed fibre product is vaporized; and
   h) dewatering the formed fibre product until it has reached a dry solids content of at least 70% after which the fibre product is subjected to drying by microwaves.
31. A method according to claim 30, wherein the heating and vaporizing step that is carried out between the first tool and the second tool lasts for no more than 1 second.

32. A method according to claim 30, wherein, during the forming step, no stock is fed to the moulding tank.

33. A method according to claim 32, wherein, during the forming step, stock from (New) a machine vat is caused to by-pass the moulding tank and that, after the forming step, the stock from the machine vat is fed to the moulding tank.

34. A method according to claim 30, wherein the forming step lasts 1-2 seconds.

35. A method according to claim 30, wherein the fibre product is dewatered in several dewatering steps between opposed tools and subsequently subjected to steam before it is dried by microwaves.

36. A method according to claim 30, wherein the stock has a dry solids content of 0.4-0.7% by weight.

37. A method according to claim 30, wherein the stock has a dry solids content of 0.5% by weight.

38. A method according to claim 30, wherein the stock is dewatered to a dry solids content of 18-22% by weight.

39. A method according to claim 30, wherein the stock is dewatered to a dry solids content of 20% by weight.

40. A method according to claim 30, wherein the first tool and the second tool are pressed against each other with a force generating an overpressure of no more than 1 MPa.

41. A method according to claim 30, wherein the first tool and the second tool are pressed against each other with a force generating an overpressure of no more than 900 KPa.

42. A method according to claim 30, wherein the pressure is in the range of 10-900 KPa.

43. A method according to claim 30, wherein the stock is made from chemithermomechanical pulp (CTMP).

44. A method according to claim 30, wherein suction is applied to the first tool also when the fibre product is sandwiched between the first tool and the heated second tool.

45. A method according to claim 44, wherein also the second tool is permeable to air and water and that suction is applied also to the second tool when the fibre product is sandwiched between the tools so that steam and water can be evacuated through both the first tool and the second tool.

46. A machine for producing fibre products from stock, the machine comprising:

a) a moulding tank for holding stock;

b) a first tool that is permeable to air and water;

c) a second tool that is permeable to air and water;

d) means connected to the first tool for lowering the first tool into the tank and lifting the first tool out of the tank and for bringing the first tool against the second tool;

e) a source of underpressure connected to the first tool;

f) a source of heat arranged to heat the second tool and capable of heating the surface of the second tool to a temperature of at least 220°C. in order to vaporize water in a wet fibre product when the wet fibre product is sandwiched between the first and the second tool;

g) a microwave heater for additional removal of water from a fibre product that has previously been dewatered between the first tool and the second tool; and

h) means for transferring a fibre product from the second tool to the microwave heater.

47. A machine according to claim 46, wherein a machine vat is arranged to supply stock to the moulding tank through a conduit and that there is also a by-pass conduit that can be used selectively such that stock from the machine vat can be either passed directly to the moulding tank or pumped around in a looped flow.

48. A machine according to claim 46, wherein a steam shower is arranged before the microwave heater so that a fibre product to be passed through the microwave heater can be showered with steam before it is treated by the microwave heater.

49. A machine according to claim 46, wherein the first tool comprises particles that have been sintered together to form a porous body.

50. A machine according to claim 49, wherein also the second tool comprises particles that have been sintered together to form a porous body.

51. A machine according to claim 46, wherein the first and second tools are mounted on holders that can be rotated between different angular positions.

52. A machine according to claim 46, wherein, in addition to the first and the second tool, additional tools are arranged in a path from the pair of the first and second tool to the microwave heater, the additional tools forming cooperating pairs of tools where a fibre product may be subjected to additional dewatering and the additional tools further being arranged to convey a fibre product towards the microwave heater.

53. Shaped body mainly comprising fibres, which fibres form a web which is continuous and form stable, and which preferably forms a three dimensional body, wherein the grammage is in the range 150-600 g/m² and wherein the orientation of the fibres is stochastic such that substantially the same strength properties are obtained independent of direction within the plane of the web, wherein the density is in the range 600-900 kg/m³.

54. Shaped body according to claim 51, wherein the density is at least 700.

55. Shaped body according to claim 51, wherein corners and/or areas having a sharp radius also presents substantially the same kind of continuous, homogenous web as a substantially flat surfaces of the body.

56. Shaped body according to claim 51, wherein the roughness of a substantial portion of the surfaces on both sides of the body is within the range 750-3,000 ml/min. according to bendtsen ISO 8791-2.

57. Shaped body according to claim 51, wherein the roughness of a substantial portion of the surfaces on both sides of the body is within the range 750-2,000 ml/min. according to bendtsen ISO 8791-2.

58. Shaped body according to claim 51, wherein the roughness of a substantial portion of the surfaces on both sides of the body is within the range 750-1,500 ml/min. according to bendtsen ISO 8791-2.

59. Shaped body according to claim 51, wherein the tensile index is in the range 50-100 kN/m².

60. Shaped body according to claim 51, wherein the tensile index is in the range 65-100 kN/m².

61. Shaped body according to claim 51, wherein the tensile index is in the range 80-100 kN/m².

62. Shaped body according to claim 51, wherein the tear index is in the range 5-15 Nm²/kg.

63. Shaped body according to claim 51, wherein the tear index is in the range 8-15 Nm²/kg.
63. Shaped body according to claim 51, wherein the bonding strength of a surface layer of the body is in the range of 5-50% higher than the bonding strength of an intermediate layer near the centre portion of the web forming the body.

64. Shaped body according to claim 51, wherein the bonding strength of a surface layer of the body is in the range of 7-30% higher, higher than the bonding strength of an intermediate layer near the centre portion of the web forming the body.

65. Shaped body according to claim 51, wherein air resistance for the web, including corners/sharp bends of the body, is in the range of 60-200 sek by gurley.

66. Shaped body according to claims 65, wherein air resistance for the web, including corners/sharp bends of the body, is at least 70 sek.

67. Shaped body according to claims 65, wherein air resistance for the web, including corners/sharp bends of the body, is at least 80 sek.

68. Shaped body according to claim 51, wherein the body is obtainable without any after pressing.

69. Shaped body according to claim 51, wherein the body is obtainable without any after pressing action above 1.5 MPa after having obtained a dry solids content of at least 70%.

70. Shaped body according to claim 51, wherein the body is obtainable without any after pressing action above 1.5 MPa after having obtained a dry solids content of at least 80%.

71. Shaped body according to claim 51, wherein the body is obtainable without any after pressing action above 1.5 MPa after having obtained a dry solids content of at least 90%.