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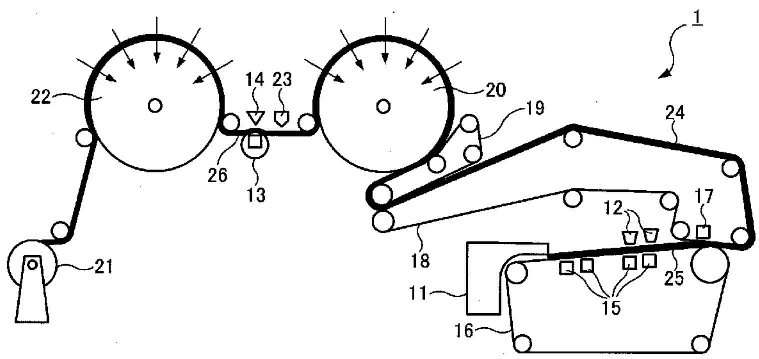
(54) **Title**: METHOD FOR PRODUCING NON-WOVEN FABRIC

Fig.1



(57) **Abstract**: A method for producing non-woven fabric that allows the obtaining of non-woven fabric that is bulky and flexible. The method for producing non-woven fabric comprises a step for forming a fiber sheet on a support by supplying a papermaking raw material containing moisture to the support, a step for drying the fiber sheet, a step for forming regions where moisture content is increased to a moisture content higher than the moisture content of the fiber sheet that has been dried by the step for drying the fiber sheet in a portion of the fiber sheet dried by the step for drying the fiber sheet, and a step for spraying high-pressure steam onto the regions of the fiber sheet where moisture content is increased.

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DESCRIPTION

METHOD FOR PRODUCING NON-WOVEN FABRIC

TECHNICAL FIELD

[0001]

The present disclosure relates to a method for producing bulky non-woven fabric.

BACKGROUND ART

[0002]

A method for producing bulky paper is known in the prior art that comprises depositing fibers on a fiber sheet forming belt by supplying a fiber suspension containing a wet strength agent to a fiber sheet forming belt from a papermaking raw material supply head, forming a fiber sheet while in the wet state, and making the moisture content of the fiber sheet to be 50% by weight to 85% by weight based on the weight of the fiber sheet by dehydrating the fiber sheet using a suction box, followed by imparting a prescribed pattern to the fiber sheet by pressing the fiber sheet against a perforated pattern structure by suction and then drying the fiber sheet (see, for example, Patent Literature 1). According to this method for producing bulky paper, bulky paper having ample bulk and absorbency can be obtained.

[Citation List]

[Patent Literature]

[0003]

[Patent Literature 1] Japanese Unexamined Patent Publication No. 2000-34690

SUMMARY OF THE INVENTION

[Technical Problem]

[0004]

However, in the method for producing bulky paper as described in Patent Literature 1, since a prescribed pattern is formed in a fiber sheet having an extremely high moisture content of 50% by weight to 85% by weight, there are cases in which a considerable amount of energy is required to dry the fiber sheet in a drying step after having formed the pattern in the fiber sheet. In this case, it is necessary to increase the equipment scale of drying equipment used in the drying step.

[0005]

In order to solve the aforementioned problem, an object of the present invention is to provide a method for producing non-woven fabric that is bulky and flexible.

[Solution to Problem]

[0006]

The present invention employs the following configuration to solve the aforementioned problem.

Namely, the method for producing non-woven fabric of the present invention comprises a step for forming a fiber sheet on a support a step for forming regions where the moisture content is increased to a moisture content higher than the moisture content of the fiber sheet, and a step for spraying high-pressure steam onto the regions of the fiber sheet where moisture content is increased.

In the step for forming a fiber sheet the fiber sheet may be formed by supplying a papermaking raw material containing moisture to the support, wherein there may be further provided a step for drying the fiber sheet, and wherein in the step for forming regions where the moisture content is increased, the moisture content may be increased to a moisture content higher than the moisture content of the fiber sheet that has been dried by the step for drying the fiber sheet in a portion of the fiber sheet dried by the step for drying the fiber sheet.

In the step for forming a fiber sheet the fiber sheet may be formed by supplying a web to the support, and wherein in the step for forming regions where the moisture content is increased, the moisture content may be increased to a moisture content that is higher than the moisture content of the fiber sheet in a portion of the fiber sheet.

[Advantageous Effects of the Invention]

[0007]

According to the present invention, the need for a large amount of energy for drying after having formed a prescribed pattern in a fiber sheet can be eliminated.

BRIEF DESCRIPTION OF DRAWINGS

[0008]

FIG. 1 is a drawing for explaining a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 2 is a drawing showing an example of a high-pressure water nozzle of a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 3 is a drawing for explaining the principle by which individual fibers of a fiber sheet are entangled by a high-pressure water stream.

FIG. 4 is a drawing showing an example of the arrangement of holes in a high-pressure water nozzle of a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 5 is a widthwise cross-sectional view of a fiber sheet sprayed with high-pressure water.

FIG. 6 is a drawing showing an example of spraying by a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 7 is a drawing showing an example of a steam nozzle of a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 8 is a drawing for explaining the principle by which fibers of a fiber sheet are loosened and the bulk of a fiber sheet is increased by high-pressure steam.

FIG. 9 is a widthwise cross-sectional view of a fiber sheet sprayed with high-pressure steam.

FIG. 10 is a drawing showing an example of the arrangement of holes in a steam nozzle of a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 11 is a drawing showing an example of a fiber sheet produced using a sprayer capable of intermittently releasing water or an aqueous solution.

FIG. 12 is a drawing for explaining a variation of a method for forming regions where moisture content is increased in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 13 is a drawing for explaining a variation of a method for forming regions where moisture content is increased in the method for producing non-woven fabric in an embodiment of the present invention.

FIG. 14 is a drawing for explaining a variation of a non-woven fabric production device used in the method for producing non-woven fabric in an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0009]

The following provides a more detailed explanation of the method for producing non-woven fabric of an embodiment of the present invention with reference to the drawings. FIG. 1 is a drawing for explaining a non-woven fabric production device 1 used in the method for producing non-woven fabric in an embodiment of the present invention.

[0010]

First, a papermaking raw material that contains moisture such as a fiber suspension may be prepared. Short fibers having a fiber length of 20 mm or less are preferably used for the fibers used in the papermaking raw material. Examples of such short fibers include chemical pulp of a coniferous tree or broad-leaved tree, wood pulp such as semi-chemical pulp or mechanical pulp, mercerized pulp and crosslinked pulp obtained by chemically treating these wood pulps, non-woody fibers such as hemp or cotton fibers, cellulose fibers in the manner of recycled fibers such as rayon fibers, and synthetic fibers in the manner of polyethylene fibers, polypropylene fibers, polyester fibers or polyamide fibers. The fibers used in the papermaking raw material are particularly preferably wood pulp, non-wood pulp or cellulose fibers such as rayon fibers.

[0011]

The papermaking raw material is preferably supplied to a fiber sheet forming belt of a fiber sheet forming conveyor 16 by a raw material supply head 11, and deposited on the fiber sheet forming belt. The fiber sheet forming belt is preferably a support having gas permeability that allows air to pass there through. For example, a wire mesh or blanket can be used for the fiber sheet forming belt.

[0012]

After being deposited on the fiber sheet forming belt, the papermaking raw material is suitably dehydrated, preferably by suction boxes 15 to form a fiber sheet 24.

It should be noted that instead of forming the fiber sheet 24 in the steps above (by a wet method), the fiber sheet 24 may be produced (by a dry method) by supplying a web to the fiber sheet forming belt.

The fiber sheet 24 preferably passes between two high-pressure water nozzles 12 arranged above the fiber sheet forming belt, and two suction boxes 15 arranged at locations opposing the high-pressure water nozzles 12 about the fiber sheet forming belt that recover water sprayed from the high-pressure water nozzles 12. At this time, the fiber sheet 24 is sprayed with high-pressure water from the high-pressure water nozzles 12, and grooves are preferably formed in the surface thereof (side facing the high-pressure water nozzles 12). It should be noted that there may be more or less water nozzles and suction boxes provided. Moreover, the water nozzles and suction boxes may be omitted.

[0013]

An example of the high-pressure water nozzle 12 is preferably shown in FIG. 2. The high-pressure water nozzle 12 sprays a plurality of high-pressure water streams 31 arranged in the machine cross direction (CD) of the fiber sheet 24. As a result, a plurality of grooves 32 are formed in the surface of the fiber sheet 24 that are arranged in the cross machine direction (CD) of the fiber sheet 24 and extend in the machine direction (MD).

[0014]

In addition, when the fiber sheet 24 is subjected to the high-pressure water streams, in addition to the grooves 32 being formed in the fiber sheet 24 as described above, individual fibers of the fiber sheet 24 become entangled resulting in an increase in strength of the fiber sheet 24. Although the principle by which individual fibers of the fiber sheet 24 become entangled when the fiber sheet 24 is subjected to the high-pressure water streams is explained with reference to FIG. 3, this principle is not intended to limit the present invention.

[0015]

As shown in FIG. 3, when the high-pressure water nozzles 12 spray the high-pressure water streams 31, the high-pressure water streams 31 pass through the fiber sheet forming belt 41. As a result, the fibers of the fiber sheet 24 are pulled in, centering on a portion 42 where the high-pressure water streams 31 pass through the fiber sheet forming belt 41. As a result, fibers of the fiber sheet 24 gather towards the portion 42 where the high-pressure water streams 31 pass through the fiber sheet forming belt 41 which causes individual fibers to become entangled.

[0016]

As a result of individual fibers of the fiber sheet 24 becoming entangled, the strength of the fiber sheet 24 increases, thereby reducing the formation of holes, tearing of the fiber sheet 24 and dispersal of the fiber sheet 24 even if high-pressure steam is sprayed onto the fiber sheet 24 in a subsequent step. In addition, the wet strength of the fiber sheet 24 can be increased without having to add a strength agent to the papermaking raw material.

[0017]

The hole diameter of the high-pressure water nozzles 12 is preferably 90 μm to 150 μm. If the hole diameter of the high-pressure water nozzles 12 is 90 μm or more, there are cases in which the problem of increased susceptibility to nozzle clogging may occur may be effectively avoided. If the hole diameter of the high-pressure water nozzles 12 is 150 μm or less, cases in which the problem of poor processing efficiency may be effectively avoided.

[0018]

The hole pitch (distance between the centers of adjacent holes) of the high-pressure water nozzles 12 is preferably 0.5 to 1.0 mm. If the hole pitch of the high-pressure water nozzles 12 is 0.5 mm or more, cases in which the withstand pressure of the nozzles decrease resulting in damage thereto may be effectively avoided. In addition, if the hole pitch of the high-pressure water nozzles 12 is 1.0 mm or less, cases in which the problem of inadequate fiber entanglement may occur may be effectively avoided.

[0019]

FIG. 4 shows an example of the arrangement of holes the high-pressure water nozzles 12. A plurality of holes 121 are preferably provided in the high-pressure water nozzles 12 that are arranged in a row in the cross machine direction (CD) of the fiber sheet 24. The hole diameter is, for example, 92 μm, and the hole pitch is, for example, 0.5 mm.

[0020]

FIG. 5 shows a widthwise cross-sectional view of the fiber sheet 24 at a location after having passed between the two high-pressure water nozzles 12 and the two suction boxes 13 (location indicated by reference symbol 25 in FIG. 1). The grooves 32 are formed in the surface of the fiber sheet by the high-pressure water streams.

[0021]

Subsequently, as shown in FIG. 1, the fiber sheet 24 is preferably transferred to a fiber sheet transport conveyor 18 by a suction pickup 17. During this transfer, the fiber sheet 24 may be subjected to pressure in the direction of thickness resulting in a decrease in the bulk of the fiber sheet 24. The fiber sheet 24 is preferably further transferred to a fiber sheet transport conveyor 19. During this transfer as well, the fiber sheet 24 may be subjected to pressure in the direction of thickness resulting in a decrease in bulk of the fiber sheet 24. Next, the fiber sheet 24 is preferably transferred to a drying dryer 20. During this transfer as well, the fiber sheet 24 is subjected to pressure in the direction of thickness resulting in a decrease in bulk of the fiber sheet 24. The drying dryer 20 is, for example, a Yankee dryer, and the fiber sheet 24 is dried by adhering the fiber sheet 24 to a drum preferably heated to about 120°C with steam.

[0022]

As a result of being dried by the drying dryer 20, the moisture content of the fiber sheet 24 is preferably made to be less than 10% and more preferably 8% or less. Here, moisture content refers to the weight of water contained in the fiber sheet 24 based on a value of 100% for the weight of the dried fiber sheet 24. If the moisture content of the fiber sheet 24 is 10% or less, it may be ensured that hydrogen bonding strength between fibers of the fiber sheet 24 is not excessively decreased so that entanglement between fibers is not weakened, and it is ensured that the fiber sheet 24 is able to obtain the required strength. In the method for producing non-woven fabric in an embodiment of the present invention, it is preferable to increase the strength of the fiber sheet 24 since regions of low strength are formed in a portion of the fiber sheet 24 in a subsequent post-processing step.

Note that when the fiber sheet 24 is produced (by a dry method) by supplying a web to the fiber sheet forming belt, the drying step may be omitted.

[0023]

Next, the fiber sheet 24 moves below a sprayer 23 where water is applied from the sprayer 23. As shown in FIG. 6, spraying nozzles 231 are preferably arranged in a row in the cross machine direction (CD) of the fiber sheet 24. In addition, the sprayer 23 is preferably arranged in close proximity to the fiber sheet 24 so that water 232 released from the sprayer 23 is only applied to a portion of the fiber sheet 24. As a result, a plurality of regions 241 where water has been applied, namely a plurality of regions 241 where moisture content is increased, are formed in a portion of the fiber sheet 24. The plurality of regions 241 where moisture content is increased are preferably arranged in the cross machine direction (CD) of the fiber sheet 24 and extend in the machine direction (MD) of the fiber sheet 24. It should be noted that alternative means for increasing the moisture content may be provided, as discussed below.

[0024]

Although there are no particular limitations on the moisture content of the regions 241 where the moisture content of the fiber sheet 24 is increased provided it is higher than the moisture content of the fiber sheet 24 that has been dried by the drying dryer 20, it is preferably 10% to 80%. If the moisture content of the fiber sheet 24 is 10% or more, hydrogen bonding force between fibers of the fiber sheet 24 does not increase too much, and the amount of energy required to loosen the fibers of the fiber sheet 24 with high-pressure steam to be subsequently described may be kept low. On the other hand, if the moisture content of the fiber sheet 24 is 80% or less, water can effectively be prevented from dripping from the fiber sheet 24.

[0025]

Furthermore, the liquid released from the sprayer 23 is not limited to water provided that it is able to increase the moisture content of the fiber sheet 24. For example, an aqueous solution obtained by dissolving another compound in water may be released from the sprayer 23.

[0026]

Since hydrogen bonding strength between fibers of the fiber sheet 24 decreases in the regions 241 where moisture content is increased, entanglement between fibers weakens. Consequently, in the regions 241 where moisture content is increased, fibers of the fiber sheet 24 can be loosened easily thereby facilitating processing of the fiber sheet 24.

[0027]

Since hydrogen bonding between fibers weakens and entanglement between fibers also weakens in the case of a high moisture content of the fiber sheet, the strength of the fiber sheet is low. Consequently, in the case the moisture content of the entire fiber sheet is 50% by weight to 85% by weight as in the fiber sheet previously described in Patent Literature 1, the strength of the fiber sheet decreases thereby preventing increases from being made in line tension or line speed of the production process. Consequently, production efficiency of the non-woven fabric decreases. However, in the method for producing non-woven fabric of an embodiment of the present invention, since the water 232 released from the sprayer 23 is preferably only applied to a portion of the fiber sheet 24, regions where moisture content is not increased remain in the fiber sheet 24. Since hydrogen bonding between fibers of the fiber sheet 24 is strong and entanglement between fibers is also strong in those regions where moisture content is not increased, the strength of the fiber sheet 24 is high. Thus, in the method for producing non-woven fabric of an embodiment the present invention, line tension or line speed of the production process can be increased and production efficiency of non-woven fabric can be enhanced due to the presence of these regions where moisture content is not increased.

[0028]

Hole diameter and hole pitch of the sprayer 23 are suitably selected based on the locations and periphery thereof where high-pressure steam sprayed from a steam nozzle 14 to be subsequently described contacts the fiber sheet 24. For example, the hole diameter and hole pitch of the sprayer 23 may be made to correspond to the hole diameter and hole pitch of the steam nozzle 14 to be subsequently described.

[0029]

Next, the fiber sheet 24 preferably moves over the mesh-like outer peripheral surface of a cylindrical suction drum 13 (see FIG. 1). At this time, high-pressure steam is sprayed onto the regions of the fiber sheet 24 where moisture content is increased from a single steam nozzle 14 arranged above the outer peripheral surface of the suction drum 13. Furthermore, high-pressure steam from two or more steam nozzles may also be sprayed onto the regions of the fiber sheet 24 where moisture content is increased. The suction drum 13 preferably contains an internal suction device, and high-pressure steam sprayed from the steam nozzle 14 is suctioned by this suction device. Grooves are preferably formed in the surface of the fiber sheet 24 (side facing the steam nozzle 14) by high-pressure steam sprayed from the steam nozzle 14.

[0030]

The high-pressure steam sprayed from the steam nozzle 14 may be steam composed of 100% water or may be steam that contains another gas such as air. However, the high-pressure steam sprayed from the steam nozzle 14 is preferably steam composed of 100% water.

[0031]

An example of the steam nozzle 14 arranged above the suction drum 13 is shown in FIG. 7. The steam nozzle 14 sprays a plurality of streams of high-pressure steam 51 arranged in the cross machine direction (CD) of the fiber sheet 24 towards the regions 241 of the fiber sheet 24 where moisture content is increased. As a result, a plurality of grooves 52 are formed in the surface of the fiber sheet 24 that are arranged in the cross machine direction (CD) of the fiber sheet 24 and extend in the machine direction (MD). Although grooves formed by high-pressure water streams as previously described are also present in the fiber sheet 24, these grooves formed by the high-pressure water streams are omitted from FIG. 7 to more easily illustrate the grooves 52 formed by the high-pressure steam 51.

[0032]

When the regions 241 of the fiber sheet 24 where moisture content is increased are sprayed with the high-pressure steam, fibers of the fiber sheet 24 at the regions 241 where moisture content is increased are loosened. The loosened fibers are then moved by the high-pressure steam to both sides in the widthwise direction of the portions sprayed with the high-pressure steam. As a result, the bulk of the fiber sheet 24 increases. Although the principle by which the bulk of the fiber sheet 24 increases is explained in detail with reference to FIG. 8, this principle is not intended to limit the present invention.

[0033]

As shown in FIG. 8, when the high-pressure steam 51 is sprayed by the steam nozzle 14, the high-pressure steam 51 contacts the suction drum 13. The majority of the high-pressure steam 51 is rebounded off the suction drum 13. As a result, fibers of the fiber sheet 24 are curled up and loosened. In particular, since hydrogen bonding between fibers has been weakened in the regions where moisture content is increased, the degree of entanglement between fibers is weak. Consequently, fibers of the fiber sheet 51 are curled up more easily in the regions where moisture content is increased, thereby enabling the fibers to be loosened more easily.

[0034]

In addition, water in the fiber sheet 24 evaporates rapidly due to the high-pressure steam. Since the moisture content of the fiber sheet 24 is increased in the regions where moisture content is increased, expansion of steam also increases due to this rapid evaporation of water. As a result, the gaps between fibers become larger and the fibers are more easily loosened.

[0035]

Fibers of the fiber sheet 24 are further pushed apart by the high-pressure steam 51, and the fibers that have been pushed apart in this manner move and gather in both directions of width at a portion 53 where the high-pressure steam 51 contacts the suction drum 13, thereby resulting in the formation of bulky portions 54 where the bulk of the fiber sheet 24 is high.

[0036]

Since the fiber sheet 24 is shaped as a result of a portion of the fibers thereof being blown together by the high-pressure steam 51, entanglement between fibers is strong. Consequently, plastic fibers may be incorporated in the fiber sheet 24 in order to maintain the bulky state of the fiber sheet. In addition, there is little crushing of the bulky portions of the fiber sheet due to the fiber sheet being wound as subsequently described. Moreover, there is also little crushing of bulky portions of the non-woven fabric even if the resulting non-woven fabric is used in a wet state.

[0037]

Since moisture content of the fiber sheet 24 is low in those regions where moisture content is not increased, hydrogen bonding between fibers is strong. Consequently, the bulk of the fiber sheet 24 does not increase that much in those regions where moisture content has not increased even if sprayed with the high-pressure steam 51. Thus, in the method for producing non-woven fabric of an embodiment of the present invention, the bulk of the fiber sheet 24 can be increased to a very high level by forming regions where moisture content is increased in the fiber sheet 24 and spraying the high-pressure steam 51 onto those regions.

[0038]

The strength of the fiber sheet 24 is enhanced by the high-pressure water streams in those regions where moisture content is not increased. Consequently, when the high-pressure water streams are used, it is not necessary to provide a net over the fiber sheet 24 for preventing the fiber sheet 24 from being blown away by the high-pressure steam 51 when spraying the high-pressure steam 51 onto the fiber sheet 24. Thus, processing efficiency of the fiber sheet 24 by the high-pressure steam 51 is improved. In addition, since it is not necessary to provide the aforementioned net, maintenance for the non-woven fabric production device and production costs of the non-woven fabric can be reduced.

[0039]

The temperature of the high-pressure steam is preferably 130°C to 220°C. For example, the temperature of the high-pressure steam is measured immediately after the steam has sprayed from the nozzle. As a result, drying of the fiber sheet 24 proceeds even when the high-pressure steam is sprayed onto the fiber sheet 24, and the bulk of the fiber sheet 24 can be increased simultaneously to drying. Since hydrogen bonding between fibers of the fiber sheet 24 becomes stronger when the fiber sheet 24 is dried, the strength of the fiber sheet 24 increases, and the increased bulk of the fiber sheet 24 is not easily reduced. In addition, as a result of the increase in strength of the fiber sheet 24, the formation of holes and tearing of the fiber sheet 24 caused by being sprayed with high-pressure steam are prevented.

[0040]

The steam pressure of high-pressure steam sprayed from the steam nozzle 14 is preferably 0.3 MPa to 1.5 MPa. If the steam pressure of the high-pressure steam is 0.3 MPa or more, a suitable increase in the bulk of the fiber sheet 24 due to the high-pressure steam may be ensured. In addition, if the steam pressure of the high-pressure steam is 1.5 MPa or less, the formation of holes in the fiber sheet 24 or the tearing and blowing away of the fiber sheet 24 may be effectively prevented.

[0041]

A suction device that suctions steam sprayed from the steam nozzle 14 is housed in the suction drum 13. The suction force generated by this suction device that enables the suction drum 13 to suction the fiber sheet 24 is preferably -1 kPa to -12 kPa. If the suction force of the suction drum 13 is -1 kPa or more, it may be ensured that the steam is able to be completely suctioned avoiding the problem of the risk of steam being blown upward. In addition, if the suction force of the suction drum 13 is -12 kPa or less, it may be ensured the problem in which there is an increase in the number of fibers that drop into the suction drum is avoided.

[0042]

The distance between the end of the steam nozzle 14 and the surface of the fiber sheet 24 is preferably 1.0 mm to 10 mm. If the distance between the end of the steam nozzle 14 and the surface of the fiber sheet 24 is 1.0 mm or more, it may be ensured that problems such as holes forming in the fiber sheet 24 or the fiber sheet 24 being torn and blown away are avoided. In addition, if the distance between the end of the steam nozzle 14 and the surface of the fiber sheet 24 is 10 mm or less, it may be ensured that the force for forming grooves in the surface of the fiber sheet 24 with the high-pressure steam is not dispersed, so that there is no impairment of the ability of the high-pressure steam to form grooves in the surface of the fiber sheet 24.

[0043]

The hole diameter of the steam nozzle 14 is preferably larger than the hole diameter of the high-pressure water nozzles 12, and the hole pitch of the steam nozzle 14 is preferably larger than the hole pitch of the high-pressure water nozzles 12. As a result, as shown in FIG. 9, the grooves 52 can be formed in the fiber sheet 24 by the high-pressure steam sprayed from the steam nozzle 14 while leaving the grooves 32 formed by the high-pressure water streams sprayed from the high-pressure water nozzles 12.

[0044]

FIG. 9 is a drawing showing a widthwise cross-section of the fiber sheet 24 after having been sprayed with high-pressure steam (location indicated by reference symbol 26 in FIG. 1). Regions 55, where a plurality of the grooves 32 are present in the fiber sheet 24 that were formed by the high-pressure water streams, correspond to the regions where moisture content has not been increased, and are regions where the strength of the fiber sheet 24 is high. Regions 56, where the grooves 52 and bulky portions 54 are present that were formed by the high-pressure steam, correspond to those regions where moisture content is increased, and are regions where strength is slightly lower than the aforementioned regions 55. In this manner, a preferable balance between strength and bulk can be achieved in the fiber sheet 24 by forming the regions 55, where strength is high but bulk is not high, and regions 56, where strength is low but bulk is high. In addition, as the bulk of the fiber sheet 24 increases, water retention of the fiber sheet 24 is improved and wet strength of the fiber sheet 24 is also improved. Moreover, grooves can also be formed in the fiber sheet 24 by high-pressure steam while suppressing decreases in strength of the fiber sheet 24 caused by the high-pressure steam.

[0045]

In the case of using the fiber sheet as a non-woven fabric for wiping up soiling, the regions 56 where the grooves 52 and the bulky portions 54 are present in the fiber sheet 24 are able to wipe up the soiling, while the regions 55 where the plurality of grooves 32 is present can be used to absorb soiling that has been wiped up. Thus, wiping performance of the fiber sheet is improved by the presence of these two types of regions 55 and 56.

[0046]

The hole diameter of the steam nozzle 14 is preferably 150 μm to 600 μm. If the hole diameter of the steam nozzle 14 is 150 μm or more, it may be ensured that the energy of the high-pressure steam is adequate, thereby ensuring sufficient fiber separation. In addition, if the hole diameter of the steam nozzle 14 is 600 μm or less, it may be ensured that the energy of the high-pressure steam is not excessively large, thereby ensuring the problem of the fiber sheet 24 being excessively damaged by the high-pressure steam is avoided.

[0047]

The hole pitch (distance between the centers of adjacent holes) of the steam nozzle 14 is preferably 1.0 mm to 10.0 mm. If the hole pitch of the steam nozzle 14 is 1.0 mm or less, the withstand pressure of the steam nozzle 14 increases, ensuring there is no risk of damage to the steam nozzle 14. In addition, if the hole pitch of the steam nozzle 14 is 10.0 mm or less, the proportion of those portions of the fiber sheet subjected to treatment by high-pressure steam increases, effectively avoiding a decrease in the effect of the high-pressure steam on the fiber sheet.

[0048]

The holes of the steam nozzle 14 may be arranged in a single row or in two or more rows in the cross machine direction (CD) of the fiber sheet 24. In addition, two or more holes in the steam nozzle 14 arranged in the cross machine direction (CD) may constitute groups of holes, and these groups of holes of the steam nozzles 14 may be arranged in the cross machine direction (CD) at a prescribed hole pitch. In this case, the distance between the centers of adjacent groups of holes becomes the hole pitch of the steam nozzle 14.

[0049]

FIG. 10 shows an example of the arrangement of holes in the steam nozzle 14. In the steam nozzle 14, groups of holes 142 composed of two holes 141 arranged in the cross machine direction (CD) of the fiber sheet 24 are arranged in two rows in the cross machine direction (CD). The hole diameter is, for example, 300 μm, the hole pitch, namely the distance between the centers of adjacent holes constituting the groups of holes 142 composed of the holes 141, is, for example, 2.0 mm, and a distance 143 between the centers of adjacent groups of holes 142 composed of the holes 141 is, for example, 6.0 mm.

[0050]

The temperature of the high-pressure steam is preferably higher than the temperature of the drying dryer 20 so as to prevent the moisture content of the fiber sheet 24 after having been sprayed with the high-pressure steam from being higher than the moisture content of the fiber sheet 24 before spraying with the high-pressure steam as much as possible. For example, the temperature of the high-pressure steam is preferably 130°C to 220°C. As a result, drying of the fiber sheet 24 proceeds when the high-pressure steam is sprayed onto the fiber sheet 24, and the bulk of the fiber sheet 24 can be increased simultaneous to drying. Since hydrogen bonding between fibers of the fiber sheet 24 becomes stronger when the fiber sheet 24 is dried, the strength of the fiber sheet 24 increases, and the increased bulk of the fiber sheet 24 is not easily reduced. In addition, as a result of the increase in strength of the fiber sheet 24, the formation of holes and tearing of the fiber sheet 24 caused by being sprayed with high-pressure steam are prevented.

[0051]

The moisture content of the fiber sheet 24 after being sprayed with the high-pressure steam is preferably 35% or less. If the moisture content of the fiber sheet 24 after being sprayed with the high-pressure steam is 35% or less, cases in which the moisture content of the fiber sheet 24 cannot be made to be 5% or less by drying with the drying dryer to be subsequently described may be effectively avoided. In this case, no additional drying is required thereby resulting in improved non-woven fabric production efficiency.

[0052]

In addition grooves being formed in the surface of the fiber sheet 24 by the high-pressure steam, surface irregularities (not shown) corresponding to the pattern of the outer peripheral surface of the suction drum 13 may be formed on the lower surface of the fiber sheet 24 (side of the fiber sheet 24 facing the suction drum 13).

[0053]

Subsequently, as shown in FIG. 1, the fiber sheet 24 is preferably transferred to a drying dryer 22 separate from the drying dryer 20. The drying dryer 22 is, for example, a Yankee dryer. The fiber sheet 24 is adequately dried by heating the drum of the drying dryer 22 with steam to about 150°C and adhering the fiber sheet 24 to the drum. The fiber sheet 24 after having passed over the drying dryer 22 is required to be adequately dry, and more specifically, the moisture content of the fiber sheet 24 after having passed over the drying dryer 22 is preferably 5% or less.

[0054]

As was previously described, since a prescribed pattern is formed in a fiber sheet having an extremely high moisture content of 50% by weight to 85% by weight in the method for producing bulky paper as described in Patent Literature 1, there are cases in which a large amount of energy is required in a drying step following formation of the pattern in the fiber sheet in order to dry the fiber sheet. On the other hand, in the method for producing non-woven fabric of an embodiment of the present invention, since regions of the fiber sheet having high moisture content are present in a portion of the fiber sheet, a large amount of energy is not required to dry the fiber sheet. In addition, since high-pressure steam is sprayed onto regions having high moisture content present in only a portion of the fiber sheet, the moisture content of the regions having high moisture content is further lowered, thereby further reducing the need to use a large amount of energy to dry the fiber sheet.

[0055]

The dried fiber sheet 24 is preferably wound onto a winding machine 21.

[0056]

The method for producing non-woven fabric according to the aforementioned embodiment can be modified as described below.

(1) The moisture content of regions where moisture content is increased may be allowed to be changed according to the location by changing the amount of water or aqueous solution applied to the fiber sheet. Since hydrogen bonding between fibers of the fiber sheet weakens and entanglement between fibers also weakens, the higher the moisture content of those locations where moisture content is increased is, the higher the height of the bulky portions is. Thus, as a result of changing the moisture content of regions where moisture content is increased according to the location, the height of the bulky portions can be changed according to the location, thereby increasing the degree of freedom of the surface design of the fiber sheet 24.

[0057]

(2) A solenoid valve and the like may be provided in the sprayer used to form regions where moisture content is increased on the fiber sheet, and the sprayer may intermittently release water or an aqueous solution onto the fiber sheet. As a result, regions where moisture content is increased can be formed intermittently. As was previously described, the grooves 52 and the bulky portions 54 are formed in the fiber sheet 24 when high-pressure steam is sprayed at those regions where moisture content is increased since hydrogen bonding between fibers has weakened and entanglement between fibers has weakened. However, since the moisture content of the fiber sheet is extremely low in those regions where moisture content is not increased, hydrogen bonding between fibers is strong and the fibers are strongly entangled, thereby resulting in hardly any formation of the grooves 52 and the bulky portions 54 in the fiber sheet 24 even if sprayed with high-pressure steam. Thus, by using a sprayer capable of intermittently releasing

water or an aqueous solution, even in the case of continuously spraying the high-pressure steam, grooves 52A and bulky portions 54A can be formed that are arranged in the cross machine direction (CD) and intermittently extend in the machine direction (MD) in the manner of a fiber sheet 24A shown in FIG. 11. Namely, by partially forming regions where moisture content is increased, grooves and bulky portions can be partially formed even in the case of continuously spraying high-pressure steam.

[0058]

In addition, the pattern of grooves 52 and bulky portions 54 in the fiber sheet 24 can be changed by controlling the interval at which water or an aqueous solution is released by the sprayer. As a result, costs incurred in order to change the pattern of the grooves 52 and the bulky portions 54 can be reduced. On the other hand, since it was necessary to change the perforated pattern structure, suction drum and steam nozzle in order to change the pattern formed in the fiber sheet in the method for producing bulky paper described in Patent Literature 1, considerable costs were required to change the pattern formed in the fiber sheet.

[0059]

(3) As shown in FIG. 12, regions 241B where moisture content is increased may also be formed in a portion of a fiber sheet 24B by bringing the fiber sheet 24B in close proximity to openings 231B from which are discharged water or an aqueous solution of a tube 23B containing water or an aqueous solution. Thus, the regions 241B where moisture content is increased can be formed in a portion of the fiber sheet 24 using simple equipment. As a result, grooves and bulky portions can be formed only at the regions 241B where moisture content is increased even in the case of continuously spraying high-pressure steam.

[0060]

(4) As shown in FIG. 13, regions 241C where moisture content is increased may also be formed in a portion of a fiber sheet 24C by passing the fiber sheet 24C between moisture-imparting rollers 23C. The moisture-imparting rollers 23C are preferably composed of an upper roller 231C, having a patterned portion 233C in the outer peripheral surface thereof through which water or an aqueous solution is allowed to seep out, and a lower roller 232C, having a smooth outer peripheral surface. Furthermore, the water-imparting rollers may also be composed of an upper roller having a smooth outer peripheral surface and a lower roller having a patterned portion in the outer peripheral surface thereof through which water or an aqueous solution is allowed to seep out. In addition, both the upper roller and the lower roller of the moisture-imparting rollers may have a patterned portion in the outer peripheral surface thereof through which water or an aqueous solution is allowed to seep out. The patterned portion 233C is composed of a porous body, and water or an aqueous solution supplied to the inside of the upper roller 231C is supplied to the outer peripheral surface of the upper roller 231C by passing through the patterned portion 233C. As a result, when the fiber sheet 24C passes between the moisture-imparting rollers 23C, the regions 241C where moisture content is increased can be formed in the fiber sheet 24C that are of the same size and shape as the patterned portion 233C. Changing the size and shape of the patterned portion 233C offers the convenience of enabling the size and shape of the regions 241C formed in the fiber sheet 24C where moisture content is increased to be changed as desired. As a result, grooves and bulky portions can be formed only in the regions 241C, for which the size and shape thereof can be changed as desired, even in the case of continuously spraying high-pressure steam.

[0061]

(5) The high-pressure steam is able to evaporate moisture in the fiber sheet. Thus, the moisture content of the fiber sheet after spraying with the high-pressure steam can be reduced to 5% or less by increasing the energy of the high-pressure steam. In this case, since further drying of the fiber sheet is not necessary, a drying dryer may not be provided between the steam nozzle 14 and the winding machine 21 in the manner of a non-woven fabric production device 1D shown in FIG. 14.

[0062]

(6) The method for producing non-woven fabric in the aforementioned embodiment of the present invention is a method for producing non-woven fabric by a wet method. However, the method for producing non-woven fabric of the present invention can also be applied to a method for producing non-woven fabric by a dry method. For example, a web may be supplied to a support, a fiber sheet may be formed on the support, regions may be formed in a portion of the fiber sheet where moisture content is increased to a moisture content higher than the moisture content of the fiber sheet, and high-pressure steam may be sprayed onto those regions of the fiber sheet where moisture content is increased. In addition, in order to prevent the fiber sheet from being blown away by the high-pressure steam when the high-pressure steam is sprayed onto the fiber sheet, high-pressure water may be sprayed onto the fiber sheet before spraying the fiber sheet with the high-pressure steam.

[0063]

The aforementioned embodiment can also be combined with one or a plurality of variations. The variations can also be combined in any manner.

[0064]

The aforementioned explanation has merely provided an explanation of one embodiment of the present invention, and the present invention is not limited to that embodiment.

[Examples]

[0065]

Although the following provides a more detailed explanation of the present invention based on examples thereof, the present invention is not limited to these examples.

[0066]

In the examples and comparative examples, pre-steaming fiber sheet moisture content, fiber sheet basis weight, fiber sheet thickness, dry tensile strength, dry tensile elongation, wet tensile strength and wet tensile elongation were measured in the manner described below.

[0067]

(Pre-Steaming Fiber Sheet Moisture Content)

The fiber sheet 24 onto which water was released from the sprayer 23 was sampled in the non-woven fabric production device 1 shown in FIG. 1, and a region where water was released was cut out from the sampled fiber sheet 24 followed by measuring the weight (W1) of the sample piece cut from the fiber sheet. Subsequently, the sample piece was allowed to stand undisturbed for 1 hour in a constant temperature bath at 105°C followed by drying and measuring the weight of the sample piece (D1). The moisture content of the fiber sheet prior to steam spraying was calculated using the following formula.

Pre-steaming fiber sheet moisture content = (W1-D1)/W1 × 100 (%)

The average value of pre-steaming fiber sheet moisture content of 10 sample pieces was taken to be the pre-steaming fiber sheet moisture content of the example or comparative example corresponding to that sample piece.

[0068]

(Fiber Sheet Basis Weight)

The fiber sheet 24 dried with the drying dryer 20 was sampled, and a piece was cut out to a size of 30 cm ×

30 cm to prepare a sample piece. Subsequently, the sample piece was allowed to stand undisturbed for 1 hour in a constant temperature bath at 105°C followed by drying and measuring the weight of the sample piece. The fiber sheet basis weight was calculated by dividing the measured weight of the sample piece by the area of the sample piece.

The average value of fiber sheet basis weight of 10 sample pieces was taken to be the fiber sheet basis weight of the example or comparative example corresponding to that sample piece.

[0069]

(Fiber Sheet Thickness)

The thickness of produced non-woven fabric was measured under measuring conditions consisting of a measuring load of 3 g/cm^2 using a thickness gauge (Model FS-60DS, Daiei Kagaku Seiki Mfg. Co., Ltd.) equipped with a 15 cm^2 probe. Thickness was measured at three locations for each measurement sample, and the average value of the three thicknesses was taken to be the fiber sheet thickness of the example or comparative example corresponding to that non-woven fabric.

[0070]

(Dry Tensile Strength)

A strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the machine direction (MD) of the fiber sheet and a strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the cross machine direction (CD) of the fiber sheet were cut from produced non-woven fabric to prepare measurement samples. The respective tensile strengths of three machine direction (MD) measurement samples and three cross machine direction (CD) measurement samples were measured under conditions of a clamping distance of 100 mm and tension speed of 100 mm/min using a tensile tester (Autograph Model AGS-1kNG, Shimadzu Corp.) equipped with a load cell having a maximum load capacity of 50 N. The average value of the tensile strengths of the three measurement samples was taken to be the dry tensile strength of the example or comparative example corresponding to that measurement sample.

[0071]

(Dry Tensile Elongation)

A strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the machine direction (MD) of the fiber sheet and a strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the cross machine direction (CD) of the fiber sheet were cut from produced non-woven fabric to prepare measurement samples. The respective tensile elongations of three machine direction (MD) measurement samples and three cross machine direction (CD) measurement samples were measured under conditions of a clamping distance of 100 mm and tension speed of 100 mm/min using a tensile tester (Autograph Model AGS-1kNG, Shimadzu Corp.) equipped with a load cell having a maximum load capacity of 50 N. Here, tensile elongation refers to the value obtained by dividing the maximum elongation when the measurement sample is pulled with the tensile tester by the clamping distance (100 mm). The average value of the tensile elongations of the three measurement samples was taken to be the dry tensile elongation of the example or comparative example corresponding to that measurement sample.

[0072]

(Wet Tensile Strength)

A strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the machine direction (MD) of the fiber sheet and a strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the cross machine direction (CD) of the fiber sheet were cut from produced non-woven fabric, followed by impregnating the resulting test pieces with an amount of water equal to 2.5 times the weight thereof (moisture content: 250%) to prepare measurement samples. The respective tensile strengths of three machine direction (MD) measurement samples and three cross machine direction (CD) measurement samples were measured under conditions of a clamping distance of 100 mm and tension speed of 100 mm/min using a tensile tester (Autograph Model AGS-1kNG, Shimadzu Corp.) equipped with a load cell having a maximum load capacity of 50 N. The average value of the tensile strengths of the three measurement samples was taken to be the wet tensile strength of the example or comparative example corresponding to that measurement sample.

[0073]

(Wet Tensile Elongation)

A strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the machine direction (MD) of the fiber sheet and a strip-like test piece having a width of 25 mm such that the lengthwise direction thereof was the cross machine direction (CD) of the fiber sheet were cut from produced non-woven fabric, followed by impregnating the resulting test pieces with an amount of water equal to 2.5 times the weight thereof (moisture content: 250%) to prepare measurement samples. The respective tensile elongations of three machine direction (MD) measurement samples and three cross machine direction (CD) measurement samples were measured under conditions of a clamping distance of 100 mm and tension speed of 100 mm/min using a tensile tester (Autograph Model AGS-1kNG, Shimadzu Corp.) equipped with a load cell having a maximum load capacity of 50 N. The average value of the tensile elongations of the three measurement samples was taken to be the wet tensile elongation of the example or comparative example corresponding to that measurement sample.

[0074]

The following provides an explanation of methods used to produce the examples and comparative examples.

[0075]

(Example 1)

Example 1 was produced using the non-woven fiber production device 1 in an embodiment of the present invention shown in FIG. 1. A papermaking raw material was produced that contained 70% by weight of northern bleached kraft pulp (NBKP) and 30% by weight of rayon having fineness of 1.1 dtex and fiber length of 7 mm (Corona, Daiwabo Rayon Co., Ltd.). The basis weight of the papermaking raw material was 45 g/m^2. The papermaking raw material was supplied to the fiber sheet forming belt 16 (OS80, Nippon Filcon Co., Ltd.) using the raw material supply head 11, and the papermaking raw material was dehydrated using the suction boxes 15 to form the fiber sheet 24. The fiber sheet moisture content of the fiber sheet 24 at this time was 80%. Subsequently, high-pressure water streams were sprayed into the fiber sheet 24 using two high-pressure water nozzles 12. The high-pressure water flow energy of the high-pressure water streams sprayed onto the fiber sheet 24 using the two high-pressure water nozzles 12 was 0.46 kW/m^2. Here, the high-pressure water flow energy was calculated using the following formula:

high-pressure water flow energy (kW/m^2) = 1.63 × spraying pressure (kg/cm^2) × spraying flow rate (m^3/min) / processing speed (m/min)

where,

spraying pressure (kg/cm^2) = 750 × total orifice opening surface area (m^2) × spraying pressure (kg/cm^2)$^{0.495}$

[0076]

In addition, the distance between the ends of the high-pressure water nozzles 12 and the surface of the fiber sheet 24 was 10 mm. Moreover, the hole diameter of the high-pressure water nozzles 12 was 92 μm and the hole pitch was 0.5 mm.

[0077]

After being transferred to the two fiber sheet transport conveyors 18 and 19, the fiber sheet 24 was transferred to the Yankee dryer 20 heated to 120°C and dried so that the moisture content of the fiber sheet 24 was 8% or less.

[0078]

Next, a plurality of regions where moisture content was increased was formed in a portion of the fiber sheet 24 by releasing water onto the fiber sheet 24 from the sprayer 23. The hole diameter of the sprayer 23 was 200 μm, and the hole pitch of the sprayer 23 was 6 mm. The pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where the moisture content was increased was 40%.

[0079]

Next, high-pressure steam was sprayed onto the regions of the fiber sheet 24 where moisture content was increased using two steam nozzles 14. The steam pressure of the high-pressure steam at this time was 0.7 MPa and the steam temperature was 190°C. In addition, the distance between the ends of the steam nozzles 14 and the surface of the fiber sheet was 2 mm. Moreover, the arrangement of holes in the steam nozzles was the arrangement of holes shown in FIG. 10, the hole diameter of the steam nozzles was 300 μm and the hole pitch was 2.0 mm. In addition, the suction force used by the suction drum 13 to suction the fiber sheet was -1 kPa. A stainless steel, 18 mesh perforated sleeve was used for the outer peripheral surface of the suction drum 13. The moisture content of the fiber sheet 24 in the regions where moisture content was increased after the fiber sheet 24 was sprayed with the high-pressure steam was 35%.

[0080]

The fiber sheet 24 was then transferred to the

Yankee dryer 22 heated to 150°C and dried so that the moisture content of the fiber sheet 24 was 5% or less. The dried fiber sheet 24 was used as Example 1. The line speed during production of Example 1 was 50 m/min.

[0081]

(Example 2)

Example 2 was produced according to the same method as the production method of Example 1 with the exception of making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 60% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24.

[0082]

(Example 3)

Example 3 was produced according to the same method as the production method of Example 1 with the exception of making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 80% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24.

[0083]

(Comparative Example 1)

Comparative Example 1 was produced according to the same method as the production method of Example 1 with the exception of not releasing water onto the fiber sheet 24 from the sprayer 23.

[0084]

(Examples 4 to 8)

Examples 4 to 8 were produced according to the same method as the production method of Example 1 with the exception of using a single steam nozzle 14 and changing the line speed.

[0085]

(Examples 9 to 13)

Examples 9 to 13 were produced according to the same method as the production method of Example 1 with the exception of using a single steam nozzle 14, making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 60% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24, and changing the line speed.

[0086]

(Examples 14 to 18)

Examples 14 to 18 were produced according to the same method as the production method of Example 1 with the exception of using a single steam nozzle 14, making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 80% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24, and changing the line speed.

[0087]

(Examples 19 to 22)

Examples 19 to 22 were produced according to the same method as the production method of Example 1 with the exception of changing the line speed.

[0088]

(Examples 23 to 26)

Examples 23 to 26 were produced according to the same method as the production method of Example 1 with the exception of making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 60% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24, and changing the line speed.

[0089]

(Examples 27 to 30)

Examples 27 to 30 were produced according to the same method as the production method of Example 1 with the exception of making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 80% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24, and changing the line speed.

[0090]

(Examples 31 and 32)

Examples 31 and 32 were produced according to the same method as the production method of Example 1 with the exception of using a single steam nozzle 14, further providing the steam nozzle 14 and the suction drum 13 such that the vertical positional relationship thereof was inverted, making the pre-steaming fiber sheet moisture content of the fiber sheet 24 in the regions where moisture content was increased to be 80% by adjusting the amount of water released from the sprayer 23 onto the fiber sheet 24, and changing the line speed.

[0091]

The detailed production conditions used for the aforementioned examples and comparative examples are shown in Tables 1 to 3.

[0092]

[Table 1] Comparative Example and Example Production Conditions

	Papermaking raw materials		High-pressure water flow energy (kW/m²)	Steam pressure (MPa)	Steam nozzle temp. (°C)	Steam nozzle hole diam. (μm)	Steam nozzle hole pitch (mm)	No. of steam nozzles	Distance between steam nozzles and fiber sheet (mm)	Pressure of fiber sheet forming belt (kPa)	Mesh of fiber sheet forming belt	Pre-steaming fiber sheet moisture content	Line speed (m/min)
	NBKP (CSF700cc)	Rayon 1.1 dtex × 7 mm											
Ex.1	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	40%	50
Ex.2	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	60%	50
Ex.3	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	80%	50
Comp.Ex.1	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	5%	50

[0093]

[Table 2] Example Production Conditions

	Papermaking raw materials		High-pressure water flow energy (kW/m^2)	Steam pressure (MPa)	Steam nozzle temp. (°C)	Steam nozzle hole diam. (μm)	Steam nozzle hole pitch (mm)	No. of steam nozzles	Distance between steam nozzle and fiber sheet (mm)	Pressure of fiber sheet forming belt (kPa)	Mesh of fiber sheet forming belt	Pre-steaming fiber sheet moisture content	Line speed (m/min)
	NBKP (CSF700cc)	Rayon 1.1 dtex × 7 mm											
Ex.4	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	40%	50
Ex.5	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	40%	100
Ex.6	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	40%	150
Ex.7	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	40%	200
Ex.8	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	40%	250
Ex.9	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	60%	50
Ex.10	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	60%	100
Ex.11	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	60%	150
Ex.12	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	60%	200
Ex.13	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	60%	250
Ex.14	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	80%	50
Ex.15	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	80%	100
Ex.16	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	80%	150
Ex.17	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	80%	200
Ex.18	70%	30%	0.46	0.7	190	300	2	1	2	-1.0	18	80%	250

[0094]

[Table 3] Example Production Conditions

	Papermaking raw materials		High-pressure water flow energy (kW/m^2)	Steam pressure (MPa)	Steam nozzle temp. (°C)	Steam nozzle hole diam. (μm)	Steam nozzle hole pitch (mm)	No. of steam nozzles	Distance between steam nozzles and fiber sheet (mm)	Pressure of fiber sheet forming belt (kPa)	Mesh of fiber sheet forming belt	Pre-steaming fiber sheet moisture content	Line speed (m/min)
	NBKP (CSF700cc)	Rayon 1.1 dtex × 7 mm											
Ex.19	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	40%	100
Ex.20	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	40%	150
Ex.21	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	40%	200
Ex.22	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	40%	250
Ex.23	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	60%	100
Ex.24	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	60%	150
Ex.25	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	60%	200
Ex.26	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	60%	250
Ex.27	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	80%	100
Ex.28	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	80%	150
Ex.29	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	80%	200
Ex.30	70%	30%	0.46	0.7	190	300	2	2	2	-1.0	18	80%	250
Ex.31	70%	30%	0.46	0.7	190	300	2	1 upper 1 lower	2	-1.0	18	80%	100
Ex.32	70%	30%	0.46	0.7	190	300	2	1 upper 1 lower	2	-1.0	18	80%	250

[0095]

The fiber sheet thickness, dry tensile strength, dry tensile elongation, wet tensile strength and wet tensile elongation of the aforementioned examples and comparative examples are shown in Tables 4 to 6.

[0096]

[Table 4] Fiber Sheet Basis Weight, Fiber Sheet Thickness, Dry Tensile Strength, Dry Tensile Elongation, Wet Tensile Strength and Wet Tensile Elongation of Examples and Comparative Examples

	Fiber sheet basis weight (g/m^2)	Fiber sheet dry thickness (mm)	Dry tensile strength (N/25 mm)		Dry tensile elongation (%)		Wet tensile strength (N/25 mm)		Wet tensile elongation (%)	
			MD	CD	MD	CD	MD	CD	MD	CD
Ex.1	45.3	0.62	6.05	3.41	4.91	8.89	0.99	0.75	15.83	18.86
Ex.2	45.0	0.67	6.82	3.44	7.72	8.61	1.65	0.87	26.83	25.58
Ex.3	45.6	0.70	5.69	3.23	7.03	8.72	1.17	0.86	21.53	21.36
Comp.Ex.1	48.6	0.28	22.9	11.50	1.45	1.95	1.11	0.69	3.64	2.27

[0097]

[Table 5] Fiber Sheet Basis Weight, Fiber Sheet Thickness, Dry Tensile Strength, Dry Tensile Elongation, Wet Tensile Strength and Wet Tensile Elongation of Examples

	Fiber sheet basis weight (g/m^2)	Fiber sheet dry thickness (mm)	Dry tensile strength (N/25 mm)		Dry tensile elongation (%)		Wet tensile strength (N/25 mm)		Wet tensile elongation (%)	
			MD	CD	MD	CD	MD	CD	MD	CD
Ex.4	47.2	0.57	4.53	2.85	6.47	9.89	1.42	0.66	22.00	19.78
Ex.5	46.9	0.53	8.17	5.24	6.55	8.50	1.47	1.05	24.09	26.28
Ex.6	46.0	0.49	6.17	4.10	5.00	7.83	1.35	0.76	24.47	18.00
Ex.7	46.8	0.52	7.31	4.83	6.96	10.11	1.30	0.85	22.89	19.50
Ex.8	46.3	0.50	7.29	4.88	4.23	9.39	1.28	0.75	20.50	18.92
Ex.9	47.2	0.62	8.10	4.89	7.38	13.50	1.42	1.02	23.06	26.06
Ex.10	45.6	0.56	8.23	4.44	4.83	9.06	1.54	0.84	23.78	24.58
Ex.11	44.6	0.53	7.59	4.54	5.00	8.75	1.45	0.85	18.28	23.55
Ex.12	45.8	0.52	7.83	4.82	5.55	9.89	1.72	0.89	25.86	26.28
Ex.13	46.3	0.52	7.83	4.77	6.39	8.16	1.19	0.96	16.14	22.20
Ex.14	45.7	0.61	6.60	3.64	6.25	7.94	1.50	0.91	22.56	27.94
Ex.15	45.8	0.57	6.38	2.75	6.39	6.72	1.23	0.91	20.83	24.83
Ex.16	44.0	0.50	6.25	3.02	5.78	9.11	1.19	0.62	16.03	20.92
Ex.17	43.5	0.54	5.27	3.25	5.16	11.14	1.43	0.75	26.14	25.55
Ex.18	43.1	0.53	6.34	3.84	5.25	11.05	1.00	0.67	20.59	19.50

[0098]

[Table 6] Fiber Sheet Basis Weight, Fiber Sheet Thickness, Dry Tensile Strength, Dry Tensile Elongation, Wet Tensile Strength and Wet Tensile Elongation of Examples

	Fiber sheet basis weight (g/m^2)	Fiber sheet dry thickness (mm)	Dry tensile strength (N/25 mm)		Dry tensile elongation (%)		Wet tensile strength (N/25 mm)		Wet tensile elongation (%)	
			MD	CD	MD	CD	MD	CD	MD	CD
Ex.19	45.4	0.62	6.83	4.00	5.44	7.14	1.23	0.68	19.17	19.45
Ex.20	45.8	0.53	7.49	3.97	6.19	9.89	1.66	0.95	24.47	28.28
Ex.21	45.0	0.55	7.49	3.60	4.44	8.47	1.30	0.93	16.25	30.25
Ex.22	45.8	0.53	6.63	2.57	5.11	5.28	1.44	0.65	17.95	18.58
Ex.23	45.0	0.60	7.76	4.79	6.06	10.75	1.59	0.98	22.39	27.42
Ex.24	45.7	0.58	6.93	3.49	5.11	7.19	1.71	0.91	23.69	23.75
Ex.25	44.4	0.54	7.73	3.26	5.47	8.28	1.64	0.80	25.47	20.81
Ex.26	44.3	0.56	7.74	3.17	5.64	6.86	1.48	0.78	19.72	20.50
Ex.27	44.7	0.62	7.25	4.09	8.67	14.83	1.22	0.89	18.22	22.83
Ex.28	45.0	0.60	7.47	3.53	4.44	8.39	1.48	0.91	25.11	27.78
Ex.29	44.3	0.61	7.31	3.10	5.97	8.22	1.19	0.81	18.00	30.78
Ex.30	44.3	0.58	6.12	4.95	6.72	10.50	1.17	1.05	19.44	28.39
Ex.31	43.3	0.68	5.71	3.21	5.44	8.00	1.13	0.98	18.92	27.72
Ex.32	43.5	0.63	6.53	3.72	6.16	8.53	1.39	0.96	28.86	33.22

[0099]

All of the fiber thicknesses of Examples 1 to 32 were greater than the fiber sheet thickness of Comparative Example 1. In addition, all of the wet tensile elongations of Examples 1 to 32 were greater than the wet tensile elongation of Comparative Example 1. As a result, according to the method for producing non-woven fabric according to the present invention, non-woven fabric can be produced that is bulky and has flexibility in a wet state.

[0100]

Moreover, a sample (Comparative Example 2) having a moisture content of 40% throughout the entire fiber sheet before spraying with steam was prepared by controlling the temperature of drying dryer 20 and without applying water from the sprayer 23. The moisture content of the entire fiber sheet of comparative Example 2 after spraying with steam and before finally drying was 31%. In addition, the moisture content of the entire fiber sheet of Example 1 was measured after spraying steam onto it and before finally drying it. As a result, the moisture content of Example 1 was 18%. As a result, a large amount of energy was determined to not be required to dry the fiber sheet according to the present invention since the moisture content of Example 1 after spraying with steam and before finally drying is low.

INDUSTRIAL APPLICABILITY

[0101]

Non-woven fabric produced according to the method for producing non-woven fabric of the present invention can be preferably used as cooking paper, paper towels, tissue, wet tissue, non-woven fabric cleaning products and the like.

[0102]

The disclosure regarding the present invention described above may be summarized in the following general description, which may be considered in isolation of the exemplary embodiments above:

(i) According to a first aspect, there is provided a method for producing non-woven fabric, comprising: a step for forming a fiber sheet on a support, a step for forming regions where the moisture content is increased to a moisture content higher than the moisture content of the fiber sheet, and a step for spraying high-pressure steam onto the regions of the fiber sheet where moisture content is increased.

The aspect described in the above item (i) may include at least the following embodiments, which may be taken in isolation or in combination with one another:

In the step for forming a fiber sheet the fiber sheet may be formed by supplying a papermaking raw material containing moisture to the support, wherein there may be further provided a step for drying the fiber sheet, and wherein in the step for forming regions where the moisture content is increased, the moisture content may be increased to a moisture content higher than the moisture content of the fiber sheet that has been dried by the step for drying the fiber sheet in a portion of the fiber sheet dried by the step for drying the fiber sheet.

The moisture content of the fiber sheet following the drying step is preferably less than 10% and more preferably 8% or less.

The papermaking raw material may comprise fibers having a fiber length of 20 mm or less. All of the fibers or some only of the fibers forming the fiber sheet may have a length of 20 mm or less.

The method may further comprise a step for spraying high-pressure water streams onto the fiber sheet prior to the step for drying the fiber sheet.

A plurality of high pressure water streams may be arranged in a machine cross direction, each of the streams being arranged to create a groove in an upper surface of the fiber sheets, which extends in a machine direction, such that the fiber sheet is provided with a plurality of grooves spaced from one another in the cross machine direction and extending in the machine direction.

High-pressure water nozzles that are provided to supply the high pressure water streams may have a hole diameter of 90 μm to 150 μm.

The hole pitch of the high-pressure water nozzles is preferably 0.5 to 1.0 mm.

In the step for forming a fiber sheet the fiber sheet may be formed by supplying a web to the support, and wherein in the step for forming regions where the moisture content is increased, the moisture content may be increased to a moisture content that is higher than the moisture content of the fiber sheet in a portion of the fiber sheet.

The moisture content of the fiber sheet in the regions of the fiber sheet where moisture content is increased is preferably 10% to 80%.

The moisture content of the fiber sheet is preferably increased only in the regions of the fiber sheet where moisture content is increased with the moisture content outside these regions not being altered during the step for forming regions where the moisture content is increased.

The plurality of regions where moisture content is increased are preferably spaced from one another in the cross machine direction of the fiber sheet and extend in the machine direction of the fiber sheet.

The plurality of regions where moisture content is increased may comprise lines that extend intermittently in the machine direction.

A plurality of regions where the moisture content of the fiber sheet is not increased are preferably provided between adjacent regions where the moisture content is increased.

In the step for forming regions where moisture content is increased, the regions where moisture content is increased are preferably formed in a portion of the fiber sheet by applying water or an aqueous solution to the fiber sheet using a sprayer.

The sprayer is preferably able to intermittently release water or an aqueous solution.

In the step for forming regions where moisture content is increased, the regions where moisture content is increased may be formed in a portion of the fiber sheet by bringing the fiber sheet in close proximity to openings from which water or an aqueous solution are discharged from a tube containing water or an aqueous solution.

In the step for forming regions where moisture content is increased, the regions where moisture content is increased may be formed in a portion of the fiber sheet by passing the fiber sheet between moisture-imparting rollers that include a roller having a patterned portion in the outer peripheral surface thereof through which water or an aqueous solution is allowed to seep out.

A plurality of streams of high-pressure steam may be provided, arranged in one or more rows in a cross machine direction of the fiber sheet, each of the streams being arranged to create a groove in a surface of the fiber sheet, which extends in a machine direction, such that the fiber sheet is provided with a plurality of grooves spaced from one another in the cross machine direction and extending in the machine direction.

Bulky portions may be formed either side in the cross machine direction of each of the grooves formed by the high-pressure steam.

The hole diameter of the steam nozzle is preferably larger than the hole diameter of the high-pressure water nozzles.

The hole pitch of the steam nozzle is preferably larger than the hole pitch of the high-pressure water nozzles.

The grooves formed by the high-pressure water streams and the grooves formed by the streams of high-pressure steam are preferably arranged such that a plurality of the grooves formed by the high-pressure water streams lie between each pair of the grooves formed by the streams of high-pressure steam in the cross machine direction. All of the grooves are preferably parallel to one another.

The moisture content of the fiber sheet after being sprayed with the high-pressure steam is preferably 35% or less.

The temperature of the high-pressure steam is preferably higher than the temperature of a drying dryer used in the step for drying the fiber sheet.

The temperature of the high-pressure steam is preferably 130°C to 220°C.

The steam pressure of high-pressure steam is preferably 0.3 MPa to 1.5 MPa.

Preferably, in the step for spraying high-pressure steam onto the fiber sheets, high-pressure steam is sprayed from a single steam nozzle or plural steam nozzles. The distance between the end of the steam nozzle and the upper surface of the fiber sheet may be 1.0 to 10.0mm. The diameter of the holes in the steam nozzle may be 150 μm to 600 μm. The hole pitch of the steam nozzle may be 1.0 to 10.0mm. The holes of the steam nozzle may be arranged in a single row extending in the cross machine direction or in two or more rows. Two or more holes in the steam nozzle spaced in the cross machine direction may constitute groups of holes, and these groups of holes of the steam nozzles may be arranged in the cross machine direction at a prescribed hole pitch.

In the step for spraying high-pressure steam onto the fiber sheets, the high-pressure steam that passes through the fiber sheets is suctioned at a suction force of -1 kPa to -12 kPa.

BRIEF DESCRIPTION OF THE REFERENCE SYMBOLS

[0103]

1,1D Non-woven fabric production device
11 Raw material supply head
12 High-pressure water nozzle
13 Suction drum
14 Steam nozzle
15 Suction box
16 Fiber sheet forming conveyor
17 Suction pickup
18,19 Fiber sheet transport conveyors
20,22 Drying dryers
21 Winding machine
23 Sprayer
24 Fiber sheet
31 High-pressure water streams
32 Grooves
41 Fiber sheet forming belt
51 High-pressure steam
52 Grooves
54 Bulky portions
241 Regions where moisture content is increased

CLAIMS

1. A method for producing non-woven fabric, comprising:

a step for forming a fiber sheet on a support,

a step for forming regions where the moisture content is increased to a moisture content higher than the moisture content of the fiber sheet, and

a step for spraying high-pressure steam onto the regions of the fiber sheet where moisture content is increased.

2. The method for producing non-woven fabric according to claim 1, wherein in the step for forming a fiber sheet the fiber sheet is formed by supplying a papermaking raw material containing moisture to the support, wherein there is further provided a step for drying the fiber sheet, and wherein in the step for forming regions where the moisture content is increased, the moisture content is increased to a moisture content higher than the moisture content of the fiber sheet that has been dried by the step for drying the fiber sheet in a portion of the fiber sheet dried by the step for drying the fiber sheet.

3. The method for producing non-woven fabric according to claim 1, wherein in the step for forming a fiber sheet the fiber sheet is formed by supplying a web to the support, and wherein in the step for forming regions where the moisture content is increased, the moisture content is increased to a moisture content that is higher than the moisture content of the fiber sheet in a portion of the fiber sheet.

4. The method for producing non-woven fabric according to claim 2, further comprising a step for spraying high-pressure water streams onto the fiber sheet prior to the step for drying the fiber sheet.

5. The method for producing non-woven fabric according to claim 4, wherein a plurality of high

pressure water streams are arranged in a machine cross direction, each of the streams being arranged to create a groove in an upper surface of the fiber sheet, which extends in a machine direction, such that the fiber sheet is provided with a plurality of grooves spaced from one another in the cross machine direction and extending in the machine direction.

6. The method for producing non-woven fabric according to any of claims 1 to 5, wherein the moisture content of the fiber sheet in the regions of the fiber sheet where moisture content is increased is 10% to 80%.

7. The method for producing non-woven fabric according to any of claims 1 to 6, wherein the plurality of regions where the moisture content is increased comprise lines that extend in the machine direction of the fiber sheet and are spaced from one another in the cross machine direction of the fiber sheet, and wherein regions where the moisture content of the fiber sheet is not increased are provided between adjacent pairs of regions where the moisture content is increased.

8. The method for producing non-woven fabric according to any of claims 1 to 7, wherein in the step for forming regions where moisture content is increased, the regions where moisture content is increased are formed in a portion of the fiber sheet by applying water or an aqueous solution to the fiber sheet using a sprayer.

9. The method for producing non-woven fabric according to claim 8, wherein the sprayer is able to intermittently release water or an aqueous solution.

10. The method for producing non-woven fabric according to any of claims 1 to 7, wherein in the step for forming regions where moisture content is increased, the regions where moisture content is increased are formed in a portion of the fiber sheet by bringing the fiber sheet in close proximity to openings from which water or an aqueous solution are discharged from a tube

containing water or an aqueous solution.

11. The method for producing non-woven fabric according to any of claims 1 to 7, wherein in the step for forming regions where moisture content is increased, the regions where moisture content is increased are formed in a portion of the fiber sheet by passing the fiber sheet between moisture-imparting rollers that include a roller having a patterned portion in the outer peripheral surface thereof through which water or an aqueous solution is allowed to seep out.

12. The method for producing non-woven fabric according to any preceding claim, wherein a plurality of streams of high-pressure steam are provided, arranged in one or more rows in a cross machine direction of the fiber sheet, each of the streams being arranged to create a groove in a surface of the fiber sheet, which extends in a machine direction, such that the fiber sheet is provided with a plurality of grooves spaced from one another in the cross machine direction and extending in the machine direction.

13. The method for producing wet tissue according to claim 12, wherein bulky portions are formed either side of each of the grooves in the cross machine direction.

14. The method for producing wet tissue according to claim 12 or 13 when dependent on any of claims 4 to 11, wherein a hole diameter of a steam nozzle, which produces the streams of high-pressure steam is larger than the hole diameter of high-pressure water nozzles, which produce the high pressure water streams and the hole pitch of the steam nozzle is preferably larger than the hole pitch of the high-pressure water nozzles.

15. The method for producing wet tissue according to claim 12, 13 or 14 when dependent on any of claims 4 to 11, wherein the grooves formed by the high-pressure water streams and the grooves formed by the streams of high-pressure steam are preferably arranged such that a

plurality of the grooves formed by the high-pressure water streams lie between each pair of the grooves formed by the streams of high-pressure steam in the cross machine direction.

Fig.1

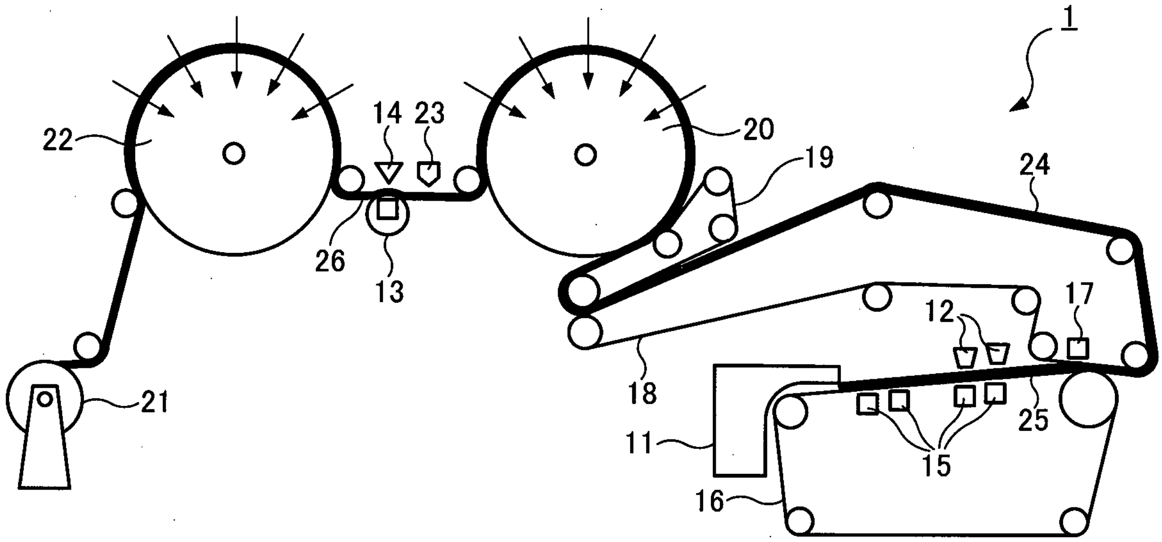


Fig.2

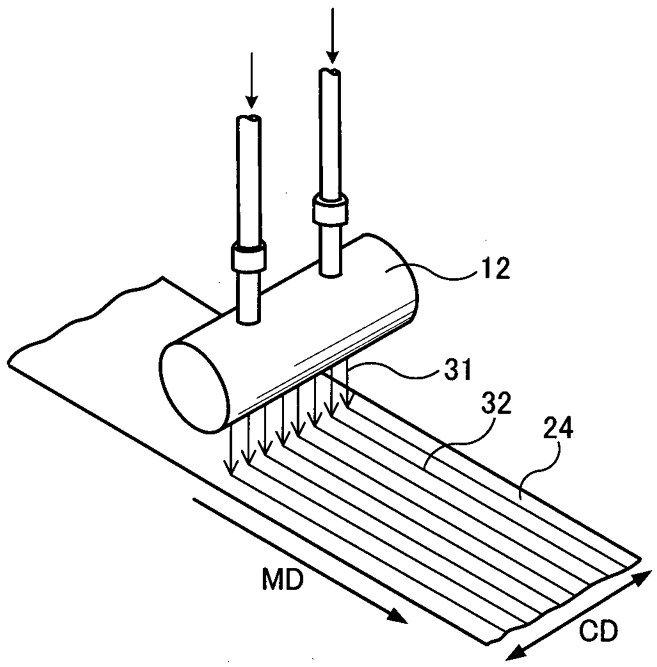


Fig.3

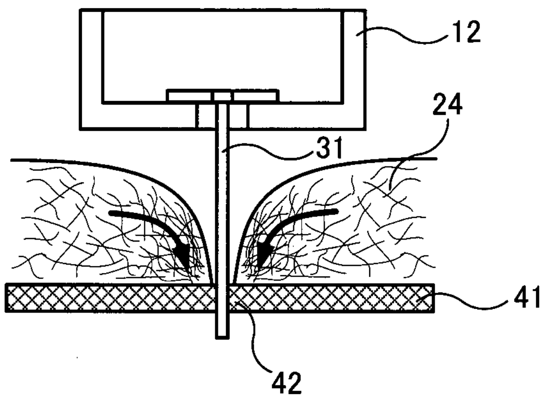


Fig.4

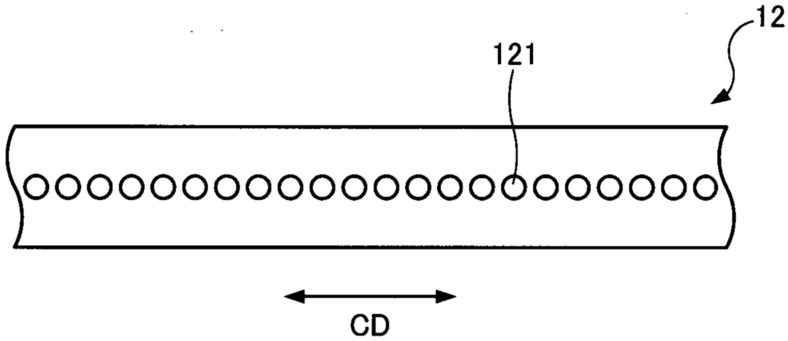


Fig.5

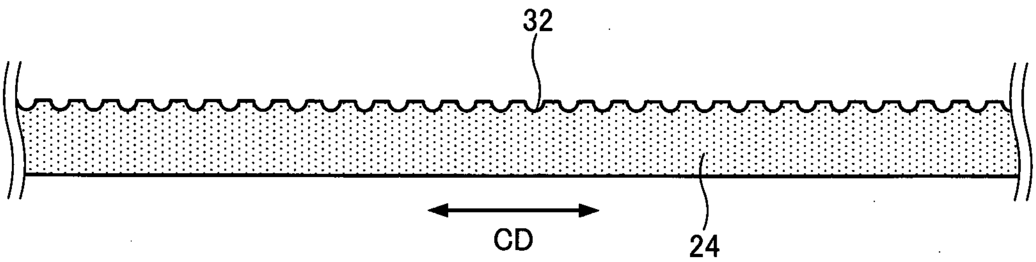


Fig.6

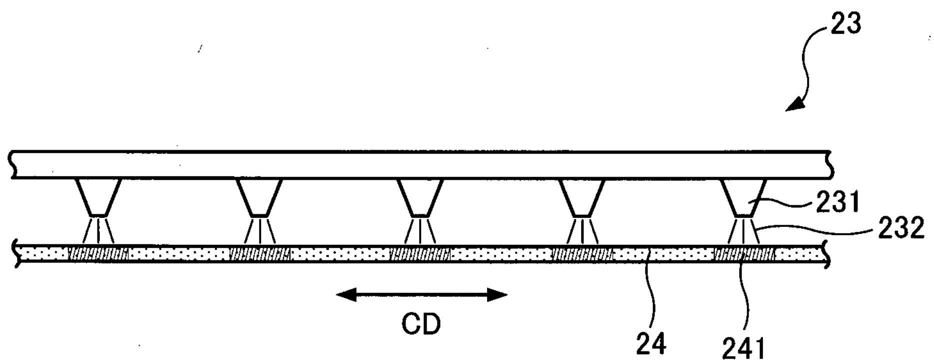


Fig.7

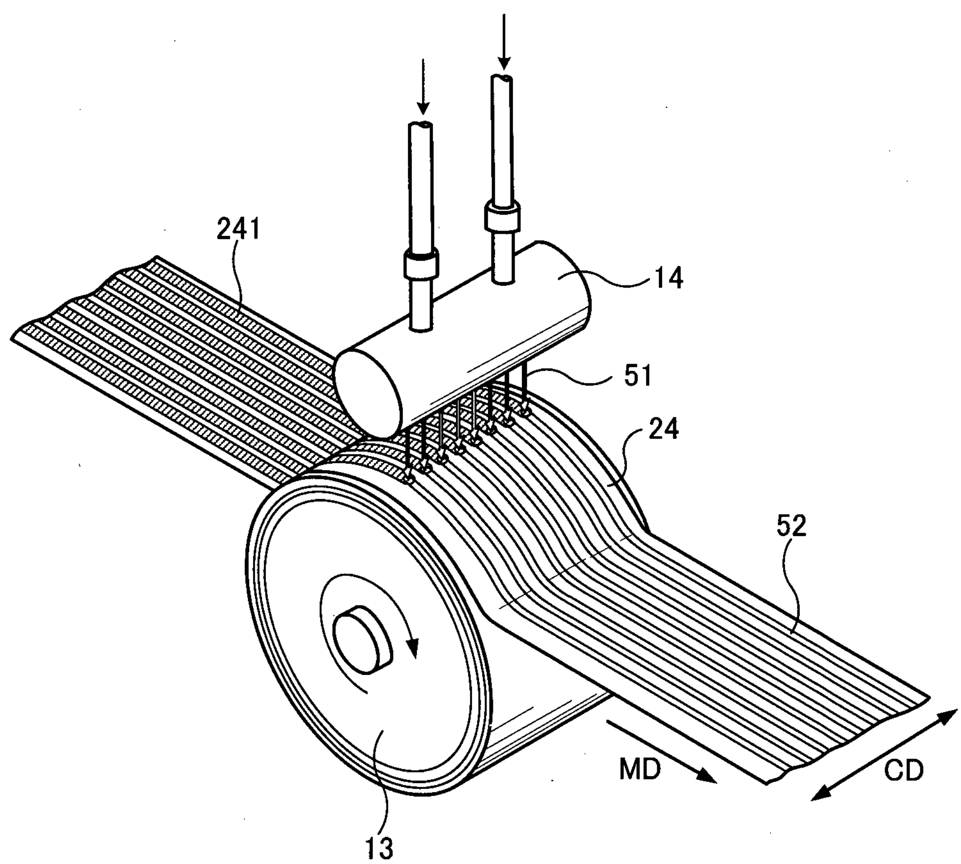


Fig.8

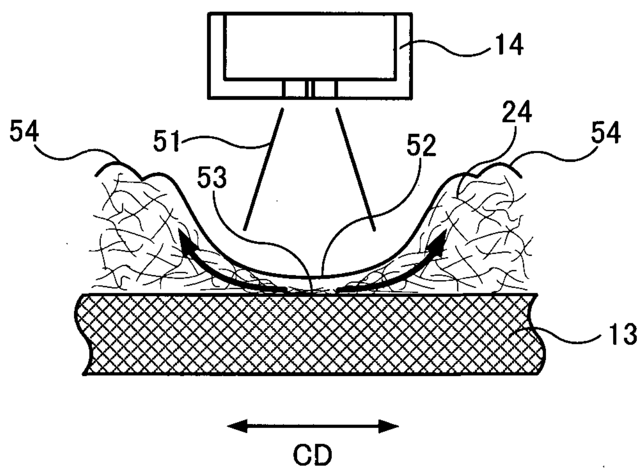


Fig.9

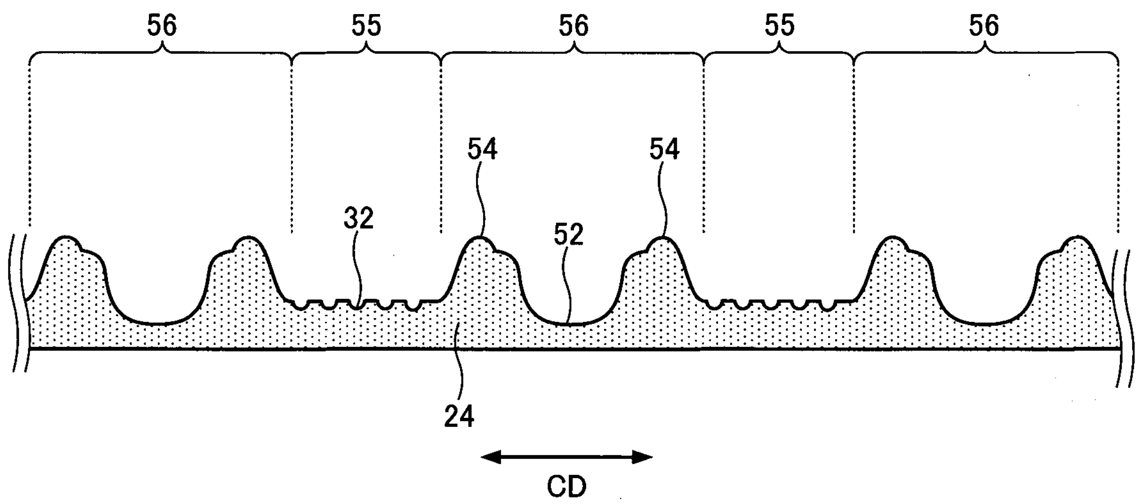


Fig.10

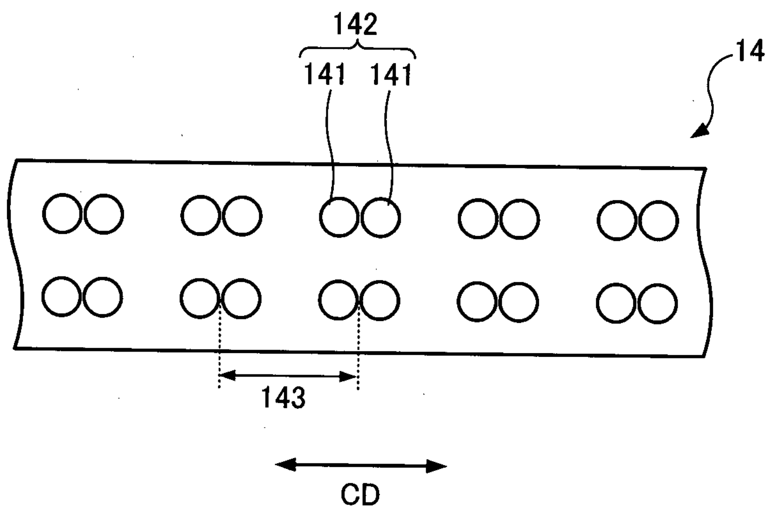


Fig.11

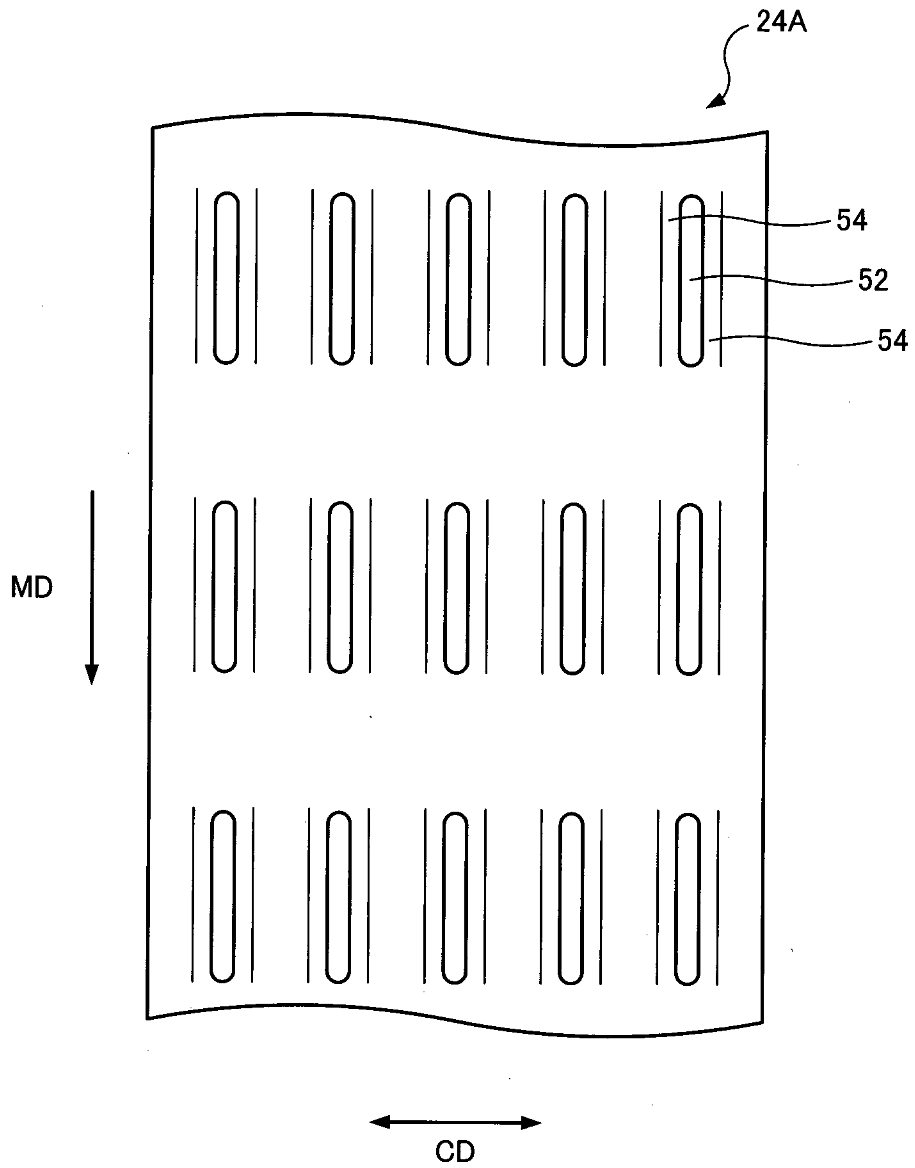


Fig.12

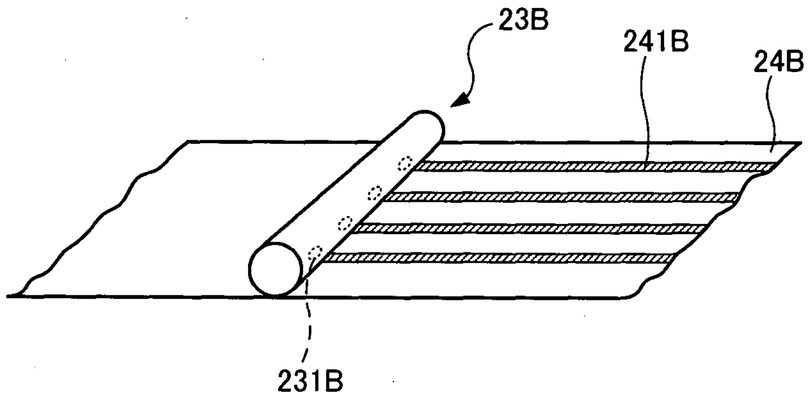


Fig.13

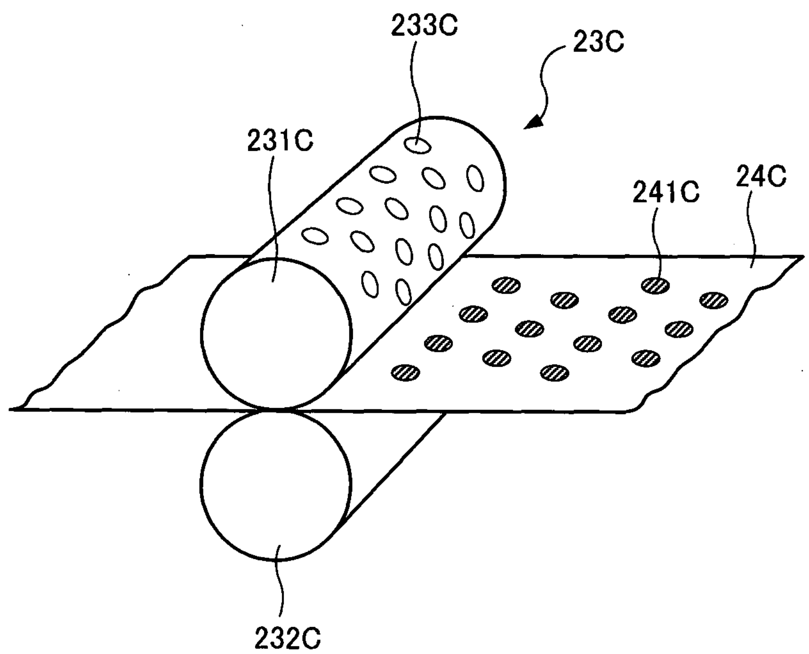
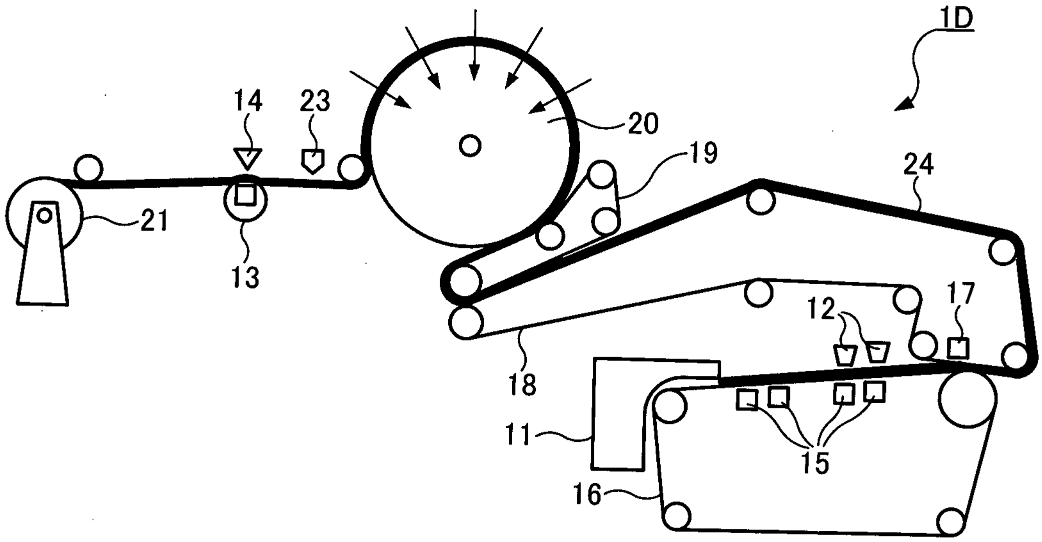


Fig.14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/075286

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. D21H25/16(2006.01)i, D21H27/00(2006.01)i

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)

Int.Cl. D21B1/00-1/38, D21C1/00-11/14, D21D1/00-99/00, D21F1/00-13/12, D21G1/00-9/00, D21H11/00-27/42, D21J1/00-7/00, D04H1/00-18/04, A47K7/00-10/48

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2012
Registered utility model specifications of Japan 1996-2012
Published registered utility model applications of Japan 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2009-97133 A (KURARAY KURAFLEX CO., LTD.) 2009.05.07, 【0063】-【0078】 (Family: none)	1,3-5,7-10, 12-15 2,6,11
P,X	JP 2012-202004 A (UNICHARM CORPORATION) 2012.10.22, Claims1-6 (Family: none)	1,3,4,8,10
P,X	JP 2012-202011 A (UNICHARM CORPORATION) 2012.10.22, claims1-5 (Family: none)	1,3,4,8,10

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25.10.2012	06.11.2012

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