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(71) Applicant: **Japan Tobacco, Inc.**
Tokyo 105-8422 (JP)

(72) Inventors:
- **TAGUCHI, Satoshi**
  Tokyo 130-8603 (JP)
- **UEMATSU, Hiromi**
  Tokyo 130-8603 (JP)
- **NISHIMURA, Manabu**
  Tokyo 130-8603 (JP)
- **SAKAMOTO, Koji**
  Tokyo 130-8603 (JP)
- **TSUCHIZAWA, Kazuyuki**
  Tokyo 130-8603 (JP)

(74) Representative: **Peckmann, Ralf**
Isarpatent
Friedrichstraße 31
80801 München (DE)

(54) **TOBACCO MATERIAL EXPANSION METHOD AND DEVICE**

(57) A tobacco material expansion method includes the steps of wetting and swelling a tobacco material by bringing the tobacco material into contact with a water vapor stream at 100 to 160°C, and drying the cut midribs by bringing the wetted swelled tobacco material into contact with a superheated water vapor stream at a temperature higher than that of the water vapor.

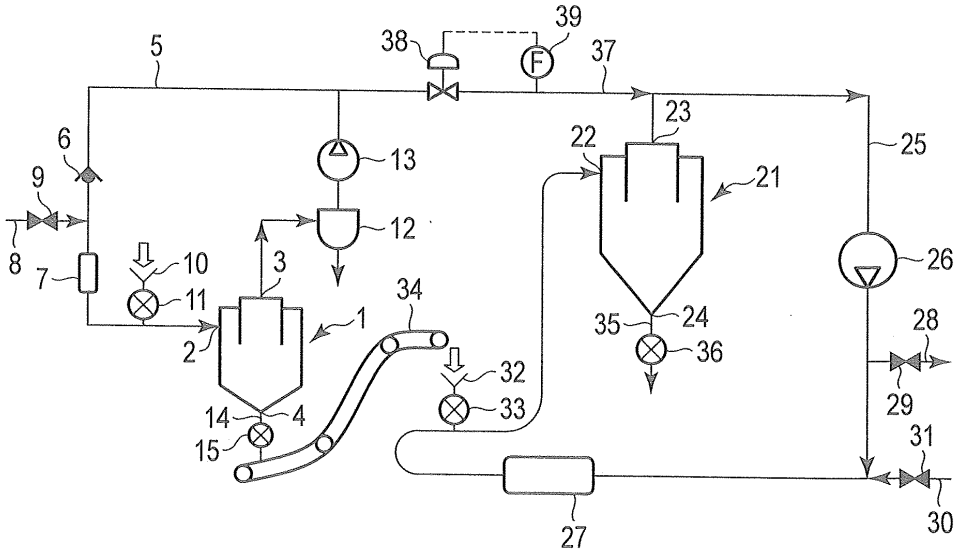

FIG. 1

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Description

Technical Field

[0001] The present invention relates to a method and apparatus for expanding a tobacco material.

Background Art

[0002] A tobacco material (for example, midribs) is separated from tobacco leaves, and occupies 20 to 30 wt% of tobacco leaves. Cut midribs (cut stem) are used in cut tobacco together with cut lamina from which midribs are removed in order to effectively use the tobacco material. The cut midribs are generally obtained by rolling and cutting midribs. An expansion process is performed on the cut midribs by humidification and drying, in order to increase the filling capacity and combustibility, and relax the smoke flavor. The conventional cut midrib expansion processes and related techniques will be explained below.

[0003] A method and apparatus for applying a conditioning agent to the tobacco material are disclosed in Japanese Patent No. 4031115. This apparatus has a structure in which a nozzle hole is attached to a protrusion, for example, a band-line pin, such as an impeller having a rotating winnowing roll (to be referred to as a winnower hereinafter). In this method, a conditioning agent spraying process of spraying steam against a freely falling tobacco material from the nozzle is performed before drying by using the abovementioned apparatus. After that, the tobacco material is conveyed to a drying process zone.

[0004] A method and apparatus for expanding the tobacco material are disclosed in U.S. Patent No. 4766912. This apparatus includes a steam spray device and fluidized bed dryer which include a vibrating conveyor for conveying the tobacco material, and convey the tobacco material while vibrating the conveyed tobacco material and spraying steam against the material through holes formed in the lower surface of the vibrating conveyor, thereby increasing the filling capacity of the tobacco material. In connection with this U.S. patent, an apparatus including a closed transport pipeline formed as a vibrating conveyor having an inlet and outlet, a supply device for supplying steam or a heated gas to the bottom portion of this transport pipeline, and a spray hole is disclosed in U.S. Patent No. 2802334.

[0005] A method and apparatus for a tobacco drying process of continuously performing a two-step stream drying process are disclosed in Jpn. Pat. Appln. KOKAI Publication No. 62-3778. That is, the tobacco material is supplied into a high-temperature gas medium and transferred to a first separator through a first duct, thereby separating the material and gas medium. The high-temperature gas medium is supplied to a second duct, and the separated tobacco material is supplied downstream of the first separator. The tobacco material and high-temperature gas medium are transferred to a second separator through the second duct, and separated from each other. By thus passing the material and medium through two drying zones, it is possible to 1) shorten the time during which the tobacco material is continuously exposed to the high-temperature gas medium, 2) eliminate the occurrence of excessively concentrated overheating, and 3) increase the drying efficiency by the relative velocity difference because the tobacco material is accelerated in two steps. The use of a separator for shortening the time during which the tobacco material and high-temperature gas medium are in contact with each other is also described.

[0006] Unfortunately, the above-described related arts have the following problems.

[0007] In Japanese Patent No. 4031115, the passing time of the tobacco material and steam in the apparatus is short from the description of the free-fall velocity, the effective height of the apparatus, and the rotational speed (200 rpm) of the winnower. Since the contact time of the tobacco material and steam is short, therefore, wetting and swelling are not sufficiently performed. Also, the parts of the winnower deteriorate rapidly because the winnower has the rotating portion. Furthermore, the tobacco material is readily twined around the rotating portion. The twined tobacco material exerts a large influence on the smoke flavor and physical properties.

[0008] In U.S. Patent No. 4766912, the steam spray device has the structure that conveys the material by vibration, and sprays steam from the holes in the bottom surface of the vibrating conveyor. This decreases the durability because driving parts deteriorate rapidly due to vibration. Also, steam is sprayed from the bottom surface of the vibrating conveyor by using pores having a diameter of, for example, 0.8 mm. Therefore, the pores are clogged with a scale (an inorganic material such as calcium carbonate) contained in the steam and fine powder of the tobacco material. This clogging of the pores fluctuates the steam amount, thereby making the quality of the processed tobacco material unstable.

[0009] In Jpn. Pat. Appln. KOKAI Publication No. 62-3778, the two-step stream drying process is performed using the two separators connected in series, so drying of the tobacco material progresses in each step. However, the characteristics of the apparatus extremely shorten the contact time of the tobacco material and the high-temperature wet air or superheated steam flow. This makes it difficult to sufficiently wet or swell the tobacco material. In addition, the tobacco material is deposited on a mesh screen of the separator, and closes an exhaust system. This interferes with the continuous operation of the separator.

Disclosure of Invention

[0010] The present invention provides a tobacco material expansion method capable of increasing the filling capacity of a tobacco material when compared to the conventional methods.

[0011] The present invention provides a tobacco material expansion apparatus capable of increasing the filling capacity of a tobacco material when compared to the conventional methods, and having a simple structure that implements continuous processing and high durability.

[0012] According to the first aspect of the present invention, there is provided a tobacco material expansion method including the steps of wetting and swelling a tobacco material by bringing the tobacco material into contact with a water vapor stream at 100 to 160°C, and drying the wetted swelled tobacco material by bringing the tobacco material into contact with a superheated water vapor stream at a temperature higher than that of the water vapor.

[0013] According to the second aspect of the present invention, there is provided a tobacco material expansion apparatus including a first cyclone including an inlet, an exhaust port, and an outlet, a first supply-side duct connected to the inlet of the first cyclone, a first exhaust-side duct connected to the exhaust port of the first cyclone, a first water vapor supply unit connected to the first supply-side duct, a first tobacco material supply unit connected to the first supply-side duct positioned between a connecting portion of the first water vapor supply unit and the inlet of the first cyclone, a second cyclone including an inlet, an exhaust port, and an outlet, a second supply-side duct connected to the inlet of the second cyclone, a second exhaust-side duct connected to the exhaust port of the second cyclone, a heating member placed in the second supply-side duct, a second water vapor supply unit connected to the second supply-side duct positioned downstream of the heating member, a second tobacco material supply unit connected to the second supply-side duct positioned between the inlet of the second cyclone and the heating member, and a conveyor member configured to convey the tobacco material discharged from the outlet of the first cyclone to the second tobacco material supply unit.

Brief Description of Drawings

[0014]

FIG. 1 is a schematic view showing a tobacco material expansion apparatus according to an embodiment.

Best Mode for Carrying Out the Invention

[0015] A tobacco material expansion method according to an embodiment of the present invention will be explained below.

(First Step)

[0016] A tobacco material is wetted and swelled by bringing it into contact with a water vapor stream at 100 to 160°C.

[0017] As the tobacco material, it is possible to use, for example, cut midribs. The cut midribs can be obtained by separating rod-like midribs from tobacco leaves, and rolling and cutting the rod-like midrib material in accordance with the conventional methods. More specifically, the rod-like midrib material is humidified to have a water content of, for example, 15 to 50 wt%, and preferably, 20 to 40 wt%. The humidified rod-like midrib material is rolled by a rolling mill having a roll distance of, for example, 0.5 to 1.2 mm, and shredded into a width of 0.1 to 0.3 mm, thereby forming cut midribs.

[0018] Since the water vapor has a temperature of 100 to 160°C, the tobacco material can be wetted and swelled without being dried. The water vapor temperature is more preferably 110 to 150°C.

[0019] The tobacco material can be brought into contact with the water vapor stream by, for example, rotating the tobacco material together with the water vapor stream. This rotation can be performed by using, for example, a cyclone. The residence time during the rotation is preferably 0.5 to 5 s.

[0020] When the tobacco material is brought into contact with the water vapor stream at the abovementioned temperature for the abovementioned residence time, condensation heat transfer of the water vapor to the tobacco material occurs. This condensation heat transfer raises the water content and temperature (temperature of goods) of the tobacco material, and softens the tobacco texture, thereby causing wetting and swelling. When the tobacco material is brought into contact with the water vapor stream at the aforementioned temperature for the aforementioned residence time, the wetted swelled tobacco material is not dried, and the water content of the tobacco material is equal to or increases by 5 wt% or less from that before the tobacco material is brought into contact with the water vapor stream.

(Second Step)

[0021] The wetted swelled tobacco material is dried by bringing it into contact with a superheated water vapor stream

at a temperature higher than that of the water vapor in the first step, thereby expanding the tobacco material.

[0022] Since the superheated water vapor has a temperature higher than that of the water vapor in the first step, the wetted swelled tobacco material can efficiently be dried. The superheated water vapor has a temperature higher than that of the water vapor in the first step, and preferably has a temperature range of 160 to 280°C. For example, when the temperature of the superheated water vapor is 160°C, the water vapor temperature in the first step is set at a temperature lower than 160°C, thereby making the temperature of the superheated water vapor higher than the water vapor temperature. The temperature of the superheated water vapor is more preferably 180 to 270°C.

[0023] The wetted swelled tobacco material can be brought into contact with the superheated water vapor stream by using various existing methods. It is particularly favorable to rotate the tobacco material together with the superheated water vapor stream. This rotation can be performed by using, for example, a cyclone. The residence time during the rotation is preferably 2 to 15 s.

[0024] In the abovementioned drying step, the water content of the tobacco material can be reduced to, for example, 3 to 15 wt%.

[0025] In this embodiment, the tobacco material can be re-humidified after the drying step. This re-humidification can be performed by, for example, spraying water against the tobacco material. The re-humidification is desirably executed on the tobacco material having a water content of 10 wt% or less.

[0026] In the tobacco material expansion method according to the embodiment explained above, the tobacco material is first brought into contact with a water vapor stream at 100 to 160°C. This makes it possible to sufficiently wet and swell the texture of the tobacco material (for example, cut midribs) in a state in which the water content of the humidified tobacco material is maintained or increased by 5 wt% or less, i.e., in an undried state. After that, the wetted swelled tobacco material is dried by bringing it into contact with a superheated water vapor stream at a temperature higher than that of the water vapor in the above step, preferably, within a temperature range of 160 to 280°C. Consequently, it is possible to obtain an expanded tobacco material (for example, expanded cut midribs) having filling capacity higher than that obtained when a humidified tobacco material is directly dried with superheated water vapor by the conventional method. By making the water content of the dried tobacco material lower than 12 wt%, it is possible to obtain an expanded tobacco material having a greatly increased filling capacity.

[0027] Especially when bringing the tobacco material into contact with the water vapor stream in the wetting/swelling step, the tobacco material is rotated together with the water vapor stream. This can further increase the wettability and swellability of the tobacco material without damaging it.

[0028] Also, when bringing the tobacco material into contact with the superheated water vapor stream in the drying step, the wetted swelled tobacco material is rotated together with the superheated water vapor stream. Consequently, it is possible to more efficiently dry the tobacco material without damaging it.

[0029] In the embodiment, the tobacco material (having a water content of, for example, 10 wt% or less) after the drying step is further re-humidified, for example, re-humidified to have a water content of 12 wt%. This makes it possible to obtain an expanded tobacco material having filling capacity higher than that obtained by directly drying the humidified tobacco material with superheated water vapor such that the water content is 12 wt%. This is so because when the tobacco material is dried to have a low water content once, the rigidity of the tobacco material texture (for example, the midrib texture) increases, so the expanded state can strongly be fixed, and the texture of the expanded tobacco material hardly shrinks even when the material is re-humidified.

[0030] Next, the tobacco material expansion apparatus according to the embodiment will be explained with reference to FIG. 1.

[0031] A first cyclone 1 has an inlet 2 in the sidewall, an exhaust port 3 in the upper portion, and an outlet 4 in the bottom portion. A first circulation duct 5 has one end connected to the inlet 2 of the first cyclone 1, and the other end connected to the exhaust port 3 of the first cyclone 1.

[0032] A check valve 6 is attached to the first circulation duct 5 so as to be positioned near the middle of the length of the first circulation duct 5. The check valve 6 lets a water vapor stream flow in the first circulation duct 5 from the exhaust port 3 to the inlet 2 of the first cyclone 1, and restricts a flow in the opposite direction. A first heater 7 is attached to a portion of the first circulation duct 5, which is positioned between the check valve 6 and the inlet 2 of the first cyclone 1.

[0033] A first water vapor supply pipe 8 is connected to a portion of the first circulation duct 5, which is positioned between the check valve 6 and first heater 7. The first water vapor supply pipe 8 has an open/close valve 9 for regulating the water vapor supply amount. A first tobacco material supply unit 10 is connected, via a first air lock 11, to a portion of the first circulation duct 5, which is positioned between the first heater 7 and the inlet 2 of the first cyclone 1. A drain separator 12 and exhaust fan 13 are arranged in the first circulation duct 5 in this order from the exhaust port 3 of the first cyclone 1 toward the check valve 6.

[0034] The outlet 4 of the first cyclone 1 is connected to a first discharge duct 14. A second air lock 15 is inserted into the first discharge duct 14.

[0035] A second cyclone 21 is installed adjacent to the first cyclone 1. The second cyclone 21 has an inlet 22 in the sidewall, an exhaust port 23 in the upper portion, and an outlet 24 in the bottom portion. A second circulation duct 25

has one end connected to the inlet 22 of the second cyclone 21, and the other end connected to the exhaust port 23 of the second cyclone 21.

[0036] A circulation fan 26 and a second heater 27 as a heating member are arranged in the second circulation duct 25 in this order from the exhaust port 23 toward the inlet 22 of the second cyclone 21, i.e., in a direction in which a superheated water vapor stream flows. An exhaust duct 28 is connected to a portion of the second circulation duct 25, which is positioned between the circulation fan 26 and second heater 27. The exhaust duct 28 exhausts the superheated water vapor stream flowing in the second circulation duct 25 as needed. The exhaust duct 28 has an open/close valve 29 for regulating the exhaust amount.

[0037] A second water vapor supply pipe 30 is connected to a portion of the second circulation duct 25, which is positioned between the connecting portion of the exhaust duct 28 and the second heater 27. The second water vapor supply pipe 30 has an open/close valve 31 for regulating the water vapor supply amount. A second tobacco material supply unit 32 is connected, via a third air lock 33, to a portion of the second circulation duct 25, which is positioned between the second heater 27 and the inlet 22 of the second cyclone 21. A conveyor member 34 has one end positioned near the first discharge duct 14 of the first cyclone 1, and the other end positioned near the second tobacco material supply unit 32. The conveyor member 34 conveys the tobacco material discharged from the first cyclone 1 to the second tobacco material supply unit 32.

[0038] The outlet 24 of the second cyclone 21 is connected to a second discharge duct 35. A fourth air lock 36 is inserted into the second discharge duct 35.

[0039] A connection duct 37 connects a portion of the first circulation duct 5, which is positioned near the exhaust fan 13, to a portion of the second circulation duct 25, which is positioned near the exhaust port 23 of the second cyclone 21. A diaphragm valve 38 is attached to the connection duct 37. A pressure gauge 39 is connected to a portion of the connection duct 37, which is positioned between the diaphragm valve 38 and second circulation duct 25. The opening of the diaphragm valve 38 is controlled based on pressure detection data (a pressure detection signal) from the pressure gauge 39.

[0040] The tobacco material expansion method using the tobacco material expansion apparatus shown in FIG. 1 described above will now be explained.

[0041] First, a tobacco material (for example, cut midribs) is prepared. The cut midribs are obtained by humidifying a rod-like midrib material to have a water content of 15 to 50 wt% (wet material basis), rolling the humidified material by a rolling mill having a roll distance of 0.5 to 1.2 mm, and cutting the rolled material into a width of 0.1 to 0.3 mm.

[0042] Dried saturated water vapor is sprayed from the first water vapor supply pipe 9 to the first circulation duct 5 at a gauge pressure of 1 to 7 bars. Note that the water vapor stream is heated by the first heater 7 of the first circulation duct 5 as needed. After that, the abovementioned cut midribs are continuously supplied from the first tobacco material supply unit 10 to the first circulation duct 5 through the first air lock 11. By driving the exhaust fan 13 beforehand, the cut midribs flow together with the water vapor stream at a temperature of 100 and 160°C from the first circulation duct 5 into the first cyclone 1, and rotate together with the water vapor stream. In this state, the water content of the cut midribs is equal to or increases by 5 wt% from that before the supply, i.e., the cut midribs are sufficiently wetted and swelled. The time of circulation in the first circulation duct 5 and rotation in the first cyclone 1 is preferably, for example, 0.5 to 5 s.

[0043] After the rotation, the cut midribs are separated from the water vapor stream. The separated cut midribs are discharged from the first discharge duct 14 connected to the first output 14 of the first cyclone 1 to the conveyor member 34 through the second air lock 15. On the other hand, the water vapor stream is discharged from the first exhaust hole 3 of the first cyclone 1 to the first circulation duct 5 by driving the exhaust fan 13, and circulated toward the first inlet 2. In this circulation of the water vapor stream, water condensed in the water vapor stream is discharged from the drain separator 12.

[0044] The wetted cut midribs are conveyed to the second tobacco material supply unit 32 by the conveyor member 34, and supplied to the second circulation duct 25 through the third air lock 33. Saturated water vapor is sprayed from the second water vapor supply pipe 30 to the second circulation duct 25, and heated while passing through the second heater 27, thereby forming a superheated water vapor stream at a temperature higher than the temperature of the water vapor supplied to the first cyclone 1, and falling within the temperature range of 160 to 280°C. By driving the circulation fan 26 beforehand, the wetted cut midribs supplied to the second circulation duct 25 flow together with the superheated water vapor stream from the second circulation duct 25 into the second cyclone 21, and rotate together with the superheated water vapor stream. In this state, the wetted cut midribs are dried and expanded. The time of the circulation in the second circulation duct 25 and the rotation in the second cyclone 21 is preferably, for example, 2 to 15 s.

[0045] The rotated cut midribs (expanded cut midribs) are separated from the superheated water vapor stream. The separated expanded cut midribs are discharged and collected, through the fourth air lock 36, from the second discharge duct 35 connected to the second outlet 24 of the second cyclone 1. On the other hand, the superheated water vapor stream is exhausted from the second exhaust port 23 of the second cyclone 21 to the second circulation duct 25 by driving the circulation fan 26, and circulated toward the second inlet 22.

[0046] The water content of the obtained expanded cut midribs is 3 to 15 wt%. Also, the filling capacity of the expanded cut midribs is 5.8 to 7.5 cc/g. Therefore, when compared to the filling capacity (4.5 cc/g) of the undried cut midribs immediately after cutting, the filling capability can be increased by about 30 to 70%.

[0047] In the humidifying and drying processes of the cut midribs as described above, the opening of the diaphragm valve 38 attached to the connection duct 37 is controlled based on the pressure detection data (pressure detection signal) from the pressure gauge 39, and a desired amount of a water vapor stream flowing through the first circulation duct 5 is supplied to the second circulation duct 25 through the connection duct 37 and used as a part of the superheated water vapor.

[0048] Note that in the cut midrib drying step performed by the system of the second cyclone 21 and second circulation duct 25, if the water content becomes, for example, 10 wt% or less, the cut midribs can be re-humidified by a well-known method such as water spraying.

[0049] In the tobacco material expansion apparatus according to the embodiment as explained above, a tobacco material (for example, cut midribs) is wetted and dried by using the first and second cyclones 1 and 21, and the first and second circulation ducts 5 and 25 respectively connected to the first and second cyclones 1 and 21. This makes it possible to increase the opportunity of contact between the cut midribs and water vapor stream or superheated water vapor stream, without damaging the cut midribs. Consequently, it is possible to efficiently wet and swell the cut midribs, and efficiently dry the cut midribs after that. Accordingly, expanded cut midribs having an increased filling capacity can be obtained.

[0050] Also, the first and second cyclones 1 and 21 and first and second circulation ducts 5 and 25 incorporated into the expansion apparatus have extremely simplified structures, require neither a rotating part nor a mesh screen unlike the conventional apparatuses, and hence have high durability. This makes it possible to continuously wet and dry the cut midribs.

[0051] Furthermore, when the first and second circulation ducts 5 and 25 are connected by the connection duct 37, the water vapor circulating in the first circulation duct 5 can effectively be used as a part of the superheated water vapor in the second circulation duct 25, and this can implement an energy-saving operation.

[0052] Examples of the present invention will be explained in detail below by referring to the tobacco material expansion apparatus shown in FIG. 1.

(Example 1: Comparative Example)

[0053] In Example 1, the drying step was performed using the system of the second cyclone and second circulation duct shown in FIG. 1.

[0054] First, a rod-like midrib material obtained by mixing 70 wt% of flue-cured tobacco and 30 wt% of burley tobacco was humidified to have a water content of 37 wt% by a method known to those skilled in the art, for example, spraying of water or water vapor. This rod-like midribs were rolled by a pair of rollers having a distance of 0.8 mm, and shredded into a width of 0.2 mm, thereby preparing cut midribs as a tobacco material.

[0055] Saturated water vapor was supplied at a flow rate of 40 kg/hr from the second water vapor supply pipe 30 to the second circulation duct 25 (diameter: about 100 mm, length: about 22 m), and heated while passing through the second heater 27. The humidified cut midribs were continuously supplied at a flow rate of 25 kg/hr on humidified weight basis from the second tobacco material supply unit 32 to the second circulation duct 25 through the third air lock 33. In this state, the water vapor stream circulating through the second circulation duct 25 was saturated water vapor having a vapor ratio of 90 vol% (an almost superheated water vapor stream), a flow velocity of 25 m/s, atmospheric pressure, and a temperature of 260°C. By driving the circulation fan 26 beforehand, the humidified cut midribs were supplied together with the superheated water vapor stream from the second circulation duct 25 into the second cyclone (diameter: about 460 mm, separator effective height: 1.4 m), and dried and expanded by rotating together with the superheated water vapor stream. The residence time during the rotation was 5 s.

(Examples 2 & 3: Comparative Examples)

[0056] Humidified cut midribs were dried and expanded following the same procedures as in Example 1, except that the temperature of the superheated water vapor stream circulating together with the humidified cut midribs in the second circulation duct 25 was set at 230 and 210°C.

(Example 4: Example)

[0057] In Example 4, the above-described tobacco material expansion apparatus shown in FIG. 1 was used.

[0058] Humidified cut midribs (water content: 37 wt%, width: 0.2 mm) having undergone the same processes as in Example 1 were prepared.

[0059] Saturated water vapor having a gauge pressure of 5 bars was sprayed at a flow rate of about 20 kg/hr from the nozzle portion (diameter = 3 mm) of the first water vapor supply pipe 8 to the first circulation duct 5 (diameter: about 250 mm, length: about 0.6 m) set in a horizontal state. The humidified cut midribs were continuously supplied at a flow rate of 36 kg/hr on humidified weight basis from the first tobacco material supply unit 10 to the first circulation duct 5 through the first air lock 11. In this state, the water vapor stream circulating in the first circulation duct 5 was saturated water vapor at a temperature of 125°C. By driving the circulation fan 13 beforehand, the humidified cut midribs were supplied together with the water vapor stream from the first circulation duct 5 into the first cyclone 1 (diameter: about 50 mm, separator effective height: about 0.75 m), and wetted and swelled by rotating together with the water vapor stream. The time of passing through the first circulation duct 5 and first cyclone 1 (residence time = 1.5 s) was about 1.8 s. The water content of the wetted cut midribs was 39 wt%, i.e., increased by 2 wt% from the water content (37 wt%) when the material was humidified.

[0060] Then, the humidified cut midribs discharged from the first cyclone 1 were continuously supplied to the second circulation duct 25 via the conveyor member 34 and second tobacco material supply unit 32, and dried and expanded with a superheated water vapor stream by using the second circulation duct 25 and second cyclone 21 under the same conditions as in Example 1 descried above. Note that the temperature of the superheated water vapor was set at 270°C.

(Examples 5 & 6: Examples)

[0061] Humidified cut midribs were dried and expanded following the same procedures as in Example 4, except that the temperature of the superheated water vapor stream circulating together with the humidified cut midribs in the second circulation duct 25 was set at 240 and 220°C.

[0062] The obtained expanded cut midribs of Examples 1 to 6 were stored (matched) in a constant-temperature and constant-humidity chamber at a temperature of 22.0°C and a relative humidity of 60% for a week, thereby obtaining an equilibrium water content. After that, the filling capacity was measured.

[0063] The filling capacity indicates the filling capability of tobacco shreds in a smokable cigarette form. This measurement was performed using DD-60A available from Borgwaldt, Germany. The experiment was conducted by repetitively measuring the filling capacity of the expanded cut midribs five times, and calculating the average value.

[0064] Also, about 2 g of the expanded cut midribs were placed in a weighing bottle, and dried for 1 hour in a natural convection oven at a temperature of 100°C. After that, the water content of the expanded cut midribs was calculated from the weight difference before and after the drying, and obtained as the average value of five points.

[0065] Table 1 below shows the filling capacity and water content of the expanded cut midribs of each of Examples 1 to 6.

Table 1

	Presence/ absence and water vapor temperature of wetting process	Superheated water vapor temperature during drying (°C)	Water content (wt%) of shredded midribs		Bulkiness (cc/g)
			During humidification	After drying	
Example 1	Absent	260	37.0	5.4	6.2
Example 2	Absent	230	37.0	8.2	5.7
Example 3	Absent	210	37.0	11.0	5.4
			During wetting	After drying	
Example 4	Present (150°C)	270	39.0	4.7	7.3
Example 5	Present (150°C)	240	39.0	8.0	6.6
Example 6	Present (150°C)	220	39.0	11.0	6.5

[0066] As shown in Table 1, the filling capacity increased (improved) by 1.0 cc/g or more in each of Examples 4 to 6 in which the humidified cut midribs were wetted with water vapor at a temperature of 125°C before being dried with a superheated water vapor stream, when compared to Examples 1 to 3 in which the humidified cut midribs were not wetted with a water vapor stream before being dried with a superheated water vapor stream. When represented by a ratio, a filling capacity of 1.0 cc/g or more as described above is equivalent to about 20%. Since the filling capacity of unprocessed cut midribs before drying (after humidification and cutting) was 4.5 cc/g, the expansion ratio increased to 62% in, for example, Example 4, indicating that the expansion method was excellent.

(Example 7: Example)

[0067] In Example 7, the above-described tobacco material expansion apparatus shown in FIG. 1 was used.

[0068] Humidified cut midribs (water content: 37.0 wt%, width: 0.2 mm) having undergone the same processes as in Example 1 were prepared.

[0069] The humidified cut midribs were wetted and swelled by using the first circulation duct 5 and first cyclone 1 under the same conditions as in Example 4. The water content of the wetted cut midribs was 39.0 wt%, i.e., increased by 2 wt% from the water content (37.0 wt%) when the material was humidified.

[0070] Then, the wetted cut midribs discharged from the first cyclone 1 were continuously supplied to the second circulation duct 25 via the conveyor member 34 and second tobacco material supply unit 32, and dried and expanded with a superheated water vapor stream (temperature: 270°C) by using the second circulation duct 25 and second cyclone 21 under the same conditions as in Example 1 described above.

[0071] After that, the expanded cut midribs were re-humidified by spraying water so that the water content was 12.5 wt%.

(Example 8: Example)

[0072] Wetted cut midribs were dried and expanded following the same procedures as in Example 7, except that the temperature of the superheated water vapor stream circulating together with the wetted cut midribs in the second circulation duct 25 was set at 250°C. After that, the expanded cut midribs were re-humidified by spraying water so that the water content was 12.5 wt%.

[0073] The obtained expanded cut midribs (after drying) of Examples 7 and 8 were stored (matched) in a constant-temperature and constant-humidity chamber at a temperature of 22.0°C and a relative humidity of 60% for a week, thereby obtaining an equilibrium water content. After that, the filling capacity was measured by the same method as in Examples 1 to 6 described above. Also, the filling capacity of the re-humidified expanded cut midribs was measured by the same method as in Examples 1 to 6 described above.

[0074] In addition, the water content of the expanded cut midribs (after drying) was obtained by the same method as in Examples 1 to 6 described above.

[0075] Table 2 below shows the results.

Table 2

	Superheated water vapor temperature during drying (°C)	Water content (wt%) of shredded midribs			Bulkiness (cc/g)	
		During humidification	After drying	After re-humidification	After drying	After re-humidification
Example 7	270	39.3	4.7	12.5	7.4	7.0
Example 8	250	39.3	8.1	12.5	6.9	6.6

[0076] As shown in Table 2, in each of Examples 7 and 8 in which the humidified cut midribs were wetted with the water vapor stream at a temperature of 125°C before being dried with the superheated water vapor stream, and were re-humidified after being dried, the filling capacity decreased by only about 4% from that of the dried cut midribs (before re-humidification).

[0077] The filling capacity of the re-humidified cut midribs of each of Examples 7 and 8 as described above was higher than that of the expanded cut midribs (after drying) of Example 3 as a comparative example. When expanding the cut midribs in order to obtain a water content of 12 wt%, therefore, the filling capacity can significantly be improved in Examples 7 and 8 in which the humidified cut midribs were wetted with the water vapor stream before being dried with the superheated water vapor stream, and the water content was set at 12 wt% by re-humidification after drying, when compared to the method of setting the water content at 11 wt% by only drying the humidified cut midribs as in Example 3.

[0078] Also, the comparison of the filling capacity of the re-humidified cut midribs of each of Examples 7 and 8 with that of the expanded cut midribs of Example 1 reveals that the filling capacity of the re-humidified cut midribs of each of Examples 7 and 8 was higher than that of the expanded cut midribs of Example 1 (see Table 1) in which the humidified cut midribs were dried to have a water content of 5.4 wt% by only the drying process. This demonstrates that when wetting the humidified cut midribs with a water vapor stream at a predetermined temperature before drying the humidified cut midribs with a superheated water vapor stream as in the present invention, the filling capacity can be improved, even when re-humidification of increasing the water content was performed after drying, more significantly than that in the conventional method of performing only the drying process on the humidified cut midribs.

Claims

1. A tobacco material expansion method comprising the steps of:

   wetting and swelling a tobacco material by bringing the tobacco material into contact with a water vapor stream at 100 to 160°C; and
   drying the wetted swelled tobacco material by bringing the tobacco material into contact with a superheated water vapor stream at a temperature higher than that of the water vapor.

2. The tobacco material expansion method according to claim 1, wherein the tobacco material before contacting the water vapor stream is humidified to 15 to 50 wt%.

3. The tobacco material expansion method according to claim 1, wherein the wetted swelled tobacco material has a water content equal to or higher by not more than 5 wt% than that of the tobacco material before contacting the water vapor stream.

4. The tobacco material expansion method according to claim 1, wherein the step of wetting and swelling is performed by rotating the tobacco material together with the water vapor stream.

5. The tobacco material expansion method according to claim 4, wherein a residence time during the rotation is 0.5 to 5 s.

6. The tobacco material expansion method according to claim 1, wherein the tobacco material is re-humidified after the step of drying.

7. The tobacco material expansion method according to claim 6, wherein the re-humidification is performed by spraying water against the tobacco material.

8. The tobacco material expansion method according to claim 6, wherein the re-humidification is executed on the tobacco material having a water content reduced to not more than 10 wt% in the drying.

9. The tobacco material expansion method according to any one of claims 1 to 8, wherein the tobacco material comprises cut midribs.

10. A tobacco material expansion apparatus comprising:

    a first cyclone including an inlet, an exhaust port, and an outlet;
    a first supply-side duct connected to the inlet of the first cyclone;
    a first exhaust-side duct connected to the exhaust port of the first cyclone;
    a first water vapor supply unit connected to the first supply-side duct;
    a first tobacco material supply unit connected to the first supply-side duct positioned between a connecting portion of the first water vapor supply unit and the inlet of the first cyclone;
    a second cyclone including an inlet, an exhaust port, and an outlet;
    a second supply-side duct connected to the inlet of the second cyclone;
    a second exhaust-side duct connected to the exhaust port of the second cyclone;
    a heating member placed in the second supply-side duct;
    a second water vapor supply unit connected to the second supply-side duct positioned downstream of the heating member;
    a second tobacco material supply unit connected to the second supply-side duct positioned between the inlet of the second cyclone and the heating member; and
    a conveyor member configured to convey the tobacco material discharged from the outlet of the first cyclone to the second tobacco material supply unit.

11. The tobacco material expansion apparatus according to claim 10, wherein a first circulation duct is formed by connecting the first supply-side duct and first exhaust-side duct connected to the first cyclone, a second circulation duct is formed by connecting the second supply-side duct and second exhaust-side duct connected to the second cyclone, and the first circulation duct positioned near the exhaust port of the first cyclone and the second circulation duct positioned near the exhaust port of the second cyclone are connected by a connection duct.

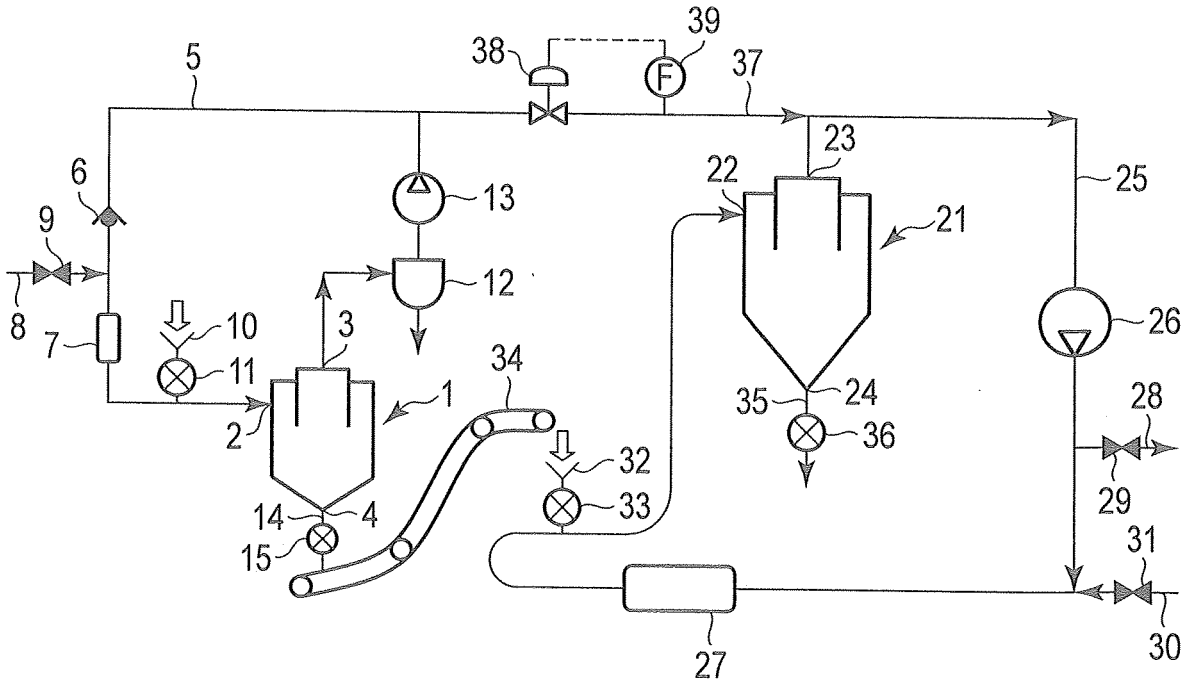
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FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058340

A. CLASSIFICATION OF SUBJECT MATTER
A24B3/04(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)
A24B3/04

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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.
Y A	JP 60-70058 A (Nippon Senbai Kosha), 20 April 1985 (20.04.1985), page 2, lower left column, line 10 to upper right column, line 9; fig. 1 (Family: none)	1-10 11
Y	JP 2006-520599 A (R.J. Reynolds Tobacco Co.), 14 September 2006 (14.09.2006), paragraph [0021]; fig. 1 & US 2004/0182404 A1 & EP 1603412 B1 & WO 2004/084657 A2 & DE 602004006096 T2 & CA 2519153 A1 & CN 1774183 A & ES 2282853 T3	1-10

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

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Date of the actual completion of the international search 25 April, 2011 (25.04.11)	Date of mailing of the international search report 10 May, 2011 (10.05.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/058340

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 04-144675 A (Japan Tobacco Inc.), 19 May 1992 (19.05.1992), page 1, lower right column, lines 10 to 16; page 2, lower right column, line 20 to page 3, upper left column, line 2 & US 5251648 A & EP 479313 A1 & DE 69103603 T2 & CN 1061896 A	6-9
Y	WO 03/046453 A1 (Japan Tobacco Inc.), 05 June 2003 (05.06.2003), page 13, line 20 to page 14, line 2; fig. 1, 4 & US 2004/0205978 A1 & EP 1450122 A1 & CA 2466865 A1 & CN 1592837 A & RU 2280220 C2	10

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REFERENCES CITED IN THE DESCRIPTION

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- JP 62003778 A **[0009]**