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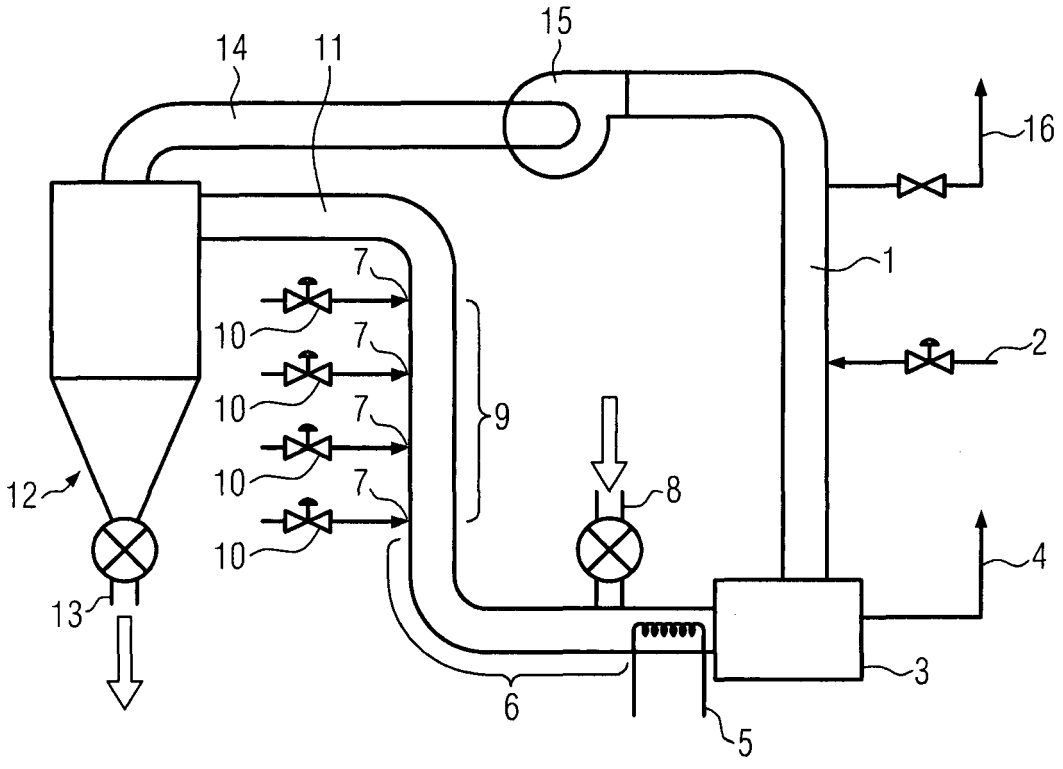
(54) Method and Apparatus for Expanding a Product Containing Starch

(57) The invention provides a method and apparatus for expanding a product containing starch which provides a more efficient expansion of the product while reducing or avoiding undesired impacts on the taste or quality of the product. The method for expanding a product containing starch comprises the steps of subjecting the product to hot process gas in a high temperature zone (6) flowing in a downstream direction, such that the product is expanded by means of a thermal shock while the product is conveyed in the process gas in the downstream direction; and lowering the temperature of the process gas by injecting cooling medium through cooling medium inlets (7) while further conveying the product in the process gas.



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Description

[0001] The present invention relates to a method and apparatus for expanding a product containing starch. The invention further relates to a product containing starch expanded by the method or apparatus, for example tobacco.

[0002] In the prior art, it is known to expand tobacco for the purpose of improving its filling properties. The majority of the solutions comprise putting wet cut tobacco into an air flow of high velocity and high temperature so that the tobacco expands and dries at the same time. The reason for the expansion is directly related to the rapid increase of the temperature of the tobacco. The expansion is the result of changes in the cell structure of the tobacco being exposed to high temperatures within a very short period of time. The mechanism of expansion is explained by the phase change of an expansion medium in the tobacco from liquid to vapor. Furthermore, the speed at which this phase change occurs is critical to the level of expansion.

[0003] Currently used methods of expansion can be divided in two categories. In the first category, a product is impregnanted with an expansion agent, such as carbon dioxide, nitrogen, Freon or organic solvents. In the second category, only water is used as an expansion medium. The first category provides excellent expansion, but it requires the additional impregnation process to allow the expansion agents to be useful. The second category also provides expansion, but it has reduced effectiveness because of the limitation on the maximum temperature. And not only is the maximum temperature limited, but a higher temperature applied for too long a period can have an undesired impact on taste or quality of the expanded product.

[0004] In addition to tobacco, further starch containing products which can be expanded using the method described include food products, for example corn or rice. These products can be transformed by means of expansion into popcorn or puffed rice, respectively.

[0005] It is the object of the invention to provide a method and apparatus for expanding a product containing starch which provides a more efficient expansion of the product while reducing or avoiding undesired impacts on the taste or quality of the product.

[0006] The invention relates to a method for expanding a product containing starch comprising the steps of:

> subjecting the product to hot process gas flowing in a downstream direction, such that the product is expanded by means of a thermal shock while the product is conveyed in the process gas in the downstream direction; and
>
> lowering the temperature of the process gas by injecting cooling medium while further conveying the product in the process gas.

[0007] In particular, the product is not only conveyed in the process gas, but by the process gas.

[0008] Due to the injection of a cooling medium, the temperature around the product can be lowered very quickly such that after product expansion, the product is not unnecessarily subjected to heat while being conveyed in the process gas. The injection of a cooling medium also allows the product to be heated to a higher temperature and maintained at that higher temperature because the cooling medium will quickly reduce the heat the product is subjected to. By heating to a higher temperature and maintaining that higher temperature to enhance thermal shock, better expansion is achieved while preventing undesired taste impacts in the product. The method according to the present invention provides a reliable way of limiting the exposure time of the product to heat.

[0009] Thus, the method allows for a higher filling power for expanded tobacco due to the high temperature shock but it prevents undesired taste impacts by limiting the exposure of the product to heat for an extended period. So, no significant taste change of the product occurs due to the improved cooling.

[0010] In some embodiments, the method is free of the injection of expansion agents, and the apparatus may use only water as an expansion medium. Thus, the invention enables that a product containing starch to be exposed to high temperatures for expansion, while it can actively limit the time of this exposure. The temperature can therefore be elevated to levels which are not possible in the prior art without using an expansion agent. The duration of the exposure can be more freely established and controlled in an individual manner to the needs of the thermal shock required for product expansion of a product.

[0011] In particular, the process gas is super-heated steam, such that its heat transfer capability can be improved. The process gas may comprise super-heated water steam. In particular, the method may be conducted in a flash tower drying system.

[0012] In particular, the product containing starch is tobacco, preferably cut tobacco, tobacco lamina, tobacco stems or whole tobacco leaves. The expansion of stem parts may enable to obtain a product with high filling power but low nicotine content. In other applications the product may be another product containing starch, such as corn or rice, which can be expanded as well, due to their starch content.

[0013] Preferably, the tobacco has a water or moisture content that is not below about 7 to 8 weight percent of water. More preferably, the moisture content in the tobacco is from about 13 to about 30 weight percent. Further, by adjusting the properties of the process gas or cooling medium, in particular the content of steam, the moisture content of the tobacco can be controlled.

[0014] In particular, the subjecting of the product to hot process gas and the lowering of the temperature of the process gas are conducted in adjacent portions of a pipe in which the process gas flows. The conveying of the

product during the expansion and cooling allows to quickly change the temperature around the product and thus to subject the product to the predetermined temperatures in a reliable manner.

[0015] The cooling medium may preferably be a cooling gas, such as air. Alternatively cooling liquids can be used as the cooling medium.

[0016] The cooling medium may in particular be water or water steam. Preferably, the cooling medium is demineralized water or water steam. Alternatively, or additionally, the cooling medium comprises or is composed of nitrogen, carbon dioxide or Argon. All these media or gases are generally not chemically reacting with starch containing products and are therefore not changing the taste or appearance of the product in an undesired manner.

[0017] In particular, the process medium or the cooling medium or the process gas and cooling medium comprise less than about 10 percent of air, or less than about 2 percent of oxygen. This prevents the starch containing product from being subject to oxidation. Preferably, the cooling medium or process gas is comprised of mainly nitrogen and carbon dioxide. The cooling medium may be injected at several locations, which are in a distance to each other in the downstream direction of the flow of process gas.

[0018] Preferably, the temperature of the process gas is lowered by injecting cooling medium at at least two downstream locations, such that a negative temperature gradient can be obtained in the process gas along the downstream direction. Thus, a cooling process with several different locations for injecting cooling medium is provided. In particular, the temperature gradient is obtained by injecting the cooling gas throughout a certain distance in the flow direction of the process gas.

[0019] In particular, the product is conveyed by means of the process gas. Thus, additional conveying means for the product are not necessary. However, in other embodiments conveying means for the product may be additionally or alternatively provided.

[0020] Preferably, the method comprises adjusting the amount of injected cooling medium. This may include operating a valve by a control means.

[0021] In some embodiments, the method is free of the use of expansion medium. In other embodiments, expansion medium may be injected to facilitate the product expansion. The expansion medium may be only water. However, the expansion medium may also comprise expansion agents.

[0022] The method may comprise the step of separating the product from the process gas after expansion and cooling.

[0023] The method may be operated in a closed loop, wherein the process gas is at least partially or fully recycled and heated after the product separation to provide the necessary heated process gas for product expansion.

[0024] The method may comprise determining the temperature of the process gas at one or several locations in which cooling medium is injected. The determined temperature may be used for controlling the temperature conditions during product expansion or cooling.

[0025] The method may comprise determining the pressure at least of the hot process gas during product expansion. The determined pressure may be used for controlling the pressure conditions during expansion.

[0026] The invention further relates to an apparatus for expanding a product containing starch comprising:

a heater adapted to heat a process gas;
a product inlet;
a high temperature zone, in which the product is expanded while being conveyed; and
a temperature reduction zone downstream of the high temperature zone, wherein the temperature reduction zone comprises at least one cooling medium inlet which is adapted to inject cooling medium to the hot process gas such that the temperature of the gas surrounding the product is reduced.

[0027] Due to the injection of a cooling medium, the temperature around the product can be lowered very quickly such that after product expansion, the product is not unnecessarily subjected to heat while continuing through the apparatus. The injection of a cooling medium also allows the product to be heated to a higher temperature and maintained at that higher temperature because the cooling medium will quickly reduce the heat the product is subjected to. By heating to a higher temperature and maintaining that higher temperature to enhance thermal shock, better expansion is achieved while preventing undesired taste impacts in the product. The present invention provides a reliable way of limiting the exposure time of the product to heat.

[0028] Thus, the invention allows for a higher filling power for expanded tobacco due to the high temperature shock but it prevents undesired taste impacts by limiting the exposure of the product to heat for an extended period. So, no significant taste change of the product occurs due to the improved cooling.

[0029] In particular, no injection of expansion agents is necessary, and the apparatus may use only water as an expansion medium. Thus, the invention enables that a product containing starch to be exposed to high temperatures for expansion, while it can actively limit the time of this exposure. The temperature can therefore be elevated to levels which are not possible in the prior art without using an expansion agent. The duration of the exposure can be more freely established and controlled in an individual manner to the needs of the thermal shock required for product expansion of a product.

[0030] In particular, the process gas is super-heated steam, such that its heat transfer capability can be improved. The process gas may comprise super-heated water steam. In particular, the apparatus may be a flash tower drying system.

[0031] In particular, the starch containing product is

tobacco, preferably cut tobacco, tobacco lamina, tobacco stems or whole tobacco leaves. The expansion of stem parts may enable to obtain a product with high filling power but low nicotine content. In other applications the product may be another starch containing product, such as corn or rice, which can be expanded as well, due to their starch content.

[0032] Preferably, the tobacco has a water content that is not below about 7 to 8 weight percent of water. More preferably, the moisture content in the tobacco is from about 13 to about 30 weight percent. Further, by adjusting the properties of the process gas or cooling medium, in particular the content of steam, the moisture content of the tobacco can be controlled.

[0033] Preferably, the product is also conveyed in the temperature reduction zone. In particular, the high temperature zone and the temperature reduction zone are formed by adjacent portions of a pipe. The conveying of the product during the expansion and cooling allows to quickly change the temperature around the product and thus to subject the product to the predetermined temperatures in a reliable manner.

[0034] The cooling medium may preferably be a cooling gas, such as air. Alternatively cooling liquids can be used as the cooling medium.

[0035] The cooling medium may in particular be water or water steam. Preferably, the cooling medium is demineralized water or water steam. Alternatively, or additionally, the cooling medium comprises or is composed of nitrogen, carbon dioxide or Argon. All these media or gases are generally not chemically reacting with starch containing products and are therefore not changing the taste or appearance of the product in an undesired manner.

[0036] In particular, the process medium or the cooling medium or the process gas and cooling medium comprise less than about 10 percent of air, or less than about 2 percent of oxygen. This prevents the starch containing product from being subject to oxidation. Preferably, the cooling medium or process gas is comprised of mainly nitrogen and carbon dioxide.

[0037] Preferably, the cooling medium inlet comprises a valve adapted to adjust the amount of injected cooling medium. In particular, the throughput of the valve or valves can be continuously adjusted. Thus, a precise control of the temperature in the temperature reduction zone can be attained. In particular, the valve may be controlled by a feedback control having a temperature condition as a feedback value, in particular, a temperature in or at the end of the temperature reduction zone.

[0038] In another embodiment, several cooling medium inlets are arranged subsequently in a downstream direction in the temperature reduction zone. Preferably, two to ten cooling medium inlets are provided. This arrangement allows a more rapid and efficient cooling of the process gas and the product comprised therein. Furthermore, a more precise adjustment of the temperature gradient in the downstream direction of the temperature reduction zone can be achieved. In particular, a valve may be assigned to each cooling medium inlet. Preferably, the valves are controlled independently of each other. However, in some embodiments the valves may also be controlled dependent on each other, for example by proportionally setting their valve opening degrees. In other embodiments, only one valve may be provided for several cooling medium inlets, such that by means of a central valve the throughput of cooling medium through several inlets can be controlled.

[0039] Preferably a control means is provided for controlling the at least one valve. In particular, the control means controls the valve in accordance with the required temperature at the end of the temperature reduction zone, which may in particular be determined by a sensor.

[0040] In another embodiment, a control means may be provided which is adapted such that the valves of the several subsequently arranged cooling medium inlets can be controlled separately to enable a defined temperature gradient in the downstream direction of the temperature reduction zone. This allows a better and more precise control of the temperature gradient in the temperature reduction zone. In particular, the control means allows adapting the apparatus to different throughput quantities of the product.

[0041] Preferably, the apparatus further comprises an expansion medium inlet. The expansion medium inlet is in particular upstream of the product inlet, and more in particular upstream of the heater. In particular, the expansion medium is steam, preferably super-heated steam.

[0042] In particular, further heat can be applied by the heater, such that the process gas becomes super-heated steam. The steam may in particular replace the gas or air which is introduced in the system together with the tobacco. Therefore, some of the tail gas may be removed from the circulation of process gas before expansion medium is injected into the process gas.

[0043] In particular, the heater is arranged upstream the product inlet. The product inlet may be arranged in the high temperature zone. In particular, the heater heats the process gas to about 160 to 600 degrees Celsius, preferably to about 200 degrees Celsius. Therefore, the heater is heated to a temperature of about 220 to 1000 degrees Celsius.

[0044] In another embodiment, the apparatus further comprises a product separation unit, in which the product is separated from the process gas. The product separation unit may be a gravity operated product separation unit, in which the product falls under gravity, while the flow of the process gas is directed in another direction, in particular towards the top. The flowing velocity of the process gas can be reduced in the product separation unit, in particular by increasing the diameter of the pipe or cylinder in the product separation unit. Other possible product separation units which can be applied in embodiments of the invention include cyclone separation units or sieves.

[0045] Preferably, the high temperature zone and the temperature reduction zone are arranged in a closed loop, with the product separation unit being arranged at a position downstream of the temperature reduction zone and the product inlet being arranged in the high temperature zone. This improves the energy efficiency, as the remaining heat of the process gas is reused. Furthermore, the expansion medium comprised in the process gas may be reused. This is in particular beneficial, if the expansion medium comprises agents which significantly affect the operation costs of the apparatus, such as Argon.

[0046] In one embodiment, temperature sensors are distributed at least along the temperature reduction zone. The temperature sensors preferably provide an input signal in the form of the temperature of the process gas at several positions to the control means of the at least one valve of the at least one cooling medium inlet. Preferably, at least one temperature sensor is provided at the downstream end of the temperature reduction zone. Furthermore, temperature sensors may be arranged before or after the cooling medium inlets. The signals of all temperature sensors may be provided to one control means, which accordingly bases the control also on the correlation of the temperatures.

[0047] Furthermore, in some embodiments pressure sensors can be provided in the apparatus according to the invention. In particular, the apparatus can be controlled such that a pressure below ambient pressure is maintained in the high temperature zone to foster the expansion of the product. Preferably, the control means is adapted to control that the pressure in the high temperature zone is lower or at least not significantly higher than ambient pressure.

[0048] In one embodiment, the product is conveyed by means of the flow of the process gas. In particular, the product is in the form of small pieces, such that the process gas can apply sufficient force for the conveying of the product. Preferably, the process gas flows with a sufficiently high velocity through a pipe into which the product is inserted. In other embodiments, the product may be conveyed by an additional conveying means, such as a conveyor belt or the like.

[0049] Furthermore, the invention provides a tobacco product comprising tobacco processed by the method or apparatus according to the invention as specified beforehand. The tobacco product is in particular cut filler tobacco. However, the tobacco product may also be full or cut tobacco leaves or final products such as smoking articles, in particular cigarettes or cigars. Furthermore, the tobacco product may be a tobacco containing product for a smoking device, which only heats but not burns the tobacco. In particular, the tobacco product differs from expanded tobacco products in the prior art by having a higher expansion level. The invention will now be further explained by means of an exemplary embodiment as shown in the following figure.

[0050] Figure 1 shows a schematic view of an apparatus according to the invention.

[0051] An apparatus according to an embodiment of the invention as shown in Figure 1 comprises an upstream pipe 1, in which at least parts of recycled process gas flow. An expansion medium inlet 2 is arranged at the upstream pipe 1. The expansion medium inlet 2 comprises in particular a controlled valve to adjust the amount of injected expansion medium. The expansion medium is in particular replacing or diluting the process gas which is recycled in the process. In particular, the expansion medium replaces gas or air which is brought into the process gas by the tobacco.

[0052] The upstream pipe 1 leads to a furnace or heat exchanger 3 in which the process gas can be heated. The furnace or heat exchanger 3 may comprise a flue gas outlet 4 to divide flue gas from the process gas. The heat exchanger 3 may use the heat of recycled process gas or tail gas to heat the process gas.

[0053] Downstream of the heat exchanger 3 a heater 5 may be provided. The heater 5 may have a temperature of about 220 to 1000 degrees Celsius during operation and may heat the process gas from 160 to 600 degrees Celsius, preferably to 180 degrees Celsius. The section downstream of the heat exchanger 3 or the heater 5 is a high temperature zone 6. The high temperature zone 6 extends in particular in between the heating means 3, 5 and the cooling medium inlets 7. In particular, a product inlet 8 is arranged in the high temperature zone 6. The product inlet 8 is arranged at a substantially upstream position in the high temperature zone. More in particular, the product inlet 8 is arranged slightly downstream of the heater 5 or the heat exchanger 3 in the high temperature zone 6. The product inlet 8 is adapted to continuously provide a controlled amount of starch containing product per time to the high temperature zone 6. This may obtained by providing a rotating drum as a dosage means in the product inlet 8, such that the amount of product can be controlled. When the product is subjected to the high temperature zone 6, an enhanced thermal shock occurs and the product is expanded. Apart from tobacco, other starch containing products may be expanded.

[0054] The product is exposed to extreme temperature, while the time of this exposure is limited by means of the length of the high temperature zone 6 and flow rate of the process gas therein. A high heat transfer coefficient to the product is achieved by using super-heated process gas as the medium for heat transfer, in particular superheated water steam. Tobacco provided by the product inlet 7 is in particular cut tobacco, which may already be pretreated, such as by applying a casing, impregnation or steam. The type, pressure, temperature and composition of the process gas may be controlled by means of the expansion medium inlet 2, the flue gas outlet 4, and the heat exchanger 3 and heater 5.

[0055] In particular, the tobacco fed through the product inlet 8 comprises at least about 7 to 8 weight percent of water. More preferably, 13 to 30 weight percent of moisture content in the tobacco are desired. The mois-

ture content is important regarding the expansion of the tobacco, as the sudden generation of steam in the starch is the main cause of the expansion of the starch in the tobacco. Downstream of the high temperature zone 6 several cooling medium inlets 7 are provided in a temperature reduction zone 9. The cooling medium inlets 7 are arranged subsequently in the temperature reduction zone 9. The cooling medium inlets 7 comprise injection nozzles, which are provided directly in the pipe forming the temperature reduction zone 9, and flow control valves 10, which control the flow of cooling medium through each of the cooling medium inlets 7. The cooling medium inlets 7 are adapted to inject a cooling medium. The cooling medium is in particular a gas of a lower temperature than the process gas in the high temperature zone 6. Thus, in the temperature reduction zone 9, the temperature of the process gas and the product is reduced. The process gas and the tobacco then flow into a reduced temperature zone 11, which is arranged downstream of a temperature reduction zone 9. The duration of the exposure of the product to the high temperature medium as provided by the process gas is controlled by providing a set of cooling medium inlets 7, in particular in the form of injection nozzles, and a control means, such that cooling medium can be introduced to the mixture of process gas and product particles, in particular tobacco particles, in order to reduce their temperature. Thus, the duration of the high temperature exposure can be freely established. This allows elevating the temperature to levels in the high temperature zone 6 which are not possible in the prior art without using expansion agents. Thus, the tobacco can be exposed to extreme temperatures, which foster an expansion of the tobacco.

[0056] In particular, the temperature reduction zone 9 may be formed by a pipe, whose extension direction in the flow direction comprises at least a vertical component. In particular, the pipe in the temperature reduction zone 9 may extend substantially in the upward vertical direction. Thus, due to gravitational forces on the product, the flow of the product may be slightly slower than the flow of the process gas, which increases the time that the product is in the temperature reduction zone 9. This may increase the cooling effect provided by the cooling medium inlets 7 by a control means and the temperature reduction zone 9. In particular, the flow control valves 10 are controlled to inject the cooling medium. The cooling medium inlets 7 can be arranged in different configurations and positions to achieve the desired cooling effect. In the present embodiment, the cooling medium inlets 7 are arranged substantially equidistant along the pipe of the temperature reduction zone 9.

[0057] The reduced temperature zone 11 extends in the present embodiment in a substantially horizontal direction. Downstream of the reduced temperature zone 11 a product separation unit 12 is provided. The product separation unit 12 is in particular a gravity operated product separation unit. The product separation unit 12 may have the form of a cylinder in its upper region and of a cone in its lower region. At the lowermost position of the cone a product outlet 13 is provided. The product outlet 13 may either be an opening, a closable opening or may comprise conveying means, such as rotatable drums to remove the processed product from the product separation unit 12. The product separation unit 12 is connected in its upper region to a recirculation pipe 14. The process gas in the recirculation pipe 14 has a temperature of about 140 degrees Celsius. The flow of the process gas in the closed loop system of the apparatus is enabled by a pump or fan 15 provided in the recirculation pipe 14. At the downstream end of the recirculation pipe 14 a tail gas outlet 16 is provided for removing parts of the process gas before other parts of the process gas flow into the upstream pipe 1. The recirculation pipe 14 and the upstream pipe 1 may be integral. The tail gas outlet 16 may be provided with a valve to control the outflow of tail gas. Throughout the apparatus, in particular in the high temperature zone 6, temperature reduction zone 9, and in some embodiments as well in the reduced temperature zone 11, one or several temperature sensors may be arranged. The temperature sensor may enable a control of the temperature of the process gas and of the tobacco. Furthermore, several temperature sensors may allow controlling a temperature profile throughout the apparatus, and in particular in the temperature reduction zone 9. In particular, the temperature in the temperature reduction zone 9 may be determined by the type, temperature, volume, flow rate or droplet size of the cooling medium.

[0058] In some embodiments, a pressure control may be implemented in the apparatus, comprising pressure sensors and accordingly controlling the fan or pump and the respective valves throughout the apparatus. Thus, a balancing of the pressure or a control of the pressure can be obtained. Furthermore, by means of controlling the flow velocity of the process gas, the duration of the high temperature exposure of the product can be controlled.

[0059] All aforementioned control parameters define the exit conditions of the product, in particular the expansion level of the tobacco, that is the percentage of volume gained of the tobacco, and the level of thermal shock.

[0060] In the following, the method according to an embodiment of the invention will be described. Initially, process gas, which may at least partially be recirculated, can be provided with expansion medium through an expansion medium inlet in an upstream pipe 1. Then, the process gas is heated by means of a heat exchanger 3 or a heater 5 or a heat exchanger 3 and a heater 5. The heater 5 may in particular be an electrical heater. However, in other embodiments, the heater 5 may also be a heater through which a heating medium flows. Then, a product, in particular cut filler tobacco, is provided through the product inlet 8 to the high temperature zone 9. Due to the moisture in the product and the starch content of the product, the thermal shock which occurs during the rapid temperature change of the product expands the product. In particular, the product is fed through the product inlet

8 at a temperature significantly lower than the temperature in the high temperature zone 6. In particular, the product is fed through the product inlet 8 at ambient temperature or even at a temperature lower than ambient temperature. The product may also be preheated, in particular to a temperature slightly below the boiling point of water.

[0061] The product is conveyed by means of the process gas through the high temperature zone 6 until it reaches a temperature reduction zone 9, in which several subsequent cooling medium inlets 7 are provided. Through each of the cooling medium inlets 7, cooling medium is injected into the temperature reduction zone 9, such that the temperature in temperature reduction zone 9 is rapidly lowered. For this purpose, flow control valves are assigned to each of the cooling medium inlets 7. After the temperature reduction zone 9, the product reaches a reduced temperature zone 11 in which the temperature of the process gas has been significantly reduced. Due to the temperature reduction zone 9 in which the cooling medium quickly cools the process gas and product, the product can be subjected to higher temperatures in the high temperature zone 6 than in comparable prior art solutions. In particular, the temperature shock is defined by the temperature difference in between the product before being fed through the product inlet 8 and the temperature in the high temperature zone 6. However, if the product would be subjected to high temperatures too long, it would degrade, which could lead to a change of taste, structure or appearance of the product, which is not desired.

[0062] After the reduced temperature zone 11, the expanded product reaches together with the process gas a product separation unit, wherein it is separated from the process gas. Then, the process gas is recirculated through a recirculation pipe 14 to the upstream pipe 1, wherein parts of the process gas can be ejected from the system through a tail gas outlet 16. A fan 15 is provided in recirculation pipe 14 to maintain the circulation of the process gas in the apparatus. Alternatively, it is also possible that the fan 15 or any other circulation means is provided at another position in the apparatus. The circulation means may be connected to a central control means. The flow of the process gas, the temperature and the cooling medium injection can be controlled by the central control means.

Claims

1. Method for expanding a product containing starch comprising the steps of:

   subjecting the product to hot process gas flowing in a downstream direction, such that the product is expanded by means of a thermal shock while the product is conveyed in the process gas in the downstream direction; and

   lowering the temperature of the process gas by injecting cooling medium while further conveying the product in the process gas.

2. Method according to claim 1, wherein the temperature of the process gas is lowered by injecting cooling medium at at least two downstream locations, such that a temperature gradient can be obtained in the process gas along the downstream direction.

3. Method according to claim 1 or 2, wherein the product is conveyed by means of the process gas.

4. Apparatus for expanding a product containing starch comprising
   a heater adapted to heat process gas;
   a product inlet;
   a high temperature zone, in which the product is expanded while being conveyed; and
   a temperature reduction zone downstream of the high temperature zone, wherein the temperature reduction zone comprises at least one cooling medium inlet which is adapted to inject cooling medium to the hot process gas such that the temperature of the gas surrounding the product is reduced.

5. Apparatus according to claim 4, wherein the cooling medium inlet comprises a valve adapted to adjust the amount of injected cooling medium.

6. Apparatus according to claim 4 or 5, wherein several cooling medium inlets are arranged subsequently in a downstream direction in the temperature reduction zone.

7. Apparatus according to any one of claims 4 to 6, further comprising a control means for controlling the at least one valve.

8. Apparatus according to claim 6, further comprising a control means which is adapted such that the valves of the several subsequently arranged cooling medium inlets can be controlled separately to enable a defined temperature gradient in the downstream direction of the temperature reduction zone.

9. Apparatus according to any one of claims 4 to 8, further comprising an expansion medium inlet.

10. Apparatus according to any one of claims 4 to 9, further comprising a product separation unit, in which the product is separated from the process gas.

11. Apparatus according to claim 10, wherein the high temperature zone and the temperature reduction zone are arranged in a closed loop, with the product separation unit being arranged at a position downstream of the temperature reduction zone and the

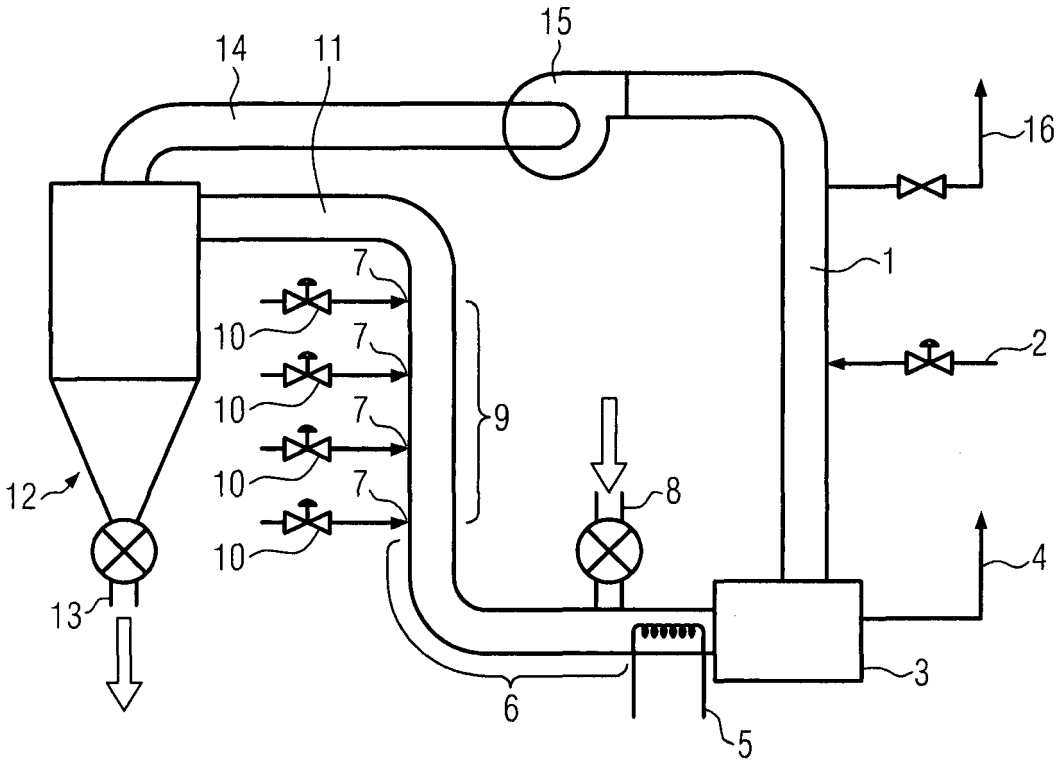
product inlet being arranged in the high temperature zone.

12. Apparatus according to any one of claims 4 to 11, wherein temperature sensors are distributed at least along the temperature reduction zone.

13. Apparatus according to any one of claims 4 to 12, further comprising at least one pressure sensor and a pressure control means which is adapted to control the pressure at least in the high temperature zone.

14. Apparatus according to any one of claims 4 to 13, wherein the product is conveyed by means of the flow of the process gas.

15. Tobacco product comprising tobacco processed by the method or apparatus according to any one of the preceding claims.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EUROPEAN SEARCH REPORT

Application Number
EP 12 00 8494

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 881 498 A (WOCHNOWSKI WALDEMAR) 6 May 1975 (1975-05-06) * column 7, line 65 - column 9, line 34; figure 3 *	4,15	INV. A24B3/18
X	US 4 646 760 A (EGRI LASZLO [CH]) 3 March 1987 (1987-03-03) * column 5, line 44 - line 64; figure 5 *	1,4,15	
X	DE 31 30 778 A1 (BAT CIGARETTENFAB GMBH [DE]) 3 March 1983 (1983-03-03) * page 6; figure 1 *	1,3-5, 9-11,14, 15	

TECHNICAL FIELDS SEARCHED (IPC)
A24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	3 June 2013	Leprêtre, François

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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D : document cited in the application
L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 00 8494

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