METHOD FOR CONDITIONING GRAIN OR SIMILAR MATERIALS

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The present invention relates to a method for conditioning grain or similar materials conveyed as a layer on a supporting plane, the grain particles being passed and fluidized by a gaseous medium and thereby being first dried and then cooled during a treatment in two or more steps.

When drying grain and similar materials, which has to be stored after drying, it is necessary to reduce the temperature of the dried grain in order to avoid severe damaging of the quality during the storing period. Generally, this cooling of the grain is effected simultaneously with the drying of the grain in such a way that during its passage through the last part of the drying unit, cold outdoor air is blown through the grain. However, this cooling method has often proved insufficient, or a relatively long treatment time has been required with a corresponding increase of the cost for the drying apparatus. Furthermore, it has been found that the quicker the drying is performed, the greater part of the treatment time will be required for the cooling of the grain.

The invention, which has for its object to eliminate this drawback and in the first place to enable a quicker cooling of the dried grain, is based on the knowledge that the necessity for a long cooling time depends upon the uneven moisture content created in the grain after the original drying. If the drying time is adjusted to obtain a certain moisture ratio in the discharged grain, the moisture ratio at the grain surface will be considerably below that value due to the delay—caused by the quick-drying—in the movement of the moisture from the inner portion of the grain and out to the surface of the same. As a consequence of this the moisture ratio in the inner part of the grain will often be below the hygroscopic equilibrium state of the outdoor air, and the grain therefore during the first part of the cooling absorbs moisture from the cooling air. Besides the disadvantage of an undesirable moistening of the grain there will be a surplus of heat resulting from the heat of condensation which prolongs the required cooling period. The super-dried surface layer will also prevent the outward movement of the moisture from the inner portion which is necessary for the moisture equalization, said moisture movement furthermore being delayed by a reduction of the temperature of the grain. Because of this prevention of the equalization of the moisture to the desired extent, the heat transmission necessary for the cooling is effected entirely by means of convection.

The method according to the invention is characterized by the fact that the material between the treatment steps is continuously transmitted to an equalizing zone, where the material is substantially isolated from the influence of the treatment medium. Owing to the fact that the moisture equalization in the grain in this manner is performed at a fixed high temperature, the moisture movement will take place quicker and the grain will enter the cooling zone with so high a moisture ratio at the surface layer, that there is no risk of water absorption. Another object of the invention is a dividing, if desired, of the drying into two steps by providing a similar equalizing zone between the steps.

The invention also relates to a device for performing the method. Such a device consists of a unit in form of a rectangular box and equipped with inlet and outlet openings at opposite ends for the material to be treated and equipped with a substantially horizontal, perforated intermediate bottom wall, functioning as a supporting plane for the material, and one or more ventilators connected to the space below the intermediate bottom wall for supplying treatment medium and a discharge opening for this medium arranged above the intermediate bottom wall. A suitable embodiment of the device is characterized in that the supporting plane in the equalizing zone or zones is made without perforations or with perforations providing a considerably reduced flow area. According to another embodiment the space below the supporting plane is equipped with partitions at opposite ends of each equalizing zone and the equalizing zones are connected to supply means for a treatment medium of considerably lower pressure than that of the treatment zones. In sections where no air is blown through the grain particles, or at such a low velocity of the medium that fluidizations do not take place, the conveying of the material can be effected by vibrating or shaking the supporting plane or by a scraping conveyor.

According to one embodiment, the device for performing the method according to the invention may consist of two or more units arranged one above the other and of equal dimensions, but a mirror image of each other and shaped as rectangular boxes. Each unit is equipped with inlet and outlet openings at opposite ends for the material to be treated and is provided with a horizontal, perforated intermediate bottom wall functioning as a supporting plane for the material, a ventilator connected to the space below the intermediate bottom wall for supplying treatment medium, and a discharge opening above the intermediate bottom wall for this medium. A characteristic feature of this embodiment is that the perforated intermediate bottom wall terminates some distance from the outlet end of its associated unit in a depending vertical partition, which defines a shaft-like space ending in the outlet opening for the material, said opening being arranged in the bottom of the unit.

According to all of the above mentioned embodiments of the device, the outer or the discharged treatment medium can suitably—in order to prevent the grain from being caught by the descending treatment medium—be made as a slot in one or both of the side walls and have the same length as the perforated intermediate bottom wall. The slot terminates in an outlet duct arranged at the outer side of the device having the same length as the slot and having a flow area of about one and a half times as large as said slot. The outlet duct has an upwardly-facing outlet opening which is defined by an inwardly bent edge, functioning as a catching rim. The side wall of the unit along the lower edge of said slot is formed with a V-shaped inwardly bent marginal portion or deflector for deflecting the material.

The invention will now be described more in detail with reference to the accompanying drawings, which show suitable embodiments of the devices for performing the method wherein:

FIG. 1 shows a vertical longitudinal section of an embodiment of the device.
FIG. 2 shows a cross section through the device along the section line 2—2 in FIG. 1.
FIG. 3 shows a vertical longitudinal section of another embodiment of the device.
FIG. 4 shows a cross section through the last mentioned embodiment of the device along the section line 4—4 of FIG. 3.
FIG. 5 shows a vertical longitudinal section through a modified embodiment of the device.
FIG. 6 shows a cross section through this modified embodiment along the section line 6—6 in FIG. 5.
FIG. 7 shows a plan view of the last mentioned device.
FIG. 8 is a fragmentary longitudinal vertical section showing a modification of the apparatus illustrated in FIGS. 1 and 2. In the drawing, and more particularly FIGS. 1 and 2, the dryer comprises a rectangular box 1 formed as a unit with end wall 2 and 2a, a bottom 7 and a roof 6 of sheet metal. The unit is provided with an inlet opening 3, made in the roof near the end wall 2 and an outlet opening 12 in the bottom of the unit near the opposite end wall 2a. In the unit there is arranged a perforated intermediate bottom wall 8, supporting the material 9 to be dried and at the same time functioning as a distributing device for the treatment medium. A partition 28 depends from the intermediate bottom wall 8 at its end adjacent the end wall 2a to define therebetween the outlet opening 12. The material to be dried, i.e. the grain, is fed from a feeding hopper 4 and the feed of material is governed by means of an adjustable partition 5, in order to obtain a suitable layer of material 9. The space 10 below the perforated intermediate bottom 8 is connected through a heater 20 to a ventilator 21 supplying the treatment medium.

According to the invention the intermediate bottom wall 8 is provided with ordinary perforations in the section A, while the bottom wall in the section B is provided with only small perforations to provide diminished flow of medium through the material in this section. If desired, the bottom wall in the section B may be imperforate as shown at 8a in FIG. 8 to provide the diminished flow. In the section C of the device next to the discharge which functions as cooling zone, the intermediate bottom wall is provided with ordinary perforations.

From the cooling zone the grain is emptied into an outlet trough 16 through the opening 12, from where the grain can be conveyed by means of an elevator 13, a screw conveyor or the like. The trough 16 can also be made with an overflow opening 14, equipped with an adjustable sliding door 15.

The grain is conveyed through the device by being put into a fluidized state by means of the treatment medium blown through the grain particles, and the treatment time is governed by maintaining the discharged quantity of grain at a suitable value. In the section B, where the medium is not blown through by the grain or the medium only has such a low velocity that fluidizing does not take place, the conveyance of the grain can be effected by a scraping conveyor shown schematically at 29 in FIGS. 1 and 2, or by vibrating the supporting plane for example by a vibrator shown at 29a in FIG. 8.

For the discharge of the treatment medium there are slot-shaped openings 11 of the same length as the perforated intermediate bottom arranged in the side walls of the section. The slot can be made with constant width as shown, or—for the purpose of an even distribution of medium—with varying width. The slot 11 terminates in an outlet duct 22 arranged on the outer side of the unit. The flow area of the duct 23 is preferably one and a half times the flow area of the slot 11. The duct has along its top an outlet opening 24, defined by an inwardly bent edge 23 functioning as a catching rim for catching grain particles, if any. Likewise, in order to prevent the grain from being caught by the discharging medium the side wall is along the lower edge of the slot provided with a V-shaped inwardly bent deflector 25 for deflecting the material. In most cases it is sufficient to use one single slot and an outlet duct for the discharge of the treatment medium. The outlet duct of similar form and size of the unit can be disposed of by a small opening 26 which may be opened for inspection and testing of the material. For heating the treatment medium used in the drying zone in the case shown in FIG. 1, the ventilator 21 is connected to the chamber 10 through the heating coil 29 for heating by means of steam or hot water. Air is supplied to the cooling zone either from a separate ventilator or, as in the case shown, from the same ventilator 21 through a by-pass 18, equipped with an adjusting dumper 19. A partition 17 is mounted in the space 10 for separating the drying and cooling mediums.

The embodiment of the device shown in FIG. 3 differs from that shown in FIG. 1 in that the space 10a below the supporting plane is provided with partitions 17a and 17b at opposite sides of the equalizing zone B. Furthermore, in this case the equalizing zones are connected to separate supplying means 21b for a treating medium of considerably lower pressure than in the treatment zones A, C to which treating medium is supplied by means of the ventilators 21a and 21c. The supplying means 21b is in the case shown connected to the equalizing zone by means of a duct 27b, which can be inserted a heating coil 29b. In similar manner a heating coil 29a can be arranged in the duct 27a from the supplying means 21a to the treatment zone A. A duct 27c connects the supply means 21c to the cooling zone C.

In the device illustrated in FIG. 5 there are two closed super-imposed units 41a and 41b in form of rectangular boxes of equal dimensions, the second unit, however, being the mirror image of the first one.

The upper unit 41a has end walls 42 and 42a, a bottom 43, and a roof 44. The unit is provided with an inlet opening 45 near the end wall 42a equipped with a feeding hopper 46. The feed of material is governed by an adjustable partition 45 to provide a suitable layer of fluidized material 49. A perforated bottom wall 48 is spaced upwardly from the bottom 47 to define therebelow a space or chamber 50 which is connected through a heater 60 to a ventilator 51. Heated medium is thus supplied to the chamber 50 and passes upwardly through the perforated bottom wall 48 to fluidize the material 49 in the upper unit 41a. To discharge the treatment medium from above the material 49, openings 61 are formed in the side walls of the unit. The openings 61 may be of constant width, or, as shown, to provide an even distribution of medium with varying widths. The outlet opening 64 is similar to the opening 24 and need not be described further. The intermediate bottom wall 48 terminates at its end adjacent the end wall 42a in a forming a shaft-like space or chamber 54 isolated from the treatment medium. The upper end of the chamber 54 forms the discharge opening for the upper unit 41a, and the lower end of the chamber 54 forms the inlet opening to the unit 41b. The sides of the inlet opening 55 is controlled by an adjustable partition 45b to determine the level of the material 49b in the lower unit. The lower unit has an intermediate bottom wall 48b which forms a space 56b therebelow supplied with cool medium by a ventilator 51b. The cooling supplied through the perforated wall 48b passes upwardly through the material 49b and is discharged through a slot 61b and discharge openings 64b (FIG. 6) similar in construction to the discharge opening 64. The perforated wall 48b is connected to the remote end wall 42b of the lower unit 41b in a depending partition 53 which defines an outlet opening 52b from which the material is removed similarly to the manner illustrated and described in connection with the embodiment illustrated in FIGS. 1 and 2.

In this embodiment said space 54 constitutes a resting and equalizing zone where the grain—being either heated thanks to an intensive blowing—will move slowly downwards and wherein its moisture at maintained constant temperature of the material is allowed to be equalized before the grain is conducted to the succeeding sub-posed unit 41b, functioning as cooling zone. The shaft-like space 54 should suitably be dimensioned so that the
equalizing time corresponds to at least \( \frac{1}{4} \) of the drying time.

In this embodiment the heating coil 60 is as illustrated in FIG. 7 arranged on the suction side of the ventilator. This heating coil may also be substituted by a heat exchanger for indirect heating by means of flue gases or the necessary heat may also be supplied by direct addition of flue gases to the supplied out-door air. In order to increase the heat economy, part of the treating medium may be recirculated. The discharge duct of the treating medium may be recirculated. The discharge duct 62 is in such cases, as illustrated in FIG. 7 connected with the heating coil or the inlet of the ventilator by means of a duct 65, provided with a damper regulated inlet 66 for outdoor air. In order to make it possible to separate impurities accompanying the medium said return connection is suitably passing a dust settling chamber 67.

What we claim is:

A method of treating granular materials which comprises the steps of introducing the material into a first bed in a drying zone, passing a stream of drying medium up through the bottom of said first bed to fluidize the material therein, whereby said material is subjected to said drying medium for a predetermined time period, continuously withdrawing the dried material from one end of said first bed and introducing the material into an equalizing zone, interrupting the fluidization of the material in the equalizing zone by keeping the material in said equalizing zone substantially isolated from the effect of treatment medium for a second predetermined time period at least one fourth said first predetermined time period to render the moisture content of the material uniform throughout, and then introducing the material from said zone into a second bed in a cooling zone, passing a stream of cooling medium upwardly through the bottom of said second bed to fluidize the material therein while cooling the same, and continuously withdrawing the cooled material from said second bed.

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