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METHOD AND APPARATUS FOR PREVENTING AGGLOMERATION

5 The present invention is a method for preventing agglomeration while drying sticky particles such as cereal dough particles, dough for chips products, pasta dough particles in a fluid bed, said method comprises application of pulsing gas onto the sticky particles while drying air is blown up through the sticky particles. The invention
10 relates as well to an apparatus for carrying out such a method.

Drying of sticky particles is well known in the production of cereal. In such a production the cereal dough may first
15 be extruded, rolled out to the appropriate thickness and cut into pieces or particles. The particles are then dried before they are puffed at a high temperature and subsequently coated etc. At the drying step described here the particles of un-baked or wet dough will be sticky.

20

Drying sticky particles such as the pieces of cereal dough mentioned above or other products e.g. dough for chips products, pasta dough etc. is difficult as the particles tend to stick together and form agglomerates, i.e. bigger
25 lumps of dough. Once an agglomerate is formed, a non-uniform drying of the dough will take place. Furthermore, the shape of particles or chips will be ruined if dough particles are allowed to stick together during the drying process. This is unsatisfactory in the production of
30 quality products.

Difficulties are experienced when dough particles or chips having a high moisture content, e.g. 15 to 20% H₂O, are dried at a high temperature, e.g. about 180°C, and contact
35 is allowed between the particles while the drying takes place. In order to avoid this and to prevent cracks in the

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surface of the particles, they must be dried at lower temperatures. Conventionally, the drying operation of such particles has therefore been carried out in a number of steps.

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Different processes are known for carrying out the drying of sticky particles. The first drying step may for example be drying in a tumbler dryer where the temperature is kept relatively low, e.g. about 100°C. The particles or chips are
10 only partly dried in this first drying step. Additional drying steps at higher temperatures may then be performed in tumbler dryers, fluid beds, etc.

The tumble drying required for drying of cereal dough in a
15 production line usually is of large dimensions. For example, the dryer drum can be from 5 to 6 m long and about 2,5 m in diameter.

In the fluid bed only a thin layer, for example about 5 cm,
20 of particles can be advanced and dried at a time. If the layer is too thick the sticky particles will tend to form agglomerates and will not be uniformly dried. The agglomeration of the particles hence limits the capacity of the fluid bed.

25

The above described multi-step drying processes, consequently are disadvantageous as they are both time and energy consuming.

30 An attempt at having a number of different drying processes in one apparatus is disclosed in US Patent 4,910,880. The apparatus described therein employs drying gases flowing up and down and which pass through a foraminous conveyor advancing the product to be dried. However, this patent
35 does not describe any attempt to prevent agglomeration of sticky particles and breaking of the same by "punching" the

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sticky particles by means of pulsing air flow while drying the particles with opposite directed drying air.

The aim of the present invention is to provide a one step
5 method for drying sticky particles or chips and to prevent
agglomeration thereof. Furthermore, it is possible with the
present invention to dry a large quantity of sticky
particles while retaining good surface properties.
Surprisingly, drying of a 10 to 20 cm thick layer of sticky
10 particles has been carried out substantially without
agglomeration of the particles. The thickness which can be
dried satisfactorily depends on the particles' moisture
content. Tests have shown, that the throughput of a
conventional fluid bed providing about 80 kg per hour can
15 be raised from 150 to 180 kg per hour when the fluid bed is
adapted in accordance with the invention. It has also,
surprisingly, been observed that it is possible to avoid
agglomeration and obtain a good product finish by exposing
the sticky particles to a pulsing air flow from above while
20 blowing drying air from below through a perforated conveyor
in a fluid bed.

The present invention further provides a compact and well
balanced apparatus. Though the apparatus employs pulsing
25 air and optionally also other means of vibration of the
sticky particles, the invention provides means for
minimising the vibrations transmitted to the surroundings.

In the first aspect, the present invention relates to a
30 method for preventing agglomeration while drying sticky
particles in a fluid bed. This method distinguishes itself
by comprising

35 supplying sticky particles to an upper surface of a
perforated conveyor and advancing said sticky particles
through the fluid bed,

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supplying drying air flow substantially upwards through
the perforated conveyor to the sticky particle on it,
5 exposing substantially from above the sticky particles
to a pulsing air flow so that they are caused to move
and to break up agglomerates of sticky particles , and
controlling the supply of the drying and pulsing air
10 flow, the pulsation, and the drying air temperature.

The sticky particles may be dried with hot air or other hot
gases allowed in food production. The temperature of the
drying air preferably ranges from 100°C to 180°C,
15 advantageously about 120°C. The pulsation may be generated
by a pulsing gas or air flow having room temperature or
alternatively heated or cooled.

It is preferred that the velocity of the pulsing air is
20 from 10 to 15 times as high as the velocity of the drying
air, preferably about 13 times as high. Beneficially, the
velocity of the drying air is about 1,5 m/s while the
velocity of the pulsing air is about 20 m/s.

25 The method may conveniently be carried out with sticky
particles having a bulk density in the range from 350 g/l
to 450 g/l, preferably about 400 g/l. Especially, a cereal
dough comprising wheat, sugar, malt and water; or rice,
sugar and water.

30 The bigger particles require a longer drying time, and the
risk that they will agglomerate is higher. With the method
according to the invention sticky particles of the
following size may advantageously be dried: length in the
35 range of 10 mm to 20 mm, preferably from 12 mm to 17 mm,
width in the range of 10 mm to 20 mm, preferably of 12 mm

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to 17 mm, and thickness in the range of 1 mm to 2 mm, preferably about 1.5 mm.

In order to prevent agglomeration, the sticky particles should preferably be moved at short intervals so that they do not have enough time to stick together. The perforated conveyor is therefore preferably a vibrating tray or table which conveyor adds to the relative movement between the sticky particles.

10

The pulsing air flow may conveniently comprise a plurality of substantially parallel pulsing air jets. Additionally, a plurality of pulsing air jets may be provided, the direction of which is adapted to the configuration of the fluid bed in order to optimise the configuration of the pulsing air flow, and hence provide substantial turbulence of the sticky particles while they are being dried. The pulsing air jets may advantageously be positioned in a matrix having a plurality of parallel rows of air jets, and wherein the pulsing air jets in one column pulse synchronically. To simplify the supply system the pulsing air jets in one row are preferably connected to a common air supply pipe.

To create sufficient "punch" and thus turbulence between the sticky particles which can break up starting agglomerates it is preferred that the high pressure period of the pulsing air jet lasts for an approximately 5 sec. period. Between a higher and a lower air pressure a time sequence of approximately 1 sec. is allowed in order to allow the air supply equipment to recharge and distribute the pressurised air.

In order to obtain a substantially similar disruption of the sticky particles all across the conveyor, the rows of pulsing air jets are preferably displaced parallel relative



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to each other and transverse to the forward direction of the conveyor. As a result of this, the sticky particles along the substantially whole width of the conveyor are exposed to pulsing air "punches".

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Many different pulsation sequences may be applied to the sticky particles, but particularly advantageous is a sequence where the air pulsation from the air jets in the matrix follows a sequence wherein the high pressure period
10 of the jets in the first row is followed by a high pressure period in the last row, followed by a high pressure period of the second row, followed by a high pressure period in the second last row, and so on until all the rows have been activated and the sequence is repeated. In this way, in
15 each sequence pulsation "punches" are applied and shifted from one end of the conveyor to the other, and stepwise moved towards the centre of the conveyor. This gives an equated displacement of the sticky particles on top of the conveyor.

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In another aspect the invention relates to a fluid bed preventing agglomeration while drying sticky particles, said fluid bed comprises

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inlet means for introducing sticky particles to an upper surface of a perforated conveyor which advances the sticky particles through the fluid bed, and outlet means for discharging the sticky particles from the fluid bed, drying air supply means supplying drying air
30 substantially upwards through the perforated conveyor to the sticky particles on it,

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pulsing air supply means exposing the sticky particles substantially from above to a pulsing air flow so that
they are caused to move and agglomerates of sticky particles are broken up, and

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control means controlling the supply of the drying and pulsing air flow, the pulsation, and the drying air temperature.

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The sticky particle supply means may e.g. be fluid valves transporting recently cut-out sticky particles such as dough pieces, by blowing the particles through supply pipes and onto the conveyor. The pulsing air is supplied by
10 supplying means such as a capacity air supply. The capacity air supply builds up an air pressure, which is discharged, after which the capacity is recharged. The pulsing air supply means comprises a plurality of discharge nozzles supplying a plurality of substantially parallel air jets
15 which are directed towards the upper surface of the perforated conveyor. The jet discharge nozzles may conveniently be positioned in a plane above substantially the whole of the perforated conveyor, and they may for example be from a matrix providing a pulsation with the
20 pulsation sequence characteristics as described above in connection with the method according to the invention.

In a preferred embodiment of the present invention the common air supply pipes are connected to a manifold wherein
25 the supply of pressurised air is controlled by the operation of said manifold. For example, each of the common air supplies may be connected to the manifold via valves, respectively. The operation of the manifold allows pressurised air to be introduced into the supply pipes or
30 cuts off the air supply. Subsequently one or more valves may be opened at a time. However, when a capacity air supply is employed it is necessary to keep all the valves closed during recharging of the capacity. To ease the operation of the manifold it may conveniently be operated
35 by means of a computer running a computer program

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comprising the instructions to open and close valves according to the desired pulsation sequence.

5 In a preferred embodiment according to the invention, the sticky particles are advanced on a perforated conveyor in the form of a vibrating tray or table advancing the sticky particles by means of its vibrations. Alternatively, a belt conveyor with openings in the belt may be used.

10 In a preferred embodiment of the fluid bed according to the invention the velocity of the pulsing air is 10 to 15 times as high as the velocity of the drying air. Advantageously, the velocity of the pulsing air is about 20 m/sec. and the velocity of the drying air is about 1,5 m/sec.

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The invention will now be described in greater detail with reference to the accompanying drawings given by way of example showing an embodiment of the invention and in which:

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Fig. 1 is a schematic illustration of a side view of the apparatus according to the invention, and
Fig. 2 is a schematic illustration of an end view of the apparatus according to the invention.

25

Fig. 1 and 2 show a fluid bed 8 according to the invention. Said fluid bed 8 comprises an inlet means 13 for introducing sticky particles to an upper surface 14 of a perforated conveyor 11 advancing the sticky particles
30 through the fluid bed 8. The dough for the sticky particles originates from an extrudate from e.g. a dough cooker or an extruder. The extrudate is cut up into particles. Conveniently, the cut out sticky particles have a length and width in the range of 10 to 20 mm, and a thickness
35 corresponding to that of the extrudate e.g. in the range of 1 to 2 mm. From the cutting zone to the fluid bed 8, the



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sticky particles are transported via fluid valves and tubes, not shown in the drawings.

The perforated conveyor 11 is preferably a vibrating tray.
5 The movements of the tray advance the sticky particles on upper surface 14 thereof. In the present embodiment of the fluid bed 8, the plate is vibrated by means of vibrators 5. In order to avoid transmission of the vibrations to the surroundings, the fluid bed 8 is positioned on damping
10 members 12. When the sticky particles have been passed the whole way through the fluid bed they are discharged through outlet means 15. The fluid bed further comprises a gate or barrier the adjustment of which causes a regulation of the thickness of the layer of the sticky particles due to the
15 mechanical stopping effect.

During the transportation through the fluid bed 8 the sticky particles are subjected to drying air supplied by
20 drying air supply means 10 substantially upwards through the perforated conveyor 11. The drying air supplying means may comprise fan and heating means. The heated air is advantageously circulated in order to save energy. There is no requirement to the drying air being pressurised air. The
25 sticky particles are further exposed to pulsing air supplied by pulsing air supply means 3 in a direction substantially from above. This combination of the drying with ascending drying air and "punching" pulsing air flow results in a drying of the initially sticky particles and
30 prevents agglomerates of particles in the final product. Agglomeration occurring during the passage in the fluid bed 8 will be broken up again by the air flows. In general the air supplied to the sticky particles should be food acceptable.

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In this preferred embodiment of the invention, the pulsing air supply means 3 comprises a capacity air supply 2 communicating with a plurality of discharge nozzles 16 supplying a plurality of substantially parallel air jets which are directed towards the upper surface 14 of the perforated conveyor 11. The jet discharge nozzles 16 are positioned in a plane above substantially the whole width of the perforated conveyor 11. The capacity air supply 2 builds up a capacity of pressurised air, which, through valves 6, is passed via distribution pipes 7 to the discharge nozzles 16. Each distribution pipe 7 is conveniently connected to a row of discharge nozzles 16. After discharge of the pressurised air, the air pressure builds up again for a subsequent outlet. In order to optimise the configuration of the pulsing air flow and provide substantial turbulence of the sticky particles while they are being dried, a further plurality of pulsing air jets 1 may be provided, the direction of which is adapted to the configuration of the fluid bed.

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For an appropriate distribution of the pulsing air the pulsing air supply means further comprises a manifold 4 wherein the supply of pressurised air is controlled by the operation of said manifold 4. For example, each of the distribution pipes 7 is connected to the manifold 4 via the valves 6. Control means are provided for controlling pulsation and supply of air. The control is enabled by operation of the manifold 4 which allows pressurised air to be introduced into the supply distribution pipes 7 or cuts off the air supply. One or more valves 6 may be opened at a time. However, when a capacity air supply is employed, it is necessary to keep all the valves closed during recharging of the capacity. To ease the operation of the manifold 4, it may conveniently be operated by means of a computer running a computer program comprising the instructions to open and close valves according to the



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desired pulsation sequence. It will be understood that other air supply and control systems may be applied for carrying out the invention.

- 5 For the control of the temperature of the drying air and the temperature within the fluid bed, sensors are provided, not shown in the drawings. The pulsing air may be heated, however, this is not a requirement. Tests have shown that the influence of the pulsing air on the temperature is not
10 substantial.

With the embodiment of the fluid bed according to the invention illustrated in Fig. 1 and 2 the moisture level of the sticky particle will e.g. be reduced to from 8 to 20%
15 H₂O. The drying times are e.g. in the range of 30 to 100 min depending on the throughput, typically about 30 min.

Tests have shown, that the throughput of the same type of sticky particles with a conventional fluid bed, having a
20 capacity of about 80 kg per hour, could be raised from 150 to 180 kg per hour when the fluid bed is adapted in accordance with the invention.

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CLAIMS

1. A method for preventing agglomeration while drying sticky particles in a fluid bed, said method comprising
- 5 supplying sticky particles to an upper surface of a perforated conveyor and advancing said sticky particles through the fluid bed,
- 10 supplying drying air flow substantially upwards through the perforated conveyor to the sticky particles on it,
- exposing substantially from above the sticky particles to a pulsing air flow so that they are caused to move
- 15 and to break up agglomerates of sticky particles, and
- controlling the supply of the drying and pulsing air flow, the pulsation, and the drying air temperature.
- 20
2. A method according to claim 1, wherein the fluid bed is vibrated.
3. A method according to claims 1 and 2, wherein the
- 25 perforated conveyor is vibrated while the sticky particles are advanced.
4. A method according to claims 1 to 3, wherein the pulsing air flow comprises a plurality of substantially parallel
- 30 pulsing air jets.
5. A method according to claims 1 to 4, wherein the pulsing air flow further comprises a plurality of pulsing air jets the direction of which is adapted to the configuration of
- 35 the fluid bed.

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6. A method according to claims 4 and 5, wherein each of the pulsing air jets pulse between a higher and a lower air pressure at time sequences of approximately 1 sec.
- 5 7. A method according to claim 6, wherein the high pressure of the pulsing air jet lasts for approximately a 5 sec. period.
8. A method according to any of claims 4 to 7, wherein the
10 plurality of pulsing air jets form a matrix having a plurality of parallel rows of air jets, and wherein the pulsing air jets synchronically pulse in one column.
9. A method according to claim 8, wherein the pulsing air
15 jets in one row are connected to a common air supply pipe.
10. A method according to claims 8 to 9, wherein the rows of pulsing air jets are displaced parallel relative to each other and transverse to the advancing direction of the
20 conveyor so that the sticky particles along substantially the whole width of the conveyor are exposed to the pulsing air.
11. A method according to claims 8 to 10, wherein the air
25 pulsation from the air jets in the matrix follows a sequence wherein the high pressure period of the jets in the first row is followed by a high pressure period in the last row, followed by a high pressure period of the second row, followed by a high pressure period in the second last
30 row, and so on until all the rows have been activated and the sequence is repeated.
12. A method according to any of claims 1 to 11, wherein the temperature of the drying air is in the range of 100°C
35 to 180°C, preferably about 120°C.

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13. A method according to any of claims 1 to 12, wherein the sticky particles have a bulk density in the range of 350 g/l to 450 g/l, preferably about 400 g/l.
- 5 14. A method according to any of claims 1 to 13, wherein the sticky particles have a length in the range of 10 mm to 20 mm, preferably from 12 mm to 17 mm, a width in the range of 10 mm to 20 mm, preferably from 12 mm to 17 mm, and a thickness in the range of 1 mm to 2 mm, preferably about
10 1.5 mm.
15. A method according to any of claims 1 to 14, wherein the velocity of the pulsing air is from 10 to 15 times as high as the velocity of the drying air, preferably about 13
15 times as high.
16. A method according to any of claims 1 to 15, wherein the velocity of the pulsing air is 10 to 15 times as high as the velocity of the drying air.
20
17. A method according to any of claims 1 to 16, wherein the velocity of the pulsing air is about 20 m/sec. and the velocity of the drying air is about 1.5 m/sec.
- 25 18. A fluid bed preventing agglomeration while drying sticky particles, said fluid bed comprising
- inlet means for introducing sticky particles to an upper surface of a perforated conveyor which advances
30 the sticky particles through the fluid bed, and outlet means for discharging the sticky particles from the fluid bed,
- drying air supply means supplying drying air
35 substantially upwards through the perforated conveyor to the sticky particles on it,

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5 pulsing air supply means exposing the sticky particles substantially from above to a pulsing air flow so that they are caused to move and agglomerates of sticky particles are broken up, and

control means controlling the supply of the drying and pulsing air flow, the pulsation, and the drying air temperature.

10

19. A fluid bed according to claim 18, further comprising a vibrator for vibrating the fluid bed.

15 20. A fluid bed according to claims 18 and 19, further comprising a vibrator for vibrating the perforated conveyor.

20 21. A fluid bed according to claims 18 to 20, wherein the pulsing air supply means comprises a plurality of discharge nozzles supplying a plurality of substantially parallel pulsing air jets.

25 22. A fluid bed according to claims 18 and 21, wherein air supply means comprises a plurality of discharge nozzles supplying pulsing air jets the direction of which is adapted to the configuration of the fluid bed.

30 23. A fluid bed according to claims 21 and 22, wherein the discharge nozzles form a matrix having a plurality of parallel rows, and wherein the pulsing air jets of the discharge nozzles in one column pulse synchronically.

35 24. A fluid bed according to claim 23, wherein the discharge nozzles in a row are connected to a common air supply pipe.

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25. A fluid bed according to claims 21 to 24, wherein the rows of discharge nozzles are displaced parallel relative to each other and transverse to the advancing direction of the conveyor so that the sticky particles along
5 substantially the whole width of the conveyor are exposed to the pulsing air.

26. A fluid bed according to any of claims 24 to 25, wherein the common air supply pipes are connected to a
10 manifold and wherein the supply of air is controlled by the operation of said manifold.

27. A fluid bed according to claim 26, wherein the operation of the manifold is carried out by running a
15 computer program by means of a computer.

28. A fluid bed according to claims 18 to 27, wherein the pulsing air supply is a capacity air pressure supply.

20 29. A fluid bed according to any of claims 18 to 28, wherein the conveyor is a vibrating table.

30. A fluid bed according to any of claims 18 to 28, wherein the conveyor is a belt conveyor.
25

31. A fluid bed according to any of claims 18 to 30, wherein the velocity of the pulsing air is 10 to 15 times as high as the velocity of the drying air.

30 32. A fluid bed according to any of claims 18 to 31, wherein the velocity of the pulsing air is about 20 m/sec. and the velocity of the drying air is about 1.5 m/sec.

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