

The invention relates to a process for wetting grains, in particular cereal grains, with a liquid, referred to below as water for the sake of simplicity, and a device for implementing the process.

For the extraction of flour, for example, the endosperm of a cereal grain must be separated from the husk (bran and germ). For this purpose the cereal grains are wetted with water so that their husk softens and can then be better separated in the grinding process.

According to the prior art, the cereals grains are treated with water in a worm conveyor and thereby mixed.

In order to attain good mixing of the cereal grains with water, the worm conveyor must be of very long design. In order to be able to use a shorter worm conveyor, FR-A 2 540 746 provides for the worm conveyor to be designed as a roller with projecting plates positioned hexically on the roller. When the roller is turned, the cereals grains are transported only slowly to the discharge opening, because part of the cereal grains can fall between the plates and is not co-transported forward, so that the retention time of the grain-liquid mixture in the mixing device is prolonged. Such wetting does usually induce a uniform water distribution on the surface of the grain. This uniform water distribution is, however, not sufficient, as has been shown, for example to separate the endosperm from the husk in an immediately subsequent grinding process. For this reason the grain-liquid mixture is left for 10 to 24 hours, depending on grain quality, after wetting of the grains with the water, so that the water can soften their husk and penetrate into the inside of the embryo. These long standing times are of great disadvantage, as a large volume capacity is required for storage during the standing time. The maximum production capacity of a mill is frequently limited by this necessary volume capacity.

The long standing time moreover has a detrimental effect on the quality of the flour, as mould and yeast fungi and/or bacteria (for example enteric bacterium C) often form and multiply during the long storage period because of the moisture of the grain. For this reason the wetting worm, which has a length of between three and eight meters or is designed according to FR-A 2 540 746, is a good germinating focus for mould fungi and/or bacteria, so that the worms have to be cleaned frequently, leading to interruptions and

very much disturbing continuous operation. In particular the worm conveyor according to FR-A 2 540 746 is difficult to clean on account of the projecting plates.

In order to soak grains completely and thereby to loosen the husk at the embryo in order to be able to rub it off, throwing the already wetted grains against sharp-edged or rough friction elements during a transport is also known. Through this measure the husk is to be damaged, i.e. to be provided with holes through which the water penetrates faster into the grains and in particular into the embryo than at undamaged points. With this process the liquid migrates primarily from the damaged point into the husk. This results in non-uniform moistening of the husk. Therefore the embryo, as has been shown, still adheres to those points at which the husk is not yet sufficiently moistened, so that the husk cannot be rubbed satisfactorily from the embryo.

Applied to a grinding process of the grains, this means that the separation of grain and husk at these points is not successful.

According to FR-A 2 234 040, grains are wetted with water for the extraction of a malt in beer production. In this case the grains in their entirety, i.e. embryo and husk, are to absorb a very high water content for production of the malt so that the grains begin to germinate. The penetration of the water into the husk and from the husk into the embryo is promoted in that the husk of each grain for its part is wetted all round as uniformly as possible, so that the water can penetrate from all sides into the husk and the embryo. For this purpose the grains are moved forward on a conveying table by vibrating the table and are sprayed in the process

with water by means of a large number of nozzles located along the conveying table, so that a good mixing of the grains with the water takes place and a water film, as it were, is placed around each grain.

This measure does induce a good mixing of the water with the grains, but not fast penetration of the water into the husks of the grains. Therefore a prolonged standing period is necessary subsequent to the wetting of the grains according to this patent specification, too, because the water does not penetrate fast enough into the husk of the grains.

According to SU inventor's certificate 1 386 290, heating of the cooled grain and moistening and soaking of the grain, executed under physical influence on the grain, is known for conditioning wheat grains prior to type grinding. In this process the grain is acted upon at each conditioning stage through vibration with an interfering force of 400 to 495 kp and a frequency of 333 to 416 Hz in the course of 90 to 150 seconds.

In this process a pressure of the wheat column on the vibration screen of at least 0.01 atmospheric excess pressure is necessary, corresponding to a thickness of the wheat layer above the vibration screen of 0.5 to 0.6 meters.

Through this process of conditioning of wheat grains prior to type grinding, an increase in the output of flour of high quality classes by 5.0 to 5.5 % is attained with a reduction of the ash content of the flour by 0.03 to 0.05 %.

The grain is soaked several times for a prolonged period in the course of conditioning. In the course of the first

treatment stage a soaking time of 10 hours, in the course of the second treatment stage a soaking time of 4 hours, and finally in the course of the third treatment stage a soaking time of 10 to 20 minutes is scheduled.

With this process, too, a very long standing time is therefore necessary. These long standing times entail the disadvantages already described above.

Similar problems occur in the treatment of other grains in which the husk is to be separated from the embryo, such as pulses, corn, rice, beans, as well as coffee beans, cocoa beans and the like. In the above-stated brewing process, the problem of the long standing time of 80 to 100 hours or more occurs quite particularly in the production of a malt, as the wetted grains are to absorb an exceptionally high proportion of water so that they start to germinate.

Therefore the term grains is to be understood as covering all fruits which have an embryo and a hard or soft husk or skin surrounding the embryo.

Water can serve as a liquid for the treatment. If, for example, corn is to be made into popcorn as an extruder product, sugar will be added to the liquid (water), i.e. sugared water is used. For the treatment of fodder, molasses can be used as a liquid.

It is the object of the invention to specify a wetting process for grains, in which the grains are wetted with liquid in such a way that the standing time is virtually eliminated as a storage time, and in which the transportability of the grains

wetted with liquid is ensured immediately, i.e. at once or after only 10 to 30 minutes.

Under transportability it is understood that the grains wetted for example with water no longer have an external water film which leads to sticking to the transport facilities (belts, worms or the like).

This object is solved by the characteristic feature of claim 1.

It has been shown that, when the grains mixed with water are subjected to vibrations, i.e. are strongly shaken, for example with a frequency of 50 to 300 Hz, preferably 75 Hz, for a period of 2 to 20 seconds, the acceleration forces exerted by the walling of the vibrator on the grain-liquid mixture already make the entire water penetrate so far into the grains, at least into their husks, that the husks still feel moist externally but a water film is no longer tangible nor present on the grains.

This shaking process can be executed gently, i.e. in such a way that the husks of the grains are not damaged, so that the liquid, uniformly distributed over the husk of each grain, penetrates direct into it.

It has moreover been shown that the grindability of such a grain is attained with application of the process according to the invention after only 30 minutes to 2 hours, depending on water added, because especially then the husk has the required degree of moisture uniformly distributed over the entire husk of each grain and can therefore be readily separated in the grinding process. A long storage of the

grains in order to obtain a uniform soaking with the required degree of moistening, as according to the prior art, is eliminated.

According to the invention, then, the husk of the grain is soaked relatively fast with moisture, and the moisture then penetrates from the husk relatively uniformly from all sides into the inside of the grain.

The advantage of the process according to the invention is thus to be seen in that the grain can be transported to its processing location immediately or after a brief retention period after the wetting, for example to be ground directly there, and that interim storage of the grain is eliminated.

It has moreover been shown that, in order to obtain a grindable grain, the entire necessary quantity of water can be fed to the grains, in particular to the cereal, at once in one single operation, by which means considerable time for the wetting of the cereal grains is saved. In the processes belonging to the prior art, which work with a worm conveyor, several additions of water are necessary at intervals.

Several additions of water are necessary at intervals according to the invention only if the grain including its embryo is to absorb very much water, for example 40 or 50 percent by weight, in order to initiate the germinating process for production of a malt at the maltings.

The process according to the invention has moreover the advantage of, for example, a wetting worm no longer being needed to mix the cereal with the water, as other

more simple facilities can be used, such as a simple agitator or a hopper assembly according to subclaim 8. By this means greater cleanliness and thus better hygiene are attained. Furthermore a power saving is attained, as the drive of the wetting worm or similar devices requires substantially more power than the agitator according to the invention.

Above all, however, bacteria and fungi in particular have less opportunity to increase due to the lack of storage time.

The device according to the invention consists advisably of a pipe with a preferably vertically positioned axle, which is connected approximately at its centre with a vibrating motor or several vibrating motors. The grains mixed with liquid, for example water, can be filled into the pipe at the top and they run out again at the bottom. The throughput can be regulated by measuring and control devices. By this means the retention time of the grain-liquid mixture in the pipe can be regulated. In particular a discharge element, which removes the grains in the required quantity either continuously or non-continuously, can be provided at the bottom end of the pipe. Such a discharge element can, for example, be formed through a cone which is inserted more or less into the pipe end and thus either interrupts the discharge flow of the grains completely or allows optionally determined quantities of grain-liquid mixture to emerge. Rotary vane batchers, vibratory troughs, valves of all kinds or worm conveyors, however, also come into question for this purpose.

As a matter of principle, however, the pipe can also be positioned with a horizontal axis, so that the grains are pushed in from one side. This vibrating may be appropriate if the grain-liquid mixture is to be vibrated batchwise.

Advantageously the pipe has smooth walls inside, so that in particular the husks of the grains are not damaged during vibration for the initially stated reasons, because, as already stated, the water penetrates, in the event of the husks being damaged, non-uniformly into the husk, namely first at the damaged points, to penetrate from here on the one hand further into the husk and on the other hand into the embryo. In this way the husk is non-uniformly moistened and the desired exact separation of husk and embryo in the grinding process therefore negatively influenced. For at those points at which the husk is not yet adequately moistened, embryo pieces of the grain still adhere firmly to the husk and remain attached to the husk in the grinding process.

The pipe can moreover have partition walls, so that the maximum distance of each grain from a wall set in vibration remains low. The grain-liquid mixture receives by this means a high acceleration during the vibration process, namely on a scale of 5 g to 15 g (g = gravitational acceleration). Despite this high acceleration, the grain-liquid mixture does not rebound hard onto the walls, as the grains mixed with liquid are located relatively compactly in the pipe or in the pipe chambers, i.e. the energy transmission to the grain-liquid mixture is not implemented by hard impacts onto this mixture but through contact of the grains and possibly of the liquid droplets with the pipe wall or a partition wall. The liquid itself is burst by these acceleration forces into very fine

droplets which are deposited directly on the husks of the grains and penetrate into the husks.

One substantial further advantage of the process according to the invention is seen in that additives can be fed to the liquid in a further configuration of the invention. Enzymes such as proteinases, proteases or the like, vitamins such as ascorbic acid, nitrates, salts and/or sugar can be provided as additives. These additives dissolved in the liquid can change the characteristics of the grains, such as crude fibres, starch, proteins, fats and/or mucocelluloses, as well as the cell structures and thus for example the grindability of the grains.

This feeding of the additives direct with the liquid into the grains during the vibration process has, for example in flour production, the following advantages:

1. The feeding of additives into the grain prior to the grinding process is cheaper than the feeding of additives after the grinding process by addition to the flour, whereby the additive, for example vitamin C, is added to the flour in powder form according to the prior art.
2. The process according to the invention can be executed temporally faster as, for example in the production of flour, the husks or the flour no longer have to be mixed separately with the pulverized additives after the grinding process.
3. The feeding of the additives according to the prior art in pulverized form may be detrimental to health if the

additives are inhaled for example. They are, however, frequently also not compatible with the human skin.

4. The mixing of flour with the additives according to the prior art demands a very thorough mixing of the flour with the additives. With the process according to the invention, an exceptionally uniform distribution of the additives in the flour is attained by the simplest means. The mixing with the additive is thus no longer so cost-intensive and so time-consuming as in accordance with the prior art.

The process according to the invention be used, besides the above-mentioned applications, as already stated, for the production of malts as required by the beer brewer, in that the grains are advisedly vibrated several times at intervals with a liquid being added. By this means more liquid, for example water, can be bound in the grains in a short time, i.e. the percentage proportion by weight of the liquid in the grain can be increased far beyond the usual extent, so that the cereal grains start to germinate in a substantially shorter time. In this application, then, it is a matter of very much water being absorbed by the endosperm itself, in order to induce the grain to germinate.

Embodiments of the invention are shown on the drawing, wherein

Fig. 1 shows a preliminary embodiment in section;

Fig. 2 shows a section following line II-II of Fig. 1

Fig. 3 shows a modified embodiment according to Fig. 2;

Fig. 4 shows a modified embodiment according to Fig. 2;

Fig. 5 shows a modified embodiment.

According to Fig. 1, cereal grains (100) are filled into a hopper (102) in the direction of the arrow (101) in such a way that fewer cereal grains run out of the hopper opening (103) than are filled in at the top, so that the cereal grains swell over the top edge (104) of the hopper and fall past it through the lower opening (105) of an outer hopper (106) surrounding the hopper (102). By means of an inflow (107), water is fed to the cereal grains in the area of the hopper (102).

A simple agitator or a difference device can, however, serve for the mixing of the grains with the water.

The cereal grains mixed in this way with water fall through a widened opening (110) of an approximately vertically positioned pipe (111). The pipe (111) is mounted by means of rubber buffers (112) on a rigid framework (113) in such a way that it can execute movements in the direction of the arrow (115) and its upper part (111a) and the lower part (111b) can vibrate transversely to the axis A-A of the pipe in the direction of the arrow (115). The pipe (111) has a sleeve (116) which is firmly connected with a vibrating motor (114). When the armature of the vibrating motor (114) rotates, the sleeve (116) and thus the central part of the pipe moves to and fro in the direction of the arrow (115), and the

ends of the pipe vibrate in the direction of the arrows (117 and 118). By this means the cereal grain-liquid mixture stored in the pipe (111) is subjected via the wall of the pipe (111) to a strong acceleration which bursts the liquid into very fine droplets through the vibrations forced upon it and distributes them fast and uniformly over the entire husk and into the grain. During this process the grains mixed with the water trickle from the intake opening (110) to the discharge opening (121). There they meet with a closing cone (120) which is insertable into a discharge opening (121). Depending on the position of the cone (120) in the discharge opening, more or fewer grains can fall past the cone (120). The position of the cone (120) and the length of the pipe thus determine the retention time of the grain-liquid mixture in the pipe (111).

Instead of the cone, however, a rotary vane batcher, a valve mechanism, a vibratory trough or the like, known per se, can be connected suitably with the pipe.

The passing through of the grain can also be executed batchwise. In this case the discharge opening (121) is closed and the pipe vibrated for a set time after the filling in of the grain-liquid mixture. After the opening of the discharge, the wetted grains flow out of the pipe, and the pipe can be refilled.

For the continuous passage of the grains, a control device (130) is provided. The control device (130) receives measured values from a sensor (131) which indicates the quantity of grains passing through the pipe (111). The device (130) regulates the refilling of the hopper (102) with grains and water. A measuring device (132) measures the quantity

of grains flowing out of the pipe (111). The measuring device (132) controls this outflowing quantity and thus the retention time of the grains in the pipe. The grain-liquid mixture is located compactly in the pipe during the vibrating process, so that it does not rebound too strongly against the pipe wall during the vibrating but is rather only exposed to high acceleration forces.

For one pipe filling 2 to approximately 15 seconds or more vibrating time are usually required, i.e. the grains inserted at the top are to be vibrated about 2 to 15 seconds or more in the pipe, irrespective of whether they are filled into the pipe and vibrated batchwise or run continuously through the pipe. The length of the pipe is correspondingly dimensioned. Usually a pipe with a length of one meter is adequate.

The grains emerging at the bottom from the pipe (111) fall through a guide pipe (140) onto a distributing plate (141) and from here into a collecting receptacle (142). The emerging grains are immediately transportable, so that they can be transported by means of conveyor belts, worms and the like, without sticking to these parts on account of adhesion forces, on to a processing location without time-intensive interim storage.

The pipe (111) can have a circular, elliptical or rectangular or else square cross section. It has only to ensure that the grains receive their acceleration energy to an adequate extent in the vibrating process from the inner wall of the pipe.

In order to be able to run large quantities through, the diameter of the pipe (111) can be enlarged. The vibrating effect is thus reduced, however, towards the inside of the pipe, as the energy transmission of the grain-liquid mixture from grain to grain is reduced towards the centre of the pipe. Therefore longitudinal walls (150) which form further energy-transmission walls for the grain-liquid mixture passing through are provided inside a pipe (122) in a further embodiment according to Fig. 3.

Another solution to this problem is shown in Fig. 4. Three pipes (151, 152, 153) which are firmly connected with one another and can be vibrated jointly are provided here.

Fig. 5 shows the pipe (123) with inserted partition walls (124), so that rectangular spaces (125) are formed in the pipe along the length of the pipe, whereby the transverse walls have a relatively low distance from one another, so that the rectangular spaces are very narrow. If such a pipe is vibrated with a frequency of 75 to 80 Hz, the pipe walls give the grain-liquid mixture an acceleration of five to fifteen times gravitational acceleration, whereby the liquid bursts and wets the grains uniformly in such a way that the liquid penetrates directly into the husks of the grains. This penetration is promoted by the acceleration forces exerted on the grains, as is the further penetration of the liquid into the embryo of the grains.

Reference numbers

100	Grains
101	Arrow
102	Hopper
103	Hopper opening
104	Top edge
105	Lower opening of 106
106	Outer hopper
107	Water inflow
110	Widened opening
111	Pipe
111a	Upper part of pipe
111b	Lower part of pipe
112	Rubber buffer
113	Framework
114	Motor
115	Arrow
116	Sleeve
117, 118	Arrows
120	Closing cone
121	Discharge opening
122	Pipe
123	Pipe
124	Partition walls
125	Extended, rectangular spaces
130	Control device
131	Sensor
132	Measuring device

140	Guide pipe
141	Distributing plate
142	Collecting receptacle

150	Partition walls
151, 152, 153	Pipes

A-A	Pipe axis
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Patent claims

1. Process for wetting grains with a liquid, in which the grains are mixed with a liquid and vibrated in a container (111) during a transport movement, characterized in that the grains run continuously or batchwise through the container of the vibrating device after or during the mixing with the liquid in such a way that the walls of the tubular container transmit their kinetic energy to the grain-liquid mixture, in such a way that the grains and the liquid are subjected to strong acceleration forces.

2. Process according to claim 1, characterized in that the grain-liquid mixture is vibrated with a frequency of 50 to 300 Hz, preferably 75 Hz.

3. Process according to claim 1, characterized in that the vibrating time is approximately 2 to 20 seconds.

4. Process according to claim 1, characterized in that the grain-liquid mixture is vibrated by mechanical, electrical and/or magnetic energy and/or by exposure to sonic waves.

5. Process according to claim 1, characterized in that the grains are arranged compactly in the container or run through it.

6. Process according to claim 1, characterized in that the grains and the water are brought together in a mixing device upstream from the vibrating device and are fed from this mixing device direct to the vibrating device.



7. Process according to claim 1, characterized in that the grains are fed to a hopper in such a quantity that they trickle out of the lower hopper opening on the one hand and fall over the top edge of the hopper on the other hand, that the liquid is directed into the intake opening of the hopper, and that the grains moistened in this way are directed or fall into the vibrating device .

8. Device for implementing the process according to claim 1, whereby a container (111) with its longitudinal axis (A-A) is positioned in the direction of the product flow and connected with at least one motor (114) setting the container in vibratory movement, characterized in that the container consists of at least one pipe (111) whose longitudinal axis (A-A) is positioned horizontally or vertically, whereby the motor (114) generating the vibratory movement engages approximately at the centre of the at least one pipe, so that the latter is vibrated transversely to its longitudinal axis.

9. Device according to claim 8, characterized in that the pipe is positioned with the axis approximately vertical, that the mixing device (102, 107) for the grains with the liquid is provided above the pipe (111), and at the lower end of the pipe (111) a device (120, 121) regulating the throughput and/or quantity of grains removed.

10. Device according to claim 9, characterized in that the device (120, 121) regulating the discharge of the grains from the pipe (111) consists of a conical body (120) more or less insertable into the pipe end (121), whose tip points into the pipe end.



11. Device according to claim 9, characterized in that the device (120, 121) is formed by a rotary vane batcher, a worm rotatable about its axis at controllable speed, a vibratory trough connected with the pipe end or a valve device.

12. Device according to claim 8, characterized by a device (130, 131) measuring and controlling the intake quantity of the grains and of the liquid into the container of the vibrating device.

13. Device according to claim 9, characterized by a device (132, 130) measuring and controlling the discharge quantity of the grains.

14. Device according to claim 12 and claim 13, characterized by a control device (130) regulating the retention time of the grain-liquid mixture in the vibrating device.

15. Device according to claim 9, characterized in that a distributing plate (141) is mounted downstream from the device (120, 121).

16. Device according to claim 8, characterized in that the pipe (111) has a circular or elliptical cross section.

17. Device according to claim 8, characterized in that the pipe has a rectangular or square cross section.

18. Device according to claim 8, characterized in that the pipe (122) has several partition walls (124, 150) dividing the internal space in longitudinal direction.



19. Device according to claim 18, characterized in that the spaces (125) formed by the walls (124) have an approximately flat rectangular cross section.

20. Device according to claim 8, characterized in that several pipes (151, 152, 153) are connected with one another.

21. Device according to claim 8, characterized in that the diameter of the pipe (111, 151, 152, 153) is approximately ten centimeters.

22. Process according to claim 1, characterized in that the acceleration exerted on the grain-liquid mixture is approximately 10 to 15 g (g = gravitational acceleration).

23. Process according to claim 1, characterized in that under grains, fruits with a hard and soft husk are understood, such as cereal grains, pulses, corn, rice, and polished rice and the like, and beans, such as coffee beans, cocoa beans or the like, as well as fruits which can be extruded.

24. Process according to claim 1, characterized in that water, sugared water, molasses or the like is used as the liquid.

25. Process according to claim 1, characterized in that at least one additive soluble in the liquid is added to it, such as enzyme, vitamin, nitrate, salt and/or sugar, which changes at least one characteristic of the grains, such as crude fibres, starch, proteins, fats, mucocelluloses or the like, or else aromatic agents, colouring agents and the like.



26. Process according to claim 1, characterized in that the grains mixed with the liquid are vibrated from one another several times at intervals.

27. Process according to claim 26, characterized in that the interval is approximately 30 minutes to 5 hours.

28. Application of the process according to claim 26 in the brewery for the production of malts, such as wheat malt, barley malt, millet malt, sorghum malt or the like, characterized in that the grains are vibrated from one another at intervals under respective addition of liquid.

29. Process according to claim 1, characterized in that the grains are vibrated without damage to their surface.

30. Device according to claim 8, characterized in that the pipe (111) has smooth walls and/or partition walls internally.

31. Process according to claim 1, characterized in that the grains are provided in such a way that an osmotic pressure effect is exerted on them on passing through the pipe.

32. Process according to claim 1, characterized in that the grains are processed into flour subsequent to the vibrating process.

33. Process according to claim 1, characterized in that the grain-liquid mixture is used for the production of extruder products subsequent to the vibrating process.