The invention relates a device for treatment, such as mixing, of particulate material (P), comprising a conical mixing vessel (1) having a vertical axis (2), which vessel narrows in a downward direction and in which vessel at least one vertical mixing shaft (3) is rotatable, from which mixing shaft (3) a number of radial elements (4) project that carry paddles at the outer end, that extend until the vicinity of the sidewall of the vessel (1).

According to the invention there are a great number of long and thin elements (4), whereas the mixing paddles (5) are relatively short and are symmetrical round the axis of the elements (4) in which the mixing shaft (3) has a high to very high number of revolutions (N) such as for instance 100 through 1,000 revolutions per minute, so that the product (P) to be treated is very intensively mixed in a very short time.

FIG. 1
Description

The invention relates to a device for mixing, cooling, heating, drying and/or granulating of powder and/or granular materials, comprising a conical mixing vessel having a vertical axis, which narrows in a downward direction and in which at least one vertical mixing shaft can rotate, which mixing shaft a number of element projects, of which the outer end extends until close to the sidewall of the vessel.

From US-5.344.232 a medical mixer of very small dimensions is known for preparing under partial vacuum small quantities of bone cement for orthopaedic purposes in or near the operation room. This cement is used during medical bone operations, in which a prosthesis is fastened to a bone, such as for instance a hip. The time at that the mixing shaft carries a great number of elements, that in a very short time, a solution of this bone cement is very limited, so that it is prepared very shortly before use.

The mixer comprises a hand driven vertical mixing shaft, which extends through a flat upper lid and carries two opposite mixing paddles with different height. At a low number of revolutions, of for instance 30 tot 40 revolutions per minute, a liquid monomere is mixed with a solid polymere powder under partial vacuum to a paste, which is pressed into a cartridge that is connected to a lower lid of the mixer and is thus ready for use.

The object of the invention is- the further development of this mixing device to an intensive mixer for industrial use, with which powdery, granular and/or pasty materials can be mixed, cooled, heated, dried and/or granulated.

According to the invention this object is reached, in that the mixing shaft carries a great number of elements, and has a high to very high number of revolutions, by which the material to be treated experiences a very strong shearing on both the elements and the inner wall, the one and the other such, that in a very short time, a very intensive mixing of the product is effected.

According to a main embodiment of the invention the number of revolutions of the mixing shaft comprises 100 tot 1.000 revolutions per minute.

At a first preferential embodiment of the invention, in which the elements each carry one or more mixing paddles at the other end, that extend with an other end parallel to and near to the inner sidewall of the vessel, is characterised in that, the elements are rod shaped and have a large radial dimension, whereas the paddles are plate shaped and have a small-radial dimension and are limited rotatable over an angle around the longitudinal axis of the rod shaped element.

At a second preferential embodiment of the invention the elements comprise knives, of which at least a part has a variable angle position with the vertical. Other characteristics and advantages of the invention will result from the description below of a number of embodiments, referring to the accompanying drawing.

Fig. 1 shows in partial left side view and partial right cross section a mounted mixing device according to a first embodiment with rod shaped elements that carry paddles at the outer end.

Fig. 1A shows on an enlarged scale in side and front view details of Fig. 1 of the fastening of the paddles to the rods.

Fig. 2 shows in partial left side view without outer wall and partial right side view a mixing device according to a second main embodiment, of which the lid has been removed and has been hoisted upwardly over at least the length of the mixing shaft, so that the mixing shaft, the mixing elements and the bottom scraper have become free from the mixing vessel and are visible.

Fig. 2A shows on an enlarged scale in side view a detail of Fig. 2 of the pivotable connection of the knives to the mixing shaft.

Fig. 3 shows a diagram of the flow of the product in the intensive mixer according to the invention.

According to Fig. 1 the mixer is provided with a conical mixing vessel, that is generally indicated with 1, having a vertical axis 2, said vessel narrowing in a downward direction and in which at least one vertical mixing shaft 3 can rotate. From this mixing shaft 3 a number of elements 4 project gradually outwards, of which the outer end 5 extends until near the inner sidewall 6 of the vessel 1.

The vessel 1 is closed at the upper side with a lid 7, of which the inner side is substantially elipsode shape, on the one hand for the strength and on the other hand for the inward guiding of the product part Pu that possibly moves upwardly along the inner sidewall 6 into the lid 7 and in the direction of the centre of the lid, from which it again drops back as Pd downwards in the mixing vessel 1. Fig. 3 shows this flow diagram.

On top of the lid 7 in the axis 2 of the central mixing shaft 3 a drive motor 9 is fastened with the use of (not shown) seals and bearings on the central lid tube stub. Of this drive motor 9 the (not shown) outgoing driveshaft 10 is coupled with the mixing shaft 3. The mixing vessel 1 with the hoistable lid 7 can be closed vacuum tight by means of different types of quick fasteners, such as the screwbolt having a starhead 11 and the clamping screw 12, so that during the operation vacuum can be applied to the mixing vessel 1. After the loosening of the quick acting fasteners it is possible to hoist the lid 2 together with its accessories by means of hoist means, such as the arm 41, the double acting plunger 42, the cylinder 43 and the second arm 44 in Fig. 2. In this way the mixing elements 4 can be cleaned, exchanged or repaired. It is also possible to inspect the vessel 1 internally or the lid 7 can be removed and quickly exchanged with another lid with accessories. At the lower end of the mixing screw 3 a scraper blade 13 is fastened in order to obtivae dead space in the bottom of the mixing vessel 1.

An excentric tube stub 14 is also mounted on the lid 7, which stub can be opened and closed by means of an inspection lid 15. This is done with a pivotable arm 16, which can be screwed with a starhead 17 on a screwbolt 18 in the closing position in a uppertaining
Vessel 1 is provided with an outer jacket 26 for heating and cooling of the contents of a product P of the vessel 1. This jacket 26 carries the connecting tube stumps 28 and 29.

At the left half of Fig. 1 is shown, that the mixing vessel 1 is provided with an outer jacket 26 for heating and cooling of the contents of a product P of the vessel 1. This jacket 26 carries the connecting tube stumps 28 and 29.

It is also possible, such as shown in the right half of Fig. 1, that the sidewall 6 is made of a so-called "tem-plate", which is a double walled plate 13 that has been connected by welding in different places and is afterwards expended. Through the created hollow space again a cooling or heating medium can be circulated. The lid 7 comprises a tube stub 32 for a looking glass 33.

According to the invention the mixing shaft 3 carries a great number of elements 4 and has a high to very high number of revolutions N. In this way the product to be treated experiences a very strong shearing at both the elements 4 as the inner sidewall 6, so that in a very short time a very intensive mixing of the product P is effected. By this mixing action a temperature rise can occur, which is counteracted by cooling the sidewall 6 of the mixing vessel 1.

According to a main embodiment of the invention the number of revolutions N of the mixing vessel comprises 100 to 1,000 revolutions per minute.

At a first preferential embodiment of the invention the elements 4 each carry at the outer end one or more mixing paddles 5, of which an outer edge extends parallel to and near the inner sidewall 6 of the vessel 1. Furthermore, the elements 4 are rod shaped and have a large radial dimension. Furthermore, the paddles 5 are plate shaped and have a small radial dimension. According to Fig. 1A at the left side of Fig. 1 the paddles 5 are limited pivotable over an angle (A) round the longitudinal axis of the rod shaped element.

In Fig. 2 a second preferential embodiment of the invention is shown in the hoisted position of the lid 7 with accessories. The lid 7 is suspended on the upwardly and downwardly moveable horizontal arm 41 on the head of a hydraulic plunger 42 of a hoisting cylinder 43 which carries a fixed horizontal arm 44 at the upperside, on which the mixing vessel 1 is suspended. Also other that hydraulic hoisting tools can be applied.

Here the elements 4 according to the invention comprise knives, of which the angle B with the vertical of at least a part of the knives is variable.

At a variant drawn at the right side of Fig. 2 the mixing shaft 3 and the knives 4 that are connected therewith are hollow and have outlet holes 45 for letting through and guiding of gasses and/or liquids L. In Fig. 2A also a detail of the pivotable connection of the knives 4 with the mixing shaft 3 is shown. Here the scraper 13 at the lower end of the mixing shaft 3 is visible.

At the variant shown at the left side of Fig. 2 the angle B is variable which the knives 4 make with the vertical. Furthermore, the outer sidewall 6 of the mixing vessel 1 is bound with a 1/2 tube spiral 46 for passing through a cooling and/or heating fluid. The lid 7 is provided with a tube stub 36 for the entrance of the product Pi. At the lower end of the mixing vessel 1 a flat outlet slide 47 with an operating lever 48 for the outgoing product PO is mounted.

At the upperside of the mixing vessel 1 the mixing shaft 3 is accoupled by means of a transmission 49 with the inverted suspended drive motor 9, which transmission is fastened on the lid 7 by means of a heightened tube stub 8. In the axis 2 an inlet 50 for liquid Li is mounted. The lid 7 is also provided with a port 38 for a low pressure sprayer 39 for process liquid and/or gas.

The sidewall 6 of the mixing vessel 1 is provided at the right side with a port 34 for a thermometer 35.

**Claims**

1. Device for mixing, cooling, heating, drying and/or granulating powdery, granular and/or pasty materials (P), comprising a conical mixing vessel (1) having a vertical axis (2), which vessel narrows in a downward direction and in which at least one vertical mixing shaft (3) can rotate, of which mixing shaft (3) a number of elements project gradually, of which the outer end extends into the vicinity of the innerwall (6) of the vessel (1), characterised in that, the mixing shaft (3) carries a great number of elements (4) and has a high to very high number of revolutions (N) by means of which the material to be treated is experiencing a very strong shearing at both the elements (4) and at the innerwall (6), the one and the other such, that in a very short time a very intensive mixing of the product (P) is effected.

2. Device according to claim 1, characterised in that, the number of revolutions (N) of the mixing shaft (3) amounts to 100 through 1,000 revolutions per minute.

3. Device according to claim 1 or 2, in which the elements (4) each carry one or more mixing paddles (5) at the outer end, of which paddles a gradual outerwall extends parallel to and near to the inner sidewall (6) of the vessel (1), characterised in that, the elements (4) are rod shaped and have a large radial dimension, whereas the paddles (5) are plate shaped and have a small radial dimension, and are limited pivotable over an angle (A) round the longitudinal axis of the rod shaped element (4).

4. Device according to one or more of claims 1 through 3, characterised in that, the elements (4) comprise...
knives, in which at least a part of the knives make a variable angle (8) with the vertical (2).

5. Device according to one or more of claims 1 through 4, characterised in that, a scraper blade (11) is mounted at the lower end of the mixing shaft (3) for obviating dead space in the bottom of the mixing vessel (1).

6. Device according to one or more of claims 1 through 5, in which the mixing vessel (1) is closed by a lid (7) at the upperside, characterised in that, the inserside of the lid (7) on the mixing vessel (1) is substantially ellipseioide shaped, for guiding the part of the product (Pu) moving upward along the inner sidewall (6) from the sidewall (6) in the direction of the centre of the lid (7), from which it drops down again into the mixing vessel (1) as the product part (Pd).

7. Device according to one or more of claims 1 through 6, characterised in that, the central mixing shaft (3) in the middle of the lid (7) is directly coupled with the outgoing drive shaft (10) of a drive motor (9) that is mounted on top of the central tube stub (8) of the lid (7).

8. Device according to one or more of claims 1 through 7, characterised in that, the lid (7) with accessories can close the mixing vessel (1) airtight, so that vacuum can be applied on the mixing vessel (1).

9. Device according to one or more of claims 1 through 8, characterised in that, the lid (7) is fastened by means of quick acting fasteners (11, 12) on the mixing vessel (1), so that after loosening the quick acting fasteners (11, 12) the lid (7) with accessories can be hoisted from the mixing vessel (1) and can be replaced and fastened again after treatment and/or replacement.

10. Device according to one or more of claims 1 through 9, characterised in that, the lid (7) comprises a port (20) for a high pressure cleaning sprayer (21).

11. Device according to one or more of claims 1 through 10, characterised in that, the sidewall (6) of the mixing vessel (1) has a double wall and is of so-called "template" for passing through a cooling and/or heating fluid.

12. Device according to one or more of claims 1 through 10, characterised in that, the mixing vessel (1) is provided with an outer jacket (26) for heating and/or cooling of the contents of product (P) of the vessel (1), whereas to this end the connecting tube stubs (28, 29) are present.

13. Device according to one or more of claims 1 through 12, characterised in that, at the lower end of the mixing vessel (1) a ball segment valve (24) is mounted.

14. Device according to one or more of claims 1 through 13, characterised in that, at the lower end of the mixing vessel (1) a flat outlet slide valve (47, 48) is mounted.

15. Device according to one or more of claims 1 through 14, characterised in that, the mixing shaft (3) is coupled by means of a transmission (49) with an inverterly suspended drivemotor (9), in which on the lid (7) a raised tube stub (8) is fastened, which carries the suspension (49) on which the motor (9) is inverterly suspended.

16. Device according to one or more of claims 1 through 15, characterised in that, the lid (7) is provided with a port (20) for a low pressure sprayer (21) for process liquid and/or gas.

17. Device according to one or more of claims 1 through 16, characterised in that, the lid (7) is provided with a tube stub (32) for a looking glass (33).

18. Device according to one or more of claims 1 through 17, characterised in that, the sidewall (6) of the mixing vessel (1) is provided with a port (34) for a thermometer (35).

19. Device according to one or more of claims 1 through 18, characterised in that, the lid (7) is provided with a tub stub (36) for the entry of product (P).

20. Device according to one or more of claims 1 through 19, characterised in that, the lid (7) is provided with a tube stub (37) for a lamp (38).

21. Device according to one or more of claims 1 through 20, characterised in that, the lid (7) is provided with a port (40) for a liquid sprayer (39).

22. Device according to one or more of claims 1 through 21, characterised in that, the lid (7) is suspended to the upwardly and downwardly moveable horizontal arm (41) at the head of a plunger (42) of a hydraulic hoisting cylinder (43) which carries a fixed horizontal arm (44) at the upper side, on which the mixing vessel (1) is suspended.

23. Device according to one or more of claims 1 through 21, characterised in that, the lid (7) is suspended to the upwardly and downwardly moveable arm (41) of a mechanical hoisting device.
FIG. 3
### DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document with indication, where appropriate, of relevant passages</th>
<th>Relevant to claim</th>
<th>CLASSIFICATION OF THE APPLICATION (Int.Cl.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 4 721 390 A (LIDGREN LARS A A) 26 January 1988 * abstract, claims, figures *</td>
<td>1-23</td>
<td>B01F13/00</td>
</tr>
<tr>
<td>A</td>
<td>US 4 577 973 A (OCCELLI LUCIANO) 25 March 1986</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D,A</td>
<td>US 5 344 232 A (NELSON CHARLES L ET AL) 6 September 1994</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 5 505 538 A (EARLE MICHAEL L) 9 April 1996</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>EP 0 306 563 A (HOSOKAWA MICRON EUROP) 15 March 1989</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The present search report has been drawn up for all claims.

**TECHNICAL FIELDS SEARCHED (Int.Cl.8)**

B01F