THIN FILM APPARATUS HAVING A TWO-PART HEAT TREATMENT CHAMBER

7 Claims, 3 Drawing Figs.

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ABSTRACT: A thin film apparatus is disclosed for converting materials suspended in a liquid medium into a powdery form, comprising a pair of substantially cylindrical heat treatment chambers having their axes disposed at an angle to each other, each of the chambers having rotatably mounted therein an agitating rotor or spreader member. In a preferred form of the invention, the first or upper chamber is disposed substantially vertically and communicates with the lower or second chamber by means of a connector member; the second chamber may be horizontal or inclined towards its discharge end either upwardly or downwardly from the first chamber.
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BACKGROUND OF THE INVENTION

This invention relates to a thin film apparatus for converting materials suspended in a liquid medium into powdery form by heat treatment, and particularly to such an apparatus having a two-part heat treatment chamber.

Thin film apparatuses having such multiple portion, substantially cylindrical heat treatment chambers are already known in the art, in which the multiple heat treatment chamber portions are disposed in substantially vertical fashion below one another. While the upper or first chamber portion is usually used as an evaporation or vaporization zone, the succeeding or lower chamber portion, in relation to the direction of flow of liquid, is used as a drier zone. In such known apparatuses, generally a rotor is provided disposed substantially coaxially to the chamber portions and rotatably supported at the extreme ends of the treatment chamber. Rigid spreader elements extend substantially axially as well as radially upon the rotor, and distribute the liquid to be treated, containing dissolved or dispersed materials therein, in a thin film or layer upon the inner wall of each of the chamber portions. The liquid thus flows under the influence of gravity towards the bottom portion towards the outlet connector member which is disposed at the bottom end of the second treatment chamber.

While passing through the first chamber portion, a substantial proportion of the liquid evaporates, whereby the materials dissolved or dispersed therein are thickened into a pastelike consistency. In this consistency, there is formed a powder-liquid mixture which, on the one hand, cannot be referred to as a liquid, but which, on the other hand, is not sufficiently dry to be termed a dried powder either. In this state, the size range of the powder particles can vary from several microns to several millimeters.

The described spreader elements of such known apparatuses, which are rigidly arranged upon the rotor, and which for design considerations are spaced a certain distance from the chamber walls are, for the most part, not suitably adapted to continue in the second chamber portion to spread out the above-described paste, which was thickened in the first chamber portion, upon the chamber wall, because, in terms of volume, not enough paste is available at this point. As a result of the insufficient spreading of paste in the second chamber portion, a flawless wetting of the chamber portion is no longer achieved.

In order to avoid the above disadvantage, it has been suggested to provide the rotor in the second chamber portion with oscillating or pendulum vanes as wiper or spreader elements. The oscillating vanes extend up to the direct vicinity of the treatment wall, and it is thereby possible to evenly spread a relatively small quantity of paste across the entire inner wall of the second chamber part in a more uniform manner.

This suggested arrangement of two different spreader elements upon the same rotor makes possible a better utilization of the heating surface of the chamber portions. However, this arrangement is disadvantageous in that the paste which is converted into powder in the second chamber portion is released from the treatment wall and falls free towards the discharge connector member without in the process being engaged and controlled in motion by the pendulum vanes. As a result, the paste in the second chamber portion can no longer be subjected to a controlled heat treatment, and therefore the moisture content of the finished powder cannot be controlled to the desired extent. In such a case, the powder obtained therefrom exhibits a moisture content which may vary considerably above or below a permissible tolerance limit. Such differences or nonuniformity in the moisture content of the powder may lead to difficulties when the powder is further processed.

In a further known form of treatment chambers for such devices, a horizontally disposed, conically shaped treatment chamber is provided which can be heated, exhibiting a rotor which is arranged substantially coaxially to the chamber. During operation of such a treatment chamber, the liquid medium to be treated is generally fed into the end of the conical treatment chamber having the smaller diameter. The material flows under the effect of centrifugal forces which are produced by rotation of the rotor blades, as well as by the force of gravity which acts upon the liquid, towards the material outlet port which is disposed at the opposite or larger diameter end of the treatment chamber.

This treatment chamber, known to the art, is encumbered with the disadvantage that the liquid medium to be treated, which contains the material to be converted into powder form, is partially mixed with the dried powder particles when fed into the treatment chamber, and therefore it becomes difficult to precisely regulate the final moisture content in the powder to be obtained.

SUMMARY OF THE INVENTION

With the above background in mind, it is a primary object of the present invention to provide a thin film apparatus having heat treatment chambers which overcomes the above-mentioned drawbacks of the prior art.

Specifically, it is a primary object of this invention to provide such a thin film apparatus having a two-part heat treatment compartment or chamber which permits converting dissolved or dispersed materials within a liquid into powdered form and, at the same time, to maintain the final moisture content of the powder with a close tolerance level.

It is a further object of the invention to provide such a thin film apparatus in which the final moisture content of the powder to be obtained can be adjusted as desired.

These as well as other objects which will become apparent as the description proceeds, are implemented by the present invention characterized by a thin film apparatus having a two-part heat treatment chamber or compartment in which the two portions of the compartment are disposed at an angle to each other. The first or upper chamber, forming an evaporation zone, is preferably disposed substantially vertically, and communicates with the second or lower chamber, forming a drying zone, by means of a connector member. Each of the portions has supported therein rotor means for spreading the liquid and paste therein. Preferably the axis of the first compartment portion intersects that of the second compartment portion at an angle less than 180°, and the rotors in each of the compartment portions can be driven if desired at varying rotational speeds.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself will be better understood, and additional advantages and features thereof will become apparent, from the following detailed description of a preferred embodiment of the invention and two alternative embodiments, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a vertical sectional view of a first embodiment of a thin film apparatus constructed according to the invention, in which the second or lower chamber portion is disposed at a right angle to the first chamber portion;

FIG. 2 is a vertical section view of a second embodiment of the invention in which the second portion is inclined downwardly from the first portion; and

FIG. 3 is a vertical sectional view of a third embodiment of the invention in which the second chamber portion is inclined upwards from the first portion.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and particularly to FIG. 1, a thin film evaporator is shown having a two-part, axially symmetrical heat treatment compartment. This heat treatment compartment comprises a first compartment portion 12, which serves as an evaporation zone, and a second compartment portion 14 disposed below the first portion 12, and having a smaller diameter than first portion 12, and which serves

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as a drying zone. The axes of the two compartment portions 12 and 14 intersect each other in this embodiment at substantially a right angle, in which case the axis of the first compartment portion 12 is disposed substantially vertically, and that of the second portion 14 is disposed substantially horizontally. In the immediate vicinity of the end of portion 14 adjacent first portion 12, there is provided an opening 16 in second portion 14 which receives therein a connector member 18 which provides fluid communication between the two portions. The axis of member 18 is disposed in such fashion that it is substantially coaxial with first compartment portion 12. A flange member 20 connects the end of compartment portion 12 facing compartment portion 14, with the connector member 18. The opposite ends of the second compartment portion 14 are closed by cover members 68 and 70.

At the upper end of compartment portion 12 is disposed a vapor chamber 22. This chamber is separated from the compartment portion 12 by a plate-like dividing wall or partition member 24 having a central opening 26 therein. The vapor compartment 22 is provided with a vapor outlet port 28. Directly below the vapor compartment 22, in the jacket of the first compartment portion 12, there is disposed an inlet port 30 which is provided for the inlet feed to be treated. First and second compartment portions 12 and 14 are each surrounded by a heatable jacket 32 and 34, respectively. An inlet port 36 in the heating jacket 32, as well as an inlet port 38 in the heating jacket 34, serve for the introduction of a suitable heat carrying medium. An outlet port 40 in the heating jacket 32, as well as an outlet port 42 in the heating jacket 34, serve to carry away or discharge the heat carrying medium which is used in the heating jackets 32 and 34.

Coaxially to the first compartment portion 12 is disposed a rotor member 44 which is rotatably supported within suitable bearings 48 and 50 upon a shaft 46. Upper bearing 48 is disposed within a cover member 49 which closes off the upper end portion 12 of the vapor compartment 22, and bearing member 50 is provided in the vicinity of the lower end of the first compartment portion 12 facing the second compartment portion 14. Rotor member 44 has secured thereto a plurality of spreader elements 45, which extend axially and also radially substantially up to the inner wall of the first compartment portion 12. The shaft 46 and the spreader elements 45 are driveably coupled with a motor 52 which is disposed upon the cover member 49 of the vapor compartment 22.

In similar manner, there is disposed within the second compartment portion 14 and coaxially thereto, a rotor member 54 which comprises a central pipe or tube member 56 which is the evaporator jacket of spreader elements 58 which are inclined with respect to the axis 57 of the pipe 56. The inclination of the edges of the spreader elements 58 with respect to the pipe axis 57 is adjustable by pivoting the respective elements by any suitable means. At both ends of the pipe member 56 there are attached respective shaft stubs 60 and 62 which are rotatably supported within bearing members 64 and 66. These bearings 64 and 66 are in turn secured to cover members 68 and 70 which close off compartment portion 14. Rotor member 54 is driveably connected with a motor means 72 by means of shaft stub 60, or alternately the motor means may be mounted on the opposite end of the second portion and secured to shaft stub 62.

Within the jacket 34 of the second compartment portion 14 is, in the vicinity of cover member 70, disposed an outlet port 74 which is displaced by 180° with respect to connector member 18 and the axis 57 of the second compartment portion 14.

During the operation of the thin film apparatus as shown, the heating jackets 32 and 34 are heated to a desired treatment temperature by introducing a suitable heat carrying medium, which in turn heats compartments portions 12 and 14. The liquid to be treated, containing dissolved or dispersed materials therein, is fed in through inlet port 30 into the first compartment portion 12 which functions as an evaporation zone, where it is engaged by the spreader elements 45 which are driven by motor means 52, and is spread in a thin film or layer upon the inner wall of the first compartment portion 12. At the same time, the liquid flows under the influence of gravity downwardly along the treatment wall of compartment portion 12 towards the lower compaction portion 14. The liquid, while passing through the first compartment portion 12, evaporated to such a degree that the materials contained in the liquid reach the connector member 18 in the form of a pastelike consistency.

The paste is then fed into connector member 18, and falls by virtue of its own weight into the second compartment portion 14 which serves as a drying zone. Upon entering compartment portion 14, the paste is spread in a thin film upon the inner wall of compartment portion 14 by the spreader elements 58 which are driven by motor 72. The spreader elements 58, as described above, are inclined with respect to the rotor axis in such a manner that they deliver or convey the paste or the dried powder towards the outlet port 74. By selecting the angle of the spreader elements 58 with regard to the axis 57, as well as the rotational speed of motor 72, the paste is conducted through the second compartment portion 14 at a suitable speed necessary to dry the paste to a desired moisture content.

The vapors rising in the second compartment portion 14 during treatment of the paste flow together with the powdered particles suspended in compartment portion 14, counter to the movement of the material to be treated, towards connector member 18 by means of which the vapors return to the first compartment portion 12. Inasmuch as it is advantageous for second compartment portion 14 to exhibit a smaller diameter as compared with the first compartment portion 12, the vapors expand when passing from the second portion into the first portion. The vapor velocity is reduced by virtue of this expansion, whereby the entrained powder particles also experience a retardation. The gravitational force acting upon the powder particles at the point 74 forms greater than the entraining effect of the rising vapors, and therefore the powder particles fall back into the second treatment compartment portion 14 where they are again mixed with the paste to be treated and are delivered towards the material outlet port 74.

The vapors freed from the powder particles flow together with the vapors which rise in the first compartment portion 12 through the opening 26 in the partition member 24 into the vapor compartment 22 from which they are discharged to a suitable condenser, not shown, by means of vapor outlet port 28, for example.

In FIG. 2 there is shown a second embodiment of the evaporation equipment having a similar two part treatment chamber. While the arrangement of the first compartment portion 76 corresponds substantially to the first compartment portion 12 of FIG. 1, the second compartment portion 78 is, in this embodiment, disposed in inclined fashion with respect to the first portion. In this case the end of the compartment portion 78 which faces away from the connector member 80 is inclined towards the bottom. Thereby, the paste which enters into the second compartment portion 78 flows under the influence of gravity, without the necessity for mechanical conveying means, towards outlet port 82. Therefore, the sole function of the rotor member 84, which is disposed coaxially within compartment portion 78 and is driven by motor means 86, is to spread the powder upon the inner wall of this compartment portion.

It is, however, possible to provide rotor member 84 with adjustably vane portions which can, as desired, bring about an acceleration or retardation of the through flow of the powder.

In FIG. 3 there is depicted in cross section a thin film apparatus according to this invention in which the liquid to be treated and/or the materials contained therein, can be treated in the second compartment portion for a particularly long period of time. In order to achieve this result, the second compartment portion 90 is inclined upwardly from connector member 92 which connects the two compartment portions, so that outlet port 94 of the second compartment
portion 90 lies above the connector member 92. In order to effectively convey the paste, passing from the first compartment portion 88 into the second compartment portion 90 by way of connector member 92, towards outlet port 94, rotor member 96, which is disposed coaxially within the second compartment portion 90 and is driven by motor means 98, is, for example, provided with helical spreader elements, forming a screw conveyor, which continuously transport the material upwardly towards outlet port 94. Depending upon the rotational speed of the rotor member 96, a relatively long residence time of the paste within the second compartment portion 90 can be achieved.

It is, of course, also conceivable to connect two compartment portions with a movable connector member. In this manner, it is possible to influence the residence time of the powder within the second compartment portion by changing the inclination of the second compartment portion during operation, without the necessity for changing the rotational speed of the rotor 96 or the inclination of the individual spreader elements.

In all of the embodiments of the two portion treatment chamber, it is of importance that the rotors disposed within the respective compartment portions may be adjusted to operate at different rotational speeds. This is important for allowing the adjustment, during the treatment of products with different properties, of the operational conditions to the given product characteristics desired.

The inventive arrangement of the heat treatment chambers of the thin film apparatus according to this invention possesses several advantages. It is, for example, possible when the second compartment portion is in a horizontal position to exactly control each phase of the treatment of the materials contained in a liquid, and thereby to adjust the final moisture content of the powder to the desired conditions. Furthermore, the invention offers the advantage of a material saving construction. Corresponding to the amount of liquid evaporated in the first compartment portion or of the reduction of volume achieved thereby, the diameter of the second compartment portion may be kept smaller than that of the first compartment portion without reducing the through quantity of the fluid to be treated. The use of different compartment portion diameters has, in addition, surprisingly shown that the powder particles, which are, during the production of powder in the second compartment portion, tossed about the spreader elements, are, indeed, partly entrained by the rising vapors into the first compartment portion. However, by virtue of the expansion effects to which the vapors are subjected when leaving the enlarged first compartment portion, the vapors flowing towards the vapor discharge port are no longer able to further entrain the powder particles. On the contrary, these particles fall back again into the second compartment portion where they are once again entrained by the spreader elements and are mixed with the paste, thereafter being delivered towards the discharge port of this second compartment portion.

In constructing the thin film apparatus according to this invention, it is advantageous to dispose the two compartment portions towards one another in such manner that their axes, when the first compartment portion is disposed substantially vertically, include an angle in the range of 70° to 110°. In this case, the angle range of 85° to 95° has proven to be especially advantageous. If the outlet end of the second compartment portion is inclined downwardly from the first compartment portion, the paste passing through said portion flows to the outlet port through the effect of gravity and without the need for mechanical conveying means. The rotor of this compartment portion, therefore, has only the function of spreading the formed powder upon the inner wall of the compartment. The inclination of the two compartment portions towards one another can also be carried out in such fashion that the second compartment portion is inclined upwardly away from the first compartment portion. When carried out in this fashion, the residence time of the paste in the second compartment portion is determined by the rotational speed of the, for example, screw conveyor means, so that the residence time can be varied within a wide range.

Furthermore, the residence time of the powder in the second compartment portion can be changed, as described above, by adjusting the inclination of this compartment portion. In order to make possible this adjustability, it is advantageous to provide a movable connector member between the two compartment portions.

By providing a thin film evaporating apparatus as described above, it is believed apparent that all of the objects set forth in the introduction to the specification have been successfully fulfilled.

What is claimed is:

1. A thin film apparatus for converting materials which are dissolved or dispersed within a liquid into powder form, comprising a first compartment portion forming an evaporation zone, a second compartment portion communicating with said first compartment portion and having a drying zone, said first compartment portion and said second compartment portion collectively defining a two-part heat treatment compartment arrangement, said second compartment portion following said first compartment portion in the direction of flow of said liquid, each of said compartment portions having respective treatment wall portions and a rotor member disposed coaxially therein, each of said rotor members having a plurality of spreader elements secured thereto, said spreader elements of each rotor member cooperating with said treatment wall portions of the associated compartment portion for spreading a thin film of the material undergoing treatment on the treatment wall portions of the associated compartment, said first compartment portion and said second compartment portion each providing a respective thin film treatment device, a connector member connecting said first compartment portion to said second compartment portion for unobstructed flow of material from said first compartment portion to said second compartment portion, said connector member providing a transition zone between said first compartment portion and said second compartment portion which permits expansion of any vapors passing from the second compartment portion into the first compartment portion and resultant reduction in the velocity of such vapors and any entrained powder particles to an extent such that gravitational forces act upon such powder particles to cause same to fall back into said second compartment portion, while the vapors continue to rise through said first compartment portion, the axis of said first compartment portion intersecting axis of said second compartment portion at an angle which is in a range between 70° and less than 180°, and drive means for each of said rotors adapted to drive said rotors at different rotational speeds.

2. A thin film apparatus as defined in claim 1, wherein said first compartment portion includes a material outlet side and said second compartment portion includes a material inlet side, said connector member being disposed directly between said material outlet side and said material inlet side of said respective first and second compartment portions, said connector member possessing a lengthwise axis which is substantially coaxially arranged with respect to the lengthwise axis of said first compartment portion, said connector member possessing a substantially tapered construction having a larger portion adjoining said material outlet side of said first compartment portion and a smaller portion adjoining said material inlet side of said second compartment portion.

3. A thin film apparatus as defined in claim 1, wherein said first compartment portion is disposed with its axis substantially vertically, and the axis of said second compartment portion intersects that of said first portion at an angle in the range of 70° to 110°.

4. An apparatus as defined in claim 3, wherein the axis of said second compartment portion intersects that of said first compartment portion at an angle between 85° to 95°.

5. A thin film apparatus as defined in claim 1, wherein said second compartment portion has an inside diameter smaller than that of said first compartment portion.
6. A thin film apparatus as defined in claim 1, wherein said connector member is disposed at the jacket of the second compartment portion.

7. A thin film apparatus as defined in claim 1, wherein said drive means serves for the adjustment of the rotational speeds of said rotor members independently with respect to each other.