

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO METHODS AND APPARATUS FOR CONCENTRATING SOLUTIONS OR SUSPENSIONS OR FOR RECOVERING THE DRY SUBSTANCE THEREFROM

(71) I, ERIC HARALD CARLSSON, a Swedish Subject, of Planteringsvagen 7B, 262 00 Angelholm, Sweden, do hereby declare the invention, for which I pray that

a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method and an apparatus for subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, in which the liquid at a liquid application point is distributed onto a great many bodies in the form of partly interengaging spheres or polygons, so that the liquid is spread and distributed as thin films on the surfaces of the bodies at the same time as the gas, such as air, is allowed to flow forth in the interstices between the bodies, and the bodies are caused to move relative to each other so that the bodies disturb the liquid films by their interengagement and relative movements.

US Patent 2 400 810 to Clarke et al of January 18, 1944 describes and shows an apparatus for treating gases with liquids. To provide large surfaces of contact between the gas and the liquid the apparatus has a great many bodies in the form of spherical bodies or polygons which occupy a relatively stationary position in the apparatus, that is, they cannot be moved for example from one end of the container to the other end thereof. By means of an agitator, however, the bodies can be caused to move relative to each other. This apparatus presupposes a gravity flow of the liquid and the gas through the apparatus, and it does not provide any possibility of producing and recovering a thickly flowing liquid or dry substance.

For the recovery of dry substances from solutions or suspensions use is at present made of methods and apparatus that are

relatively complicated and therefore imply high purchase and operating costs. In most of the prior art methods and apparatus, relatively high temperatures are utilized to gasify the liquid and to remove it from the dry substance. Some dry substances cannot be recovered without taking on for example a burnt taste or coagulating, as is the case with albumen.

According to one aspect of the invention, there is provided a method of subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, in which the liquid at a liquid application zone is distributed onto a mass of partly interengaging bodies in the form of spheres or polygons so that the liquid is spread and distributed in the form of thin films on the surfaces of the bodies at the same time as the gas, such as air, is allowed to flow forth in the interstices between the bodies, and the bodies are caused to move relative to each other so as to disturb the liquid films by their interengagement and relative movements, comprising the steps of effecting the relative movements of the bodies by causing them to move continuously in a closed path extending through the gas supply zone, the liquid application zone and a separating zone at which the concentrated solution, the concentrated suspension or the dry substance can be continuously withdrawn.

According to a further aspect, there is provided apparatus for carrying out the method defined in claims 1-4 of subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, in which the liquid at an application zone in a vertically disposed container accommodating a mass of partly interengaging bodies in the form of spheres or polygons is spread and divided in the form of thin films on the surfaces of the bodies, and the gas, such as air, is supplied at a

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gas supply zone and is allowed to flow forth in the interstices between the bodies, and the bodies are caused to move relative to each other so as to disturb the liquid films by their interengagement and relative movements, wherein a conveying means extending upwardly through the mass and serving to feed the bodies from the lower end of the container to the upper end thereof from which the bodies move downwardly by gravity to the lower end of the container, moving past the gas supply zone, the liquid application zone and the separating zone.

The invention will now be described more in detail with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of the apparatus according to the invention and some auxiliary apparatus;

Figure 2 is a more detailed longitudinal section of the apparatus;

Figure 3 is a partial section of a modified embodiment of the apparatus.

The apparatus illustrated in Figure 1 comprises a fan 2 which is driven by a motor 1 and connected to a main conduit 3 having an air filter 4 and a heat exchanger 5 in which the air flowing through the main conduit 3 can be heated to an appropriate temperature. The heat exchanger 5 can be disconnected when very sensitive products are to be treated so that air of room temperature or less flows through the main conduit 3 to a container 6 constituting the apparatus according to the invention. To this end, the main conduit 3 is connected to a passage 7 extending around the container 6 and communicating with the hollow interior 10 thereof through a number of holes 8 in the container wall 9 at a gas supply zone C. A conduit 11 extends from the lower end of the container 6, and when—as in the present case—the intention is to recover dry substance from a liquid, said conduit 11 is connected to a number of cyclones 12 for separating the dry substance from the drying air which escapes into the atmosphere via an air conduit 13 and a suction fan 15 driven by the motor 14. The drying air which is saturated with the gas from the liquid, also leaves the container 6 through conduits 16.

A great many partly interengaging bodies 17 in the form of spheres or polygons are packed into the container 6 so as to fill it almost completely. The bodies 17 can be of any desired width. Experiments have proved that spherical bodies can have a diameter of about 15 mm. Furthermore, the bodies may be of any desired material. Preferably, however, there is chosen a material which is deformable at least to some extent, a property which facilitates the removal of the dry substance from the

bodies, as will appear from the following. Use can also be made of materials having good release capacity and from which the dry substance is released practically without any particular measures being taken. Bodies of certain plastics materials or plastic-coated metals thus are most suitable. The container 6 also has a conveying means 18 which in the embodiment illustrated comprises a housing 19 and a screw 20 which is rotatable about its longitudinal axis. The conveying means 18 extends between a zone A at the upper part of the container where liquid is supplied to the bodies 17, and a zone B in the lower part of the container where concentrated liquid or, as in the embodiment illustrated, dry substance is separated from the bodies. As will appear from the drawings, the container 6 tapers from the liquid application zone A towards the separating zone B. For the application of the liquid one or more conduits 21 extend into the upper part of the container to open above the upper end of the conveying means 18, the conduits being connected to a supply (not shown) of a solution or a suspension the dry substance of which is to be recovered. The shaft 22 of the screw 20 is connected to a suitable power source (not shown). The end of the housing 19 located at the liquid application zone A has a collar 23 for spreading the bodies 17 supplied by the conveying means 18 to the liquid application zone A. At the separating point B the container 6 has a perforated bottom 24 through which the dry substance can leave the container 6 and from which the bodies are returned to the liquid application zone A. For controlling the air streams flowing through the container 6 and the interstices between the bodies 17 the conduits 16 and 13 can present valves (not shown). Moreover, the holes 8 can have connected to them tubular pieces (not shown) by means of which the drying air is carried some distance in between the bodies 17 in the container 6. The tubular pieces can have different lengths so that a favourable distribution of the air stream is realized in the container 6.

The solution or suspension which is taken from the supply (not shown) and carried through the conduits 21 onto the upper layers of the bodies 17, to some extent flows down into the conveying means 18 to a level determined by the upward movement of the bodies 17, which is imparted to them by the conveying means. The solution or suspension is distributed in the form of thin films on the bodies 17. Drying air flows from the fan 2 through the filter 4, the heat exchanger 5 and the main conduit 3 to the passage 7 encircling the container 6 and leaves said passage through the holes 8 in the container wall 9 and is

thereby introduced into the container 6 at the gas supply zone C. The drying air flows into the hollow interior 10 of the container 6 in a region between the liquid application zone A, and the separating zone B and is divided into a part stream directed to the liquid application zone A and a part stream directed towards the separating zone B. The air streams flow forth in the interstices between the bodies moving downwardly in the hollow interior 10 of the container, and because of their shape they will but partly engage each other. The conveying means 18 grasps the bodies 17 which have reached the perforated bottom 24 and carries them through the housing 19 to the liquid application zone A where they are distributed in the hollow space 10 of the container by means of the collar 23. The bodies 17 slowly sink downwards in the container 6 and the hollow interior 10 thereof while being constantly swept by the drying air flowing through the interstices between the bodies 17, said drying air evaporating the liquid and carrying away the gas through the conduits 13 and 16. As the bodies 17 in the course of their movement from the upper part of the container 6 to the lower part thereof constantly change positions and constantly disturb the liquid films by their interengagement and relative movements, the evaporation is facilitated and finally the dry substance forming on the surfaces of the bodies 17 will come loose from them. The tapering form of the container results in a further relative shifting of the bodies, which favourably affects the drying operation. By selecting a temperature for the drying air or drying gas, which is suitably adapted to the nature of the material to be treated it is possible to provide a lenient but still rapid and efficient drying which yields a dry substance hitherto unsurpassed in quality.

In the above described embodiment of the invention the bodies 17 are caused to move in a closed path through the liquid application zone A, the separating zone B and the gas supply zone C. At the separating zone B the concentrated solution, the concentrated suspension or dry substance, is continuously withdrawn. In the closed path the bodies 17 move forward from the liquid application zone A past the gas supply zone C to the separating zone B and move back in a return movement from the separating zone B to the liquid application zone A. In this instance the forward movement is commenced at the liquid application zone A and the return movement is concluded at the same zone A.

A course of operation which is more advantageous in certain cases is attained if—as shown in Figure 3—the forward movement is concluded at the liquid

application zone A and the return movement is commenced at the same zone A. In this embodiment of the apparatus of the invention both the liquid application zone A and the separating zone B are located at the lower ends of the container 6 and the screw 20 so that the liquid application zone A is in direct communication with the conveyor screw 20 and the separating zone B is in communication with the conveyor screw 20 via the liquid application zone A. The liquid application zone A comprises a vessel 25 which is open in an upward direction towards the lower ends of the conveyor screw 20 and the container 6. A container portion 26 which can be caused to rotate by means of the conveyor screw 20 extends downwards into the vessel 25. The bottom 27 of the container portion 26 in said vessel 25 is perforated so that liquid supplied to the vessel 25 can flow into the container portion 26. The container 6 also comprises a lower perforated portion 24, which portion 24 forms the separating zone B and through which the dry substance can leave the container. The withdrawal of the dry substance is facilitated and accelerated by the fact that the perforated portion 24 is also set in motion. The perforated portion 24 is connected to the conveyor screw 20 by means of angularly bent arms 28. The housing 19 has a conical collar 29 which guides the bodies 17 towards the perforated portion 24. This arrangement will produce an improved separation of the dry substance from the bodies 17 and also a more uniform distribution of the liquid on the bodies 17.

WHAT I CLAIM IS:—

1. A method of subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, in which the liquid at a liquid application zone is distributed onto a mass of partly interengaging bodies in the form of spheres or polygons so that the liquid is spread and distributed in the form of thin films on the surfaces of the bodies at the same time as the gas, such as air, is allowed to flow forth in the interstices between the bodies, and the bodies are caused to move relative to each other so as to disturb the liquid films by their interengagement and relative movements, comprising the steps of effecting the relative movements of the bodies by causing them to move continuously in a closed path extending through the gas supply zone, the liquid application zone and a separating zone at which the concentrated solution, the concentrated suspension or the dry substance can be continuously withdrawn.

2. A method as claimed in claim 1, wherein the movement of the bodies in the closed path is divided into a forward move-

thereby introduced into the container 6 at the gas supply zone C. The drying air flows into the hollow interior 10 of the container 6 in a region between the liquid application zone A and the separating zone B and is divided into a part stream directed to the liquid application zone A and a part stream directed towards the separating zone B. The air streams flow forth in the interstices between the bodies moving downwardly in the hollow interior 10 of the container, and because of their shape they will but partly engage each other. The conveying means 18 grasps the bodies 17 which have reached the perforated bottom 24 and carries them through the housing 19 to the liquid application zone A where they are distributed in the hollow space 10 of the container by means of the collar 23. The bodies 17 slowly sink downwards in the container 6 and the hollow interior 10 thereof while being constantly swept by the drying air flowing through the interstices between the bodies 17, said drying air evaporating the liquid and carrying away the gas through the conduits 13 and 16. As the bodies 17 in the course of their movement from the upper part of the container 6 to the lower part thereof constantly change positions and constantly disturb the liquid films by their interengagement and relative movements, the evaporation is facilitated and finally the dry substance forming on the surfaces of the bodies 17 will come loose from them. The tapering form of the container results in a further relative shifting of the bodies, which favourably affects the drying operation. By selecting a temperature for the drying air or drying gas, which is suitably adapted to the nature of the material to be treated it is possible to provide a lenient but still rapid and efficient drying which yields a dry substance hitherto unsurpassed in quality.

In the above described embodiment of the invention the bodies 17 are caused to move in a closed path through the liquid application zone A, the separating zone B and the gas supply zone C. At the separating zone B the concentrated solution, the concentrated suspension or dry substance, is continuously withdrawn. In the closed path the bodies 17 move forward from the liquid application zone A past the gas supply zone C to the separating zone B and move back in a return movement from the separating zone B to the liquid application zone A. In this instance the forward movement is commenced at the liquid application zone A and the return movement is concluded at the same zone A.

A course of operation which is more advantageous in certain cases is attained if—as shown in Figure 3—the forward movement is concluded at the liquid

application zone A and the return movement is commenced at the same zone A. In this embodiment of the apparatus of the invention both the liquid application zone A and the separating zone B are located at the lower ends of the container 6 and the screw 20 so that the liquid application zone A is in direct communication with the conveyor screw 20 and the separating zone B is in communication with the conveyor screw 20 via the liquid application zone A. The liquid application zone A comprises a vessel 25 which is open in an upward direction towards the lower ends of the conveyor screw 20 and the container 6. A container portion 26 which can be caused to rotate by means of the conveyor screw 20 extends downwards into the vessel 25. The bottom 27 of the container portion 26 in said vessel 25 is perforated so that liquid supplied to the vessel 25 can flow into the container portion 26. The container 6 also comprises a lower perforated portion 24, which portion 24 forms the separating zone B and through which the dry substance can leave the container. The withdrawal of the dry substance is facilitated and accelerated by the fact that the perforated portion 24 is also set in motion. The perforated portion 24 is connected to the conveyor screw 20 by means of angularly bent arms 28. The housing 19 has a conical collar 29 which guides the bodies 17 towards the perforated portion 24. This arrangement will produce an improved separation of the dry substance from the bodies 17 and also a more uniform distribution of the liquid on the bodies 17.

WHAT I CLAIM IS:—

1. A method of subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, in which the liquid at a liquid application zone is distributed onto a mass of partly interengaging bodies in the form of spheres or polygons so that the liquid is spread and distributed in the form of thin films on the surfaces of the bodies at the same time as the gas, such as air, is allowed to flow forth in the interstices between the bodies, and the bodies are caused to move relative to each other so as to disturb the liquid films by their interengagement and relative movements, comprising the steps of effecting the relative movements of the bodies by causing them to move continuously in a closed path extending through the gas supply zone, the liquid application zone and a separating zone at which the concentrated solution, the concentrated suspension or the dry substance can be continuously withdrawn.

2. A method as claimed in claim 1, wherein the movement of the bodies in the closed path is divided into a forward move-



ment and a return movement, the gas being supplied during the forward movement and divided into a part flow directed towards the liquid application zone and a part flow directed towards the separating zone.

3. A method as claimed in claim 2, wherein the forward movement is commenced and the return movement is concluded at the liquid application zone.

4. A method as claimed in claim 2, wherein the forward movement is concluded and the return movement is commenced at the liquid application zone.

5. An apparatus for carrying out the method defined in claims 1-4 of subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, in which the liquid at an application zone in a vertically disposed container

accommodating a mass of partly interengaging bodies in the form of spheres or polygons is spread and divided in the form of thin films on the surfaces of the bodies, and the gas, such as air, is supplied at a

gas supply zone and is allowed to flow forth in the interstices between the bodies, and the bodies are caused to move relative to each other so as to disturb the liquid films by their interengagement and relative movements, wherein a conveying means extending upwardly through the mass and serving to feed the bodies from the lower end of the container to the upper end thereof from which the bodies move forward downwardly

by gravity to the lower end of the container, moving past the gas supply zone, the liquid application zone and the separating zone.

6. An apparatus as claimed in claim 5, wherein the container tapers towards the lower end.

7. An apparatus as claimed in claim 5 or claim 6, wherein the conveying means is a screw which can be caused to rotate about its longitudinal axis in a housing.

8. An apparatus as claimed in claim 7, wherein the liquid application zone is disposed at the upper end of the screw, the gas supply zone is arranged peripherally in the container wall in a region between the end of the container, and the separating zone is provided at the lower end of the container.

9. An apparatus as claimed in claim 7,

wherein both the liquid application zone and the separating zone are arranged at the lower ends of the container and the screw so that the liquid application zone is in direct communication with the conveyor screw and the separating zone is in communication with the conveyor screw via the liquid application zone.

10. An apparatus as claimed in claim 7 or claim 8, wherein the end of the housing located at the liquid application zone has a collar for spreading the bodies supplied by the conveyor screw at the liquid application point.

11. An apparatus as claimed in any of claims 5-10, wherein the container at the separating zone has a perforated wall through which the dry substance can leave the container and from which the bodies are returned to the liquid application zone.

12. An apparatus as claimed in claim 9, wherein the liquid application zone comprises a vessel open in an upward direction towards the lower ends of the conveyor screw and the container, and a container portion which is rotatable together with the conveyor screw extends downwards into said vessel, the bottom of the container portion in said vessel being perforated.

13. A method of subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, substantially as hereinbefore described with reference to the accompanying drawings.

14. An apparatus for subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, substantially as hereinbefore described with reference to Figures 1 and 2 in the accompanying drawings.

15. An apparatus for subjecting a liquid containing dissolved or suspended solid material to treatment with gas, such as air, substantially as hereinbefore described with reference to Figure 3 in the accompanying drawings.

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