DIFFUSION TOWER FOR EXTRACTING PARTICULATE MATERIAL

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ABSTRACT
An upright outer tubular element concentrically surrounds a rotatable inner tubular element with which it defines an annular extraction chamber. A screen bottom is arranged in this chamber at the lower end region of the elements, and a particle distributor is rotatable with the inner tubular element above and in wiping contact with the screen bottom. The distributor has a channel from which particles enter the chamber. A bottom plate is provided on the inner tubular element below the screen bottom, being rotatable with the inner tubular element and having a cutout which communicates with the channel. A casing surrounds the lower end region of the elements and defines an annular inner space which communicates with the cutout and which is provided with an inlet for particles to be extracted.

11 Claims, 5 Drawing Figures
DIFFUSION TOWER FOR EXTRACTING PARTICULATE MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates generally to a diffusion tower, and more particularly to a diffusion tower extracting particulate material, especially sugar-beet chips. Still more particularly the invention relates to such a diffusion tower for extracting particulate material in counterflow.

Diffusion towers are well known and require no detailed discussion. They serve for extracting soluble substances from various kinds of materials, for instance, for extracting sugar from sugar-beet chips.

It is known to construct such towers by providing two upright tubular elements, which are concentric with one another and define an annular extraction chamber. At the bottom region the extraction chamber is closed off by a screen bottom, and located above the same, usually but not necessarily turnable with the inner tubular element which may be rotatable, is a distributor having a channel from which a mash containing particulate material to be extracted, for instance sugar-beet chips, which will hereafter be used for the purpose of further explanation, enters into the extraction chamber. The mash is supplied by a pump. A portion of the distributor wipes over the surface of the screen bottom, as the distributor rotates in order to continuously clean mash off the screen bottom.

The extraction chamber in this type of construction is filled with mash, and newly incoming mash is admitted below the column of mash in the annular extraction chamber. The purpose of the distributor and the channel therein is to distribute the incoming mash evenly over the screen bottom. The even distribution is an important factor in the degree of efficiency of extraction which can be obtained. To further improve it, the prior art proposes an arrangement in which the mash is admitted through a central tube or conduit in the diffusion tower. This central admission of the mash has certain disadvantages, however, including the fact that — as has been found in actual practice — two seals at different levels must be provided in the region in which the mash is admitted, because the mash admitting tube must be passed through the journal for the inner tubular element of the diffusion tower. Because the journal must surround the lower part of the inner tubular element, it has to be relatively large. On the other hand the two vertically spaced shaft seals require that the lower part of the diffusion tower, where the journal is provided must be relatively high. Moreover, the use of two such shaft seals at different levels necessitates relatively close tolerances in manufacture and great care in installation. Despite all this, it has been found that over a period of time, the shaft seals become defective. With the prior-art constructions, especially at the uppermost one of the shaft seals, defective seals are very difficult to determine while the tower is in operation, and are at least equally difficult to rectify. This is not the least due to the fact that the central mash supply tube is provided, which permits access to and repair of the journal for the inner tubular element and the seals associated therewith only when the diffusion tower is empty, that is when it is shut down and does not produce.

It is also known from the art to admit the mash in another way, namely non-centrally. In that type of construction, mash is freely pumped into the bottom region of the extraction chamber, and a forced distribution of the mash over the cross section of the chamber is not employed. This, has, of course, the disadvantage, that the newly incoming chips in the mash become admixed with already fully or partially extracted chips, and this disadvantageously influences the operation of the tower.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to overcome the disadvantages of the prior art.

More particularly, it is an object of the present invention to provide an improved diffusion tower for extracting of particulate material, which is not possessed of the aforementioned disadvantages.

An additional object of the present invention is to provide such an improved diffusion tower in which the supply and forced distribution of incoming mash is improved and simplified.

Another object of the invention is to provide such an improved diffusion tower, wherein the entire construction at the lower end portion of the tower is simplified.

In keeping with these objects and with others which will become apparent hereafter, one feature of the invention resides in a diffusion tower for extracting particulate material, particularly sugar-beet chips, which comprises an upright outer tubular element and a rotatable inner tubular element concentric with the outer tubular element and defining therewith an annular extraction chamber. Both of the elements have lower end regions and a screen bottom is mounted in the chamber at the lower end region. A particle distributor is rotatable with the inner tubular element above and in wiping contact with the screen bottom and has a channel from which particles enter the chamber. A bottom plate is provided in the inner tubular element above the screen bottom and is rotatable with the inner tubular element. The bottom plate has a cutout which communicates with the channel. A casing is provided at the lower end region and defines an annular inner space which communicates with the cutout and which has an inlet for particles through which the particles enter the inner space in the casing.

With this arrangement, one of the previously necessary two shaft seals can be omitted. Moreover, the journal or bearing for the rotatable inner tubular element will be much smaller than was previously necessary. The overall height of the lower components of the tower is substantially less than what is possible with the prior art, so that the overall height of the tower is similarly smaller and the total construction of the tower can be lighter, less complicated and less expensive.

However, the perhaps most important aspect of the present invention is the fact that the lesser height of especially the lower region of the diffusion tower permits given otherwise unchanged circumstances, the overall height of the tower to be maintained unchanged and, in such an event, the volumetric content and the height of the annular extraction chamber will of course be increased over prior art constructions.

The effectiveness of the screen bottom and the overall extraction effectiveness of the diffusion tower can be improved, without in any way detracting from the necessary constant cleaning of the screen bottom, by having the channel in the particle distributor be open in downward direction, that is towards the screen bottom.
The forced distribution of the particles over the cross-section of the annular chamber, that is over the entire surface of the screen bottom can be further improved by providing the channel in the region of the screen bottom and in a location which, as seen with reference to the direction of rotation of the particle distributor, is the trailing region of the channel, with a freely tiltable or pivotable flap which assures that the newly incoming mash will always be supplied in the region of the screen bottom, that is below the already partially extracted chips in the extraction chamber.

The upright shaft on which the inner tubular element rotates may be made to pass through the annular inner space defined by the casing, being seen with respect thereto by a shaft seal, and may be axially and radially journalled below the aforementioned casing.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and to its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a somewhat diagrammatic vertical section showing the lower region of a diffusion tower in accordance with one embodiment of the invention, the section being taken on line I-I of FIG. 2;

FIG. 2 is a section taken on line II-II of FIG. 1;

FIG. 3 is an enlarged fragmentary vertical section, showing details of FIG. 1 on an enlarged scale;

FIG. 4 is a section taken on line IV-IV of FIG. 2; and

FIG. 5 is a view similar to FIG. 2 but illustrating a further embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing now the drawing in detail, and firstly referring to the embodiment shown in FIGS. 1-4, it will be seen that the novel distribution toward of which only details of the lower end region are illustrated, has an outer tubular element 1 which is vertically arranged, and which is closed by the lower end by a housing 2. Within the outer tubular element 1, concentric therewith, is an inner tubular element 3 which defines with the outer tubular element an annular extraction chamber and can be rotated by means of a non-illustrated drive (details of the drive are known, and are not of importance for an understanding of the invention), about its vertical axis. The inner tubular element 3 is journalled for such rotation in a bearing 6 which is mounted in the lower support 5 of the tower.

The inner tubular element 3 serves not only to define with the outer tubular element, the extraction chamber, but also to rotate a particle distributor 9, the agitating arms 10, and a non-illustrated particle ejector (which would be provided at the region of the upper end of the tower). Retarding members 11 are provided at the inside of the outer tubular element 1, intermediate the agitator arms 10, to retard the mash in the annular extraction chamber.

The inner cross-section of the annular extraction chamber is spanned above the bottom wall 8 of the housing 2 by a screen bottom 7. The lower end of the inner tubular element 3 is provided with an element 12 to which the shaft 4 is secured which is journalled in the bearing 6 on which the inner tubular element 3 rotates. The lower free end of the shaft 4 is supported in the bearing 6 which is capable of absorbing axial as well as radial forces.

The lower end region of the inner tubular element 3 also is provided with a bottom plate 13 having an opening 15 which overlaps the particle channel 14 of the particle distributor 9. The bottom wall 8 is provided with a central opening which is of a larger dimension than the cross-section of the shaft 4, and downwardly of the central opening there is provided a casing 17 which forms an annular space 16 and is provided with an inlet 18 through which the newly incoming mash is admitted into the space 16. The shaft 4 extends through the space 16 and a seal 19 seals it with respect to the casing 17. The lower end wall 22 of the casing 17 is upwardly inclined from the inlet 18 towards the opposite side of the casing that is towards that side of the casing 17 which is opposite the inlet 18. A sealing ring 20 extends into the central opening of the bottom 8 and thus into the annular space 16, being connected to the underside of the bottom plate 13 and being provided in the region of the channel 14 with an opening 21.

The direction of rotation of the inner tubular element 3 and therefore the particle distributor 9 is designated by the arrow A, in FIG. 2. It will be seen that the forward edge of the particle distributor 9 descends, the term "forward" referring to the direction of rotation in the sense designated by the arrow A, is provided with slide members 24 to form the leading edge 23 and which are in wiping contact with the screen bottom 7. The channel 14 is located beneath the member 28 and delimited by the wall 25 and the wall 26. These walls extend into the region of the opening 15 of the bottom plate 13. Within the channel 14 one or more baffles 27 are provided. At the edge of the channel 14 which is the trailing edge as seen in the direction of the arrow A, is provided a freely pivotable or tiltable flap 29, and unlike the channels known from the prior art, the channel 14 of the present invention is open downwardly towards the screen bottom 7 and the housing bottom wall 8.

A gap 30 exists between the bottom plate 13 and the housing bottom wall 8. This gap is present in all diffusion towers of the type under discussion, and the tolerance variations for this gap are usually specified within a rather limited range. However, due to the presence of the sealing ring 20, these tolerance variations can be much greater in accordance with the present invention than in the prior-art constructions, so that the manufacture of the components involved in forming this gap is simpler and less expensive than heretofore possible.

In operation of the novel diffusion tower the fresh mash is admitted via the conduit 31 and the inlet 18 into the annular space 16. It enters through the central opening in the housing bottom wall 8 and the cutout 15 in the bottom plate 13 into the inlet portion 14a of the channel 14. Advantageously, the leading wall 25 delimiting the channel 14 is curved and so are the baffles 27. The wall 25 and the baffles 27 guide the incoming fresh mash to the flat 29 which deposits and distributes them onto the screen bottom 7.

The particle distributor 9 rotates beneath the column of material in the annular extraction chamber and because it constantly wipes the upper side of the screen bottom surface, it cleans the same and maintains it free
of already partially extracted chips, so that when the fresh chips of the incoming mash are admitted onto the screen bottom 7 by the flap 29, they will always be deposited onto a free portion of the screen bottom 7 which has been cleared of other chips.

Moreover, even downstream or behind the flap 29 — as seen with reference to the direction of arrow A — there will always be a certain portion of the screen bottom 7 which is still free of mash, so that the newly admitted mash and chips therein can lift the flap 29 and flow into the chamber defined between the elements 1 and 3.

The flow of the mash as it enters the tower can be improved further if the inlet is arranged as a tangential inlet 18a, as shown in the further embodiment which is illustrated in FIG. 5. This embodiment is analogous to the one in FIGS. 1-4 in most respects, and like reference numerals therefore identify like elements. Here, however, the cutout in the bottom plate 13 is configured as a cutout 15a which extends tangentially with respect to the shaft 4. The inlet portion 14a of the channel 14 is configured correspondingly, and it will be evident that the flow of incoming mash is further improved by this construction.

The casing 17 is removable from the housing bottom 8 and can be removably connected with the same in various ways known to those skilled in the art and does therefore not require detailed description, for instance by means of bolt connections or the like. The purpose of this arrangement is to simplify the installation and disassembly. The fact that the lower end wall 22 of the casing is upwardly inclined in the manner described earlier as shown in FIG. 3, prevents the formation of deposits in the annular space 16.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions, differing from the types described above.

While the invention has been illustrated and described as embodied in a diffusion tower for extracting particulate material, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by letters Patent is set forth in the appended claims.

1. In a diffusion tower for extracting particulate material, particularly sugar-beet chips, a combination comprising an upright outer tubular element, and a rotatable inner tubular element concentric with said outer element and defining therewith an annular extraction chamber, both of said elements having lower end regions; a screen bottom in said chamber at said lower end regions; a particle distributor rotatable with said inner tubular element above and in wiping contact with said screen bottom, said distributor having a channel with an open lower portion which communicates directly with said screen bottom so that particles entering said chamber through said channel are distributed evenly upon said previously wiped screen bottom; a bottom plate provided on said inner tubular element above said screen bottom, said bottom plate being rotatable with said inner tubular element and having a cutout which communicates with said channel; a casing at said lower end regions and defining an annular space which communicates with said cutout; and an inlet for particles which communicates with said inner space.

2. A combination as defined in claim 1, wherein said distributor turns in one direction and has a leading edge provided with a plurality of slide members which slide on said screen bottom.

3. A combination as defined in claim 1, wherein said channel is open in downward direction towards said screen bottom.

4. A combination as defined in claim 1, wherein said distributor rotates in one direction; further comprising a freely tiltable flap member at said channel in the region of said screen bottom and in a portion of said channel which trails with reference to said one direction.

5. A combination as defined in claim 1, further comprising an upright mounting shaft for said inner tubular element, extending through said space into said lower end region and being radially and axially journalled below said space; and a shaft seal sealing said shaft with reference to said space.

6. A combination as defined in claim 1, said bottom plate having a downwardly facing side; and further comprising a sealing ring on said downwardly facing side, facing into said space and being provided with an opening in the region of said channel.

7. A combination as defined in claim 1, wherein said casing is a discrete element; further comprising a bottom wall closing said lower end region and having a central opening; and wherein said casing is releasably connected with said bottom wall and surrounds said central opening.

8. A combination as defined in claim 1, said casing having one side at which said inlet is provided, and an opposite side, and including a lower end wall which is upwardly inclined from said one towards said other side.

9. A combination as defined in claim 8, wherein said inlet communicates tangentially with said space, and said lower end wall is upwardly inclined in spiral configuration.

10. A combination as defined in claim 5, said cutout of said bottom plate being tangential with reference to said shaft.

11. A combination as defined in claim 5, said channel having an inlet portion which extends tangentially with reference to said shaft.

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