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(54) **SOLVENT SCAVENGER FOR A DESOLVENTIZER TOASTER USING A VAPOR RECOVERY SYSTEM**

LÖSUNGSMITTELABSAUGER FÜR EINEN DESOLVENTIZER-TOASTER MIT EINEM DAMPF RÜCKGEWINNUNGSSYSTEM

ÉVACUATEUR DE SOLVANT AVEC SYSTÈME D'EXTRACTION DE LA VAPEUR POUR DÉSOLVANTISEUR-TOASTEUR

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Description

[0001] One very important industrial process is the extraction of vegetable oil from oil-bearing seeds or kernels such as soybeans, cottonseed, canola, and rapeseed. The process generally operates continuously in very large equipment, where a single unit typically extracts many tons per day of the oil. The oil is very valuable, and has many food and non-food uses. The particle mass remaining after the oil removal is also valuable, and may be used as human food or animal feed.

[0002] One type of extraction system first processes the oil-containing portion of the seeds to form a mass of flakes or particles bearing the oil (meal). Then the meal is transported to a container where a solvent such as hexane dissolves the oil in the meal. Much of the solvent-oil solution so formed is then removed from the meal by draining. The process then separates the oil and solvent removed from the meal by distillation for example, allowing the oil to be used as desired, and the solvent reused.

[0003] Hexane and other similar solvents are highly flammable, so the processes used must avoid any possibility of igniting the hexane. Hexane and other solvents also form vapors much heavier than air and water vapor, so solvent vapors tends to settle at the bottom of any vessel containing them.

[0004] The meal after the first solvent-oil removal step still has so much solvent that the meal is unfit for use as animal feed or human food. To correct this situation, a "desolventizer-toaster" (DT) unit may remove a large percentage of the remaining solvent from the meal. This leaves the remaining meal with a small amount of residual solvent. The solvent that the DT unit extracts from the meal can be reused in the process as well, making the process more cost-efficient and environmentally friendly.

[0005] A DT unit passes the meal through a number of heating stages that vaporize nearly all of the solvent remaining in the meal. Each stage comprises a floor or tray that heats the meal and/or allows steam to pass through the meal, in either case vaporizing a portion of the hexane or other solvent in the meal. A stirring element at each stage agitates the meal to assist the vaporization and to eventually shift the meal to an opening in the stage's floor through which the meal falls under the force of gravity to the next stage.

[0006] Each stage can remove only a percentage of the solvent remaining in the meal. DT units having a reasonable number of stages, say 6 - 10, do not remove as much of the solvent as desired to provide meal with a suitably small amount of solvent.

[0007] Certain newer DT units now have one or more solvent extraction flash stages at the bottom of the conventional heating stages that use a different process to extract a further percentage of the entrained solvent, meanwhile reusing a portion of the steam. This type of DT unit is explained in both US-A-6 279 250 and in an article in Inform, June 2003, pp. 338-339 (Inform). It will be helpful for the reader of this description to be familiar

with both of these publications. Such a solvent extraction and steam reuse stage form a Vapor Recovery (VR) enhancement of a DT unit.

[0008] This VR stage uses an ejector or other vapor transport device that collects steam and leaked solvent vapor from the rotary valve receiving meal discharged from the final conventional stage, see US-A-6 279 250. The ejector recycles this steam and leaked solvent vapor back into an upper conventional stage of the DT unit. The stages at and below the stage receiving the recycled steam can reuse the thermal energy of the recycled steam rather than losing it. The heat in the recycled vapor will heat the meal to extract further solvent while again passing through the conventional stages, thereby reducing solvent lost to the environment and providing more solvent for reuse. A DT unit having VR usually has only one VR stage as shown in US-A-6 279 250. Some have however, been built with two or more VR stages in order to recover more of the solvent.

[0009] WO 2010/141053 A1 shows an desolventizer toaster and desolventizer methods wherein a solvent vapor recycle system may be employed to recycle solvent vapor throughout a portion of the desolventizer portion of the apparatus housing. A water vapor recycle system may be employed to recycle water vapor throughout a portion of the toaster portion of the apparatus housing. The solvent vapor recycle system may comprise an appropriate meal dust separator, blower and super-heater. The water vapor recycle system may comprise an appropriate ejector or blower and super-heater. Water vapor recovered in the solvent extraction process may be used as a water vapor feed to the heated water vapor recycling system.

[0010] Experience shows though, that in DT units with multiple VR stages, it is difficult to assure the most efficient venting of vapors from the plurality of VR stages. That is, it is difficult to find the optimum amount of steam and vapor to recycle from above the first VR stage and how much to recycle from above the second VR stage.

[0011] These conventional VR stages do not deal with the problem of pooling or gathering of the heavy solvent vapors due to inadequate agitating of the gasses in the space involved. Hexane for example, has a specific gravity that is more than five times that of water. If the steam and solvent vapors do not thoroughly mix, the heavier solvent vapors settle in the space and eventually exit the DT unit with the meal. Experience also shows that conventional VR systems leave a small percentage of the solvent remaining in the meal. While this remaining solvent is not considered to affect the quality of the meal, it is still wasted. Therefore, it is an objective of the invention to extract a further portion of this remaining solvent, for reuse if for no other reason.

[0012] For this purpose, the desolventizer-toaster (DT) unit of the invention comprises the features of claim 1. Preferred embodiments of the invention are characterized in the sub-claims.

[0013] The invention is an improvement that allows re-

moving a further fraction of the solvent remaining in the meal when it reaches the floor of the DT unit.

BRIEF DESCRIPTION OF THE DRAWING

[0014]

Fig. 1 is an internal side elevation view of a multi-stage desolventizer-toaster (DT) unit with a final solvent scavenger stage.

Fig. 2 is a top plan view at a section of the final solvent scavenger stage.

[0015] Figs. 1 and 2 show a DT unit 10 having many of the components shown in US-A-6 279 250 mentioned earlier. Unit 10 as shown in Figs. 1 and 2 include a housing or enclosure 16 with a generally circular cylindrical cross section within which occurs removal of solvent from vegetable meal. Masses or layers 40 of meal are shown throughout housing 16 in various stages of solvent removal.

[0016] The stages of solvent removal comprise various vapor recovery (VR) trays 37a and 37b, 49a - 49e, and tray 59, collectively VR tray sets 37, 49, and 59 respectively. The tray sets 37, 49, and 59 all support layers of meal masses 40 as the meal passes through the unit 10.

[0017] Tray sets 37, 49, and 59 and floor 90 are all hollow. Steam flows into and through them to heat the meal masses 40 they hold to vaporize the solvent in the meal masses 40 on them. Both top and bottom plates forming trays 49a - 49d are porous to allow steam to percolate through the meal masses 40 held thereon, and to allow vapors from lower stages to also flow through. The upper plate of tray 49e is porous to allow steam to flow upwards through the mass 40 thereon, but the lower plate of tray 49e is non-porous to prevent flow of vapor from space 55.

[0018] Each tray and floor 90 has a stirrer 88, shown only for tray 49c and floor 90 in the Figs. Stirrers 88 may each comprise for example, an arm and paddle blade driven by a shaft 93 causing stirrers 88 to rotate circularly around the upper surface of the trays in each tray set 37, 49, and 59. Stirrers 88 mix and agitate the individual meal masses 40 to maintain constant temperature therein, to release trapped solvent vapors, and to assist vaporizing the solvent in the masses 40.

[0019] Solvent-containing meal enters enclosure 16 through a port 52 at the top of enclosure 16 in a zone 45a within enclosure 16. The entering meal initially falls under the force of gravity onto to the upper surfaces of tray 37a. From tray 37a, the stirrers sweep meal masses 40 through the trays' respective openings 43a, etc. to cascade through enclosure 16 from each of the trays to the tray directly below prevents most vapor leakage upwards through tray 49e.

[0020] Stirrers 88 continuously sweep across individual trays of tray sets trays 37, 49, and 59 causing agitation of meal masses 40 held on trays 37, 49, and 59. Stirrers

88 also shift meal masses 40 to openings 43a, 43b, and 53a - 53d, through which the meal falls to the tray surface below. Block arrows 53a - 53d represent this falling meal.

[0021] A transport device such as rotary valve 56 moves meal from tray 49e to tray 59. Such a transport device prevents most vapor leakage upwards through tray 49e.

[0022] The heated tray sets 37, 49, and 59 vaporize much of the solvent in the meal masses 40. The steam injected into trays of tray set 49 vaporizes much of the solvent in the masses 40 thereon to form a solvent-steam vapor. Much but not all of this solvent-steam vapor exits through vent 13. Equipment receiving the gasses from vent 13 maintain a pressure lower than that within housing 16, as for example by condensing the solvent-steam vapor in the course of separating the oil and solvent.

[0023] US-A-6 279 250 explains how (referring to Fig. 1 of this description) main ejector 20 introduces high-temperature steam into space 45b to increase the amount of solvent in mass 40 on bed 49a that is vaporized. Main ejector 20 is a "medium pressure ejector" that pulls in vapor at approximately atmospheric pressure and has sufficient pressure rise, perhaps between 1,517 kPa (0.22 psi positive pressure and 17,236 kPa 2.5 psi positive pressure. The precise pressure rise depends on the size of the plant, total number of trays, etc.

[0024] The term "ejector" here should be taken to include not only those gas transport devices that use momentum transfer between a steam jet and the solvent vapor, but also other types of pumps and fans that accomplish similar transport of the gasses at the ejector inlet to the ejector outlet. Because of the flammability of oil solvents such as hexane, it is likely that steam-based ejectors are preferable, since they mostly avoid the possibility of a spark within the ejector itself.

[0025] Port 61 in tray 59 allows meal with entrained liquid solvent and any of the heavier solvent vapors to fall onto floor 90 as the stirrer for tray 59 shifts and mixes the meal lying on tray 59. The solvent in the space above tray 59, being substantially denser than steam, also tends to flow through port 61.

[0026] A transport device such as rotary valve 64 prevents most vapor leakage upwards through floor 90 from outside chamber 16. Valve 64 is at the bottom of housing 16 in the Fig. and shown in US-A-6 279 250 as valve 58, removes masses of meal from space 87 while allowing only a small amount of air to enter space 87. Because of the high specific gravity of solvent vapor (in the case of hexane, nearly 5 times as heavy as steam), space 87 between floor 90 and tray 59 tends to accumulate solvent vapor. Then, as meal moves through rotary valve 64, solvent vapor can escape with the meal.

[0027] The invention includes an additional solvent vapor transfer and mixing device comprising tray 59, a first scavenger ejector 30, and a second optional scavenger ejector 30' preferably diametrically located from scavenger ejector 30 on housing 16. The scavenger ejectors 30 and 30' carry vapors from space 87 into space 55, and

also enhance circulation of the vapors in space 87. The scavenger ejector 30 is preferably one with relatively low pressure rise. The scavenger ejector 30' has a similar structure and operation.

[0028] The scavenger Ejectors 30 and 30' may have bell-shaped inlet openings 91 and 91' that are substantially larger than the duct leading into the respective scavenger ejector 30 or 30'. Such inlet openings 91 and 91' should be directed in a generally tangential direction, with reference to the nearby wall of housing 16, should face toward or upstream relative to the movement of vapors circulating as a result of stirrer 88 movement. The added areas of the inlet openings 91 and 91' may pull more solvent vapor into the scavenger ejectors 30 and 30'.

[0029] Steam flows into the scavenger ejector 30 through pipe 81 and into the scavenger ejector 30' through pipe 81'. The steam flow supplies momentum to any solvent vapor molecules to carry them into space 55. The scavenger ejector outlet 75 of the scavenger ejector 30 is preferably located close to the main ejector inlet 72 of the main ejector 20.

[0030] Fig. 2 shows the stirrer 88 in space 87 in the form of a stirring arm rotating circularly around the upper surface of scavenger tray with counterclockwise rotation. The inlet openings 91 and 91' preferably face opposite the direction of stirring arm rotation.

[0031] Movement of stirrers 88 generates a slow counterclockwise rotational movement of the vapors in space 87. The openings 91 and 91' preferably face against this rotational movement to gather added amounts of solvent vapors for transfer to space 55. The pressure in space 55 in the vicinity of the exit for duct 24 is substantially the same as the pressure within space 87. The scavenger ejectors 30 and 30' transfer some of the solvent vapor in space 87 to space 55. The main ejector 20 in recirculating vapor from space 55 to space 45b, also then transfers some of the solvent vapor that previously was in space 87. By placing at least one outlet 75 near the main ejector inlet 72, this transfer is enhanced. In any case, some of this vapor that was within space 87 then will flow upwards and exit housing 16 through vent 13. It may be possible to provide more than two of these scavenger ejectors to eliminate any stagnant pockets in space 87 in which heavy hexane settles. But even one of these ejectors 30 and 30' enhances circulation of vapors, allowing their transport by the scavenger ejectors 30 and 30' into space 55, where they may be further transported into the intermediate tray set 49.

[0032] The motive steam for both the scavenger ejector 30 and the main ejector 20 is almost completely collected by the main ejector 20 and forced back to an early stage of set 49 to recycle through unit 10. Its energy is thus almost completely re-used to vaporize solvent in the meal masses 40. There is thus little energy cost associated with operating a unit 10 with one or more scavenger ejectors 30 and 30'. In fact, considerable energy is saved by the recovery of the steam and solvent in space 87 which would otherwise be lost to the discharge convey-

ors.

[0033] The net result of these features is to reduce the solvent lost to the environment, to require less fresh solvent to be purchased at processing plants, and to do this with robust, simple, reliable, easy to control, low cost, low energy-consuming apparatus.

Claims

1. Desolventizer- toaster (DT) unit for removing liquid solvent from a mass of vegetable meal, said DT unit having:

a floor (90) and above the floor (90), a series of permeable intermediate trays (49a to 49e) and a bottom tray (49e), each said intermediate trays (49a to 49d) receiving steam for heating the meal and permeating the meal, and through which cascades downward through ports (43a, 43b, 53a to 53d) therein the meal to a bottom tray (49e), and through which upwards flows a mixture of the steam and vaporized solvent, wherein

said bottom tray (49e) and the floor (90) of the unit each have a transport device (56, 64) for passing meal to the space below but resisting passage of vapors,

said DT unit further comprising:

a main ejector (20) with a main ejector inlet (72) in the space below the bottom tray (49e) and a main ejector outlet (23) between adjacent trays above the bottom tray (49e), a scavenger tray (59) between the main ejector inlet (72) and the floor (90); and a first scavenger ejector (30) having a first inlet opening (91) in the space between the scavenger tray (59) and the floor (90) and a first scavenger outlet (75) in the space between the scavenger tray (59) and the bottom tray (49e),

characterized in that

the first scavenger ejector outlet (75) is located adjacent to the main ejector inlet (72).

2. The DT unit of claim 1, including a second scavenger ejector (30') spaced from the first scavenger ejector (30) and having a second scavenger inlet opening (91') in the space between the scavenger tray (59) and the floor (90) and a second scavenger outlet (75') in the space between the scavenger tray (59) and the bottom tray (49e).

3. The DT unit of claim 2, wherein the first and/or the second inlet opening(s) (91, 91') generally face(s) along a line tangent to the housing wall (18).

4. The DT unit of claim 3, including a stirring arm (88) moving circularly around the upper surface of the scavenger tray (59), and wherein the first and/or the second inlet opening(s) (91, 91') faces opposite the direction of stirring arm movement.
5. The DT unit of claim 4, wherein the first and/or the second inlet opening(s) (91,91') is/are bell-shaped.

Patentansprüche

1. Desolventizer-Toaster(DT)-Einheit zum Entfernen von flüssigem Lösungsmittel aus einer Gemüsemahlzeit-Masse, wobei die DT-Einheit hat:

einen Boden (90) und oberhalb des Bodens (90) eine Reihe von durchlässigen Zwischentabletts (49a bis 49d) und ein Bodentablett (49e), wobei jedes der Zwischentabletts Dampf zum Beheizen der Mahlzeit und zum Durchdringen der Mahlzeit empfängt und durch die durch Mündungen(43a, 43b, 53a bis 53d) darin die Mahlzeit in Kaskaden nach unten zu ein Bodentablett (49e) verläuft, und durch das eine Mischung des Dampfers und des verdampften Lösungsmittels nach oben fließt, wobei das Bodentablett (49e) und der Boden (90) der Einheit jeweils eine Transporteinrichtung (64) haben zur Weitergabe der Mahlzeit in den Raum und, um dem Durchtritt des Dampfers jedoch einen Widerstand entgegenzusetzen, wobei die DT-Einheit ferner umfasst:

eine Haupt-Ausstoßeinrichtung (20) mit einem Haupt-Ausstoßeinrichtungseinlass (72) in dem Raum unterhalb des Bodentabletts (49e) und einen Haupt-Ausstoßeinrichtungsauslass (23) zwischen nebeneinanderliegenden Tablett oberhalb des Bodentabletts (49e),
ein erstes Scavenger-Tablett (59) zwischen dem Haupt-Ausstoßeinrichtungseinlass (72) und dem Boden (90);
eine erste Scavenger - Ausstoßeinrichtung (30) mit einer ersten Einlassöffnung (91) in dem Raum zwischen dem Scavenger-Tablett (59) und dem Boden (90) und einen ersten Scavenger-Auslass (75) in dem Raum zwischen dem Scavenger-Tablett (59) und dem Bodentablett (49e),
dadurch gekennzeichnet, dass
der erste Scavenger--Ausstoßeinrichtungsauslass (74) in der Nachbarschaft zu dem Haupt-Ausstoßeinrichtungseinlass (72) angeordnet ist.

2. Die DT-Einheit nach Anspruch 1, umfassend eine

zweite Scavenger-Ausstoßeinrichtung (30'), die unter Abstand zu der ersten Scavenger-Ausstoßeinrichtung (30) angeordnet ist, und eine zweite Scavenger-Einlassöffnung (91') in dem Raum zwischen dem Scavenger-Tablett (59) und dem Boden (90) und einen zweiten Scavenger-Auslass (75') in dem Raum zwischen dem Scavenger-Tablett (59) und dem Bodentablett (49e).

3. Die DT-Einheit nach Anspruch 2, wohin die erste und/oder die zweite Einlassöffnung(en) (90,91') im Allgemeinen entlang einer Linientangenten zu der Gehäusewand (18) ausgerichtet ist/sind.

4. Die DT-Einheit nach Anspruch 3, umfassend einen Rührerarm (88), der sich kreisförmig um die obere Oberfläche des Scavenger-Tabletts (59) bewegt, und worin die erste und/oder die zweite Einlassöffnung(en) (90,91') in die entgegengesetzte Richtung zu der Bewegung des Rührerarms ausgerichtet sind.

5. Die DT-Einheit nach Anspruch 1, worin die erste und/oder die zweite Einlassöffnung(en) (90,91') glockenförmig ausgebildet ist/sind.

Revendications

1. Unité Désolvantiseur-toasteur (DT) pour éliminer des solvants liquides dans une masse d'un repas végétale, ladite unité comportant :

un plateau (90), et au-dessus du plateau (90) une série des plateaux perméables intermédiaires (49a à 49d), et un plateau de fond (49e), chacun des plateaux intermédiaires (49a à 49d) recevant de la vapeur pour chauffer le repas et pour pénétrer le repas, et à travers de ces cascades vers le bas à travers des orifices (43a, 43b, 53a à 53d) dans ceux-ci à un plateau de fond (49e) et à travers de ceux-ci circule un mélange de vapeur et du solvant vaporisée vers le haut,
ledit plateau de fond (49e) et le plateau (90) de l'unité chacun ayant un dispositif de transport (56, 64) pour faire passer des repas à l'espace ci-dessous mais résistant aux passages des vapeurs,
ladite unité DT comprenant en outre :

un éjecteur principal (20) ayant une entrée d'injecteur principal (72) dans l'espace au-dessous du plateau de fond (49) et une sortie d'injecteur principal (23) entre des plateaux adjacents au-dessus du plateau de fond (49e),
un plateau évacuateur (59) entre l'entrée d'injecteur principal (72) et le plateau (90) ;

et un premier éjecteur évacuateur (30) ayant une première ouverture d'entrée (91) située dans l'espace entre le plateau évacuateur (59) et le plateau (90) et une première sortie de plateau (75) située dans l'espace entre le plateau évacuateur (59) et le plateau de fond (49e),

caractérisée en ce que

la première sortie de plateau (75) se trouve adjacent de l'entrée d'injecteur principal (72).

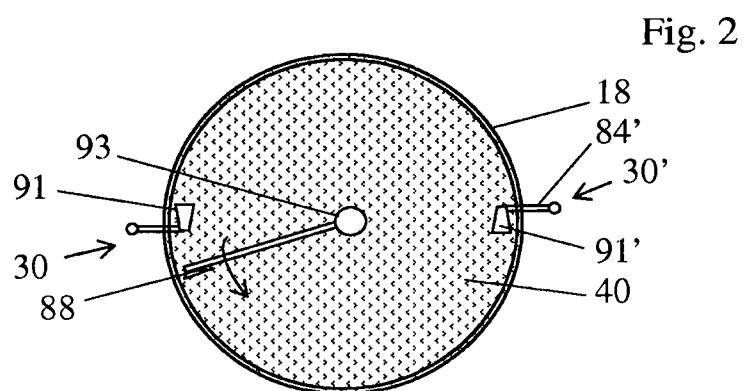
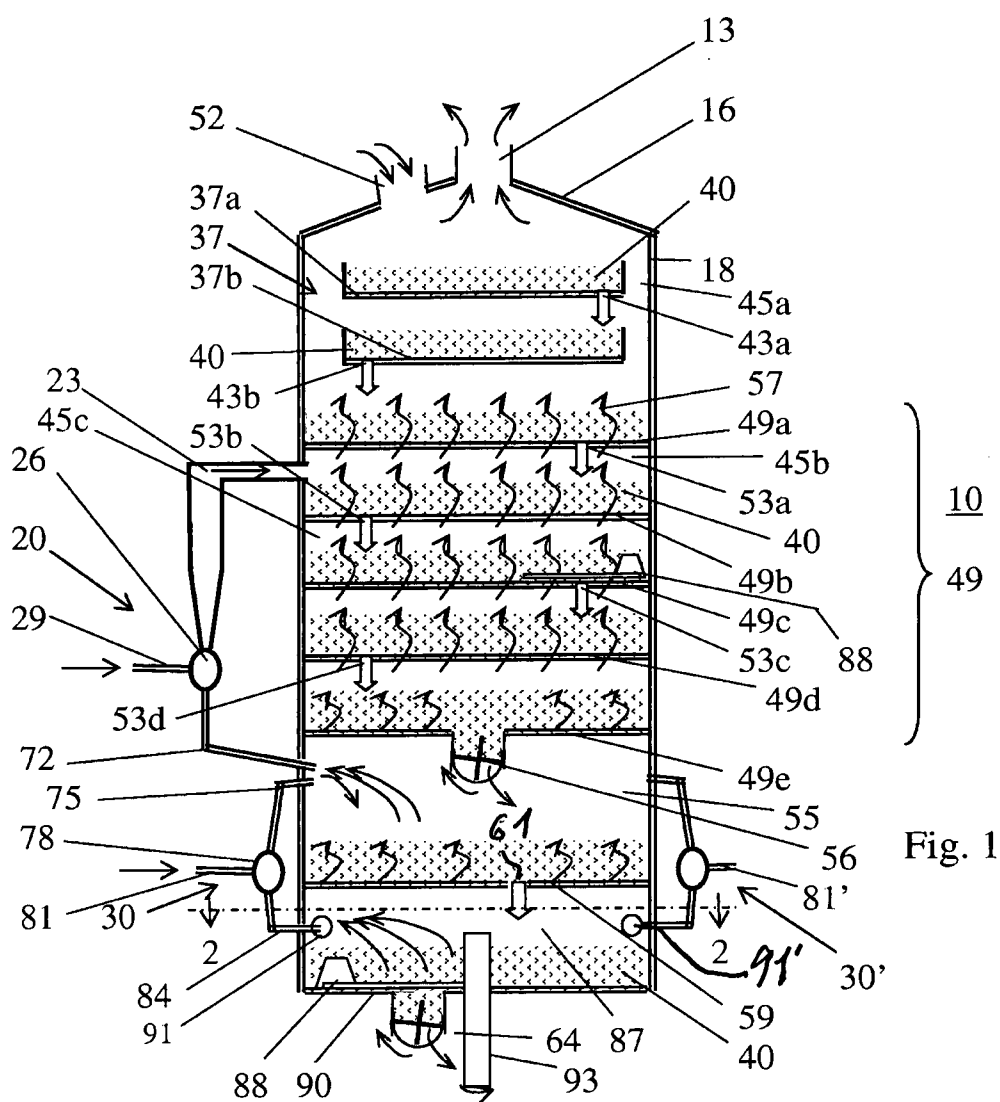
2. L'unité DT selon la revendication 1, comprenant un deuxième éjecteur évacuateur (30') à espacement du premier éjecteur évacuateur (30) et ayant une deuxième ouverture d'entrée (91') dans l'espace entre le plateau évacuateur (59) et le plateau (90) et une deuxième sortie de plateau (75') dans l'espace entre le plateau évacuateur (59) et le plateau de fond (49e).
3. L'unité DT selon la revendication 2, dans laquelle les premières et/ou deuxièmes ouvertures d'entrée (91, 91') sont en générale le long d'une ligne tangente face à paroi du logement (1, 8).
4. L'unité DT selon la revendication 3, comprenant un bras de malaxage (88) qui se déplace de façon circulaire autour de la surface supérieure du plateau évacuateur (59) et dans laquelle les premières ou deuxièmes faces d'ouvertures d'entrée (91, 91') sont opposées de la direction du mouvement du bras de malaxage (88).
5. L'unité DT selon la revendication 4, dans laquelle la première et/ ou la deuxième ouverture d'entrée (91, 91') et/sont en forme de cloche.

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REFERENCES CITED IN THE DESCRIPTION

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715005/MK (EP 2 702 343)

Szabadalmi igénypontok

1. Oldószermentesítő torony (DT) egység folyékony oldószer eltávolítására növényi liszt masszából, ahol a DT egység tartalmaz:
egy alaplapot (90) és az alaplap (90) fölött egy sor áteresztő közbenső tálcát (49a - 49e) és egy alsó tálcát (49e), ahol a közbenső tálcák (49a - 49d) a lisztet melegítő gőzt fogadnak és áteresztik a lisztet, és amelyeken keresztül a liszt lefelé vándorol kapukon (43a, 43b, 53a - 53d) keresztül egy alsó tálcáig (49e), és amelyeken keresztül felfelé folyik a gőz és az elpárologtatott oldószer keveréke, amelynél az alsó tálca (49e) és az alaplap (90) az egységben saját szállítóeszközzel (56, 64) rendelkezik a liszt átjuttatására az alsó térbe és a gőzök visszatartására, ahol a DT egység tartalmaz még:
egy fő ejektort (20) az alsó tálca (49e) alatti térbe torkolló fő ejektor beömlőnyílással (72) és az alsó tálca (49e) fölötti szomszédos tálcák közötti fő ejektor kiömlőnyílással (23),
egy tisztító tálcát (59) a fő ejektor beömlőnyílás (72) és az alaplap (90) között; és
egy első tisztító ejektort (30), amelynek a tisztító tálca (59) és az alaplap (90) közötti térbe torkolló első beömlőnyílása (91), valamint a tisztító tálca (59) és az alsó tálca (49e) közötti térbe torkolló első tisztító kiömlőnyílása (75) van,
azzal jellemezve, hogy
az első tisztító kiömlőnyílás (75) a fő ejektor beömlőnyílás (72) közelében van elhelyezve.
2. Az 1. igénypont szerinti DT egység, amelynek az első tisztító ejektortól (30) távoli második tisztító ejektora (30') is van, amelynek a tisztító tálca (59) és az alaplap (90) közötti térbe torkolló második tisztító beömlőnyílása (91') valamint a tisztító tálca (59) és az alsó tálca (49e) közötti térbe torkolló második tisztító kiömlőnyílása (75') van.
3. A 2. igénypont szerinti DT egység, amelynél az első és/vagy a második beömlőnyílás (91, 91') lényegében a ház falát (18) érintő egyenes mentén húzódik.
4. A 3. igénypont szerinti DT egység, amelynek a tisztító tálca (59) felső felületén körkörös mozgást végző keverőkarja (88) van, és amelynél az első és/vagy a második beömlőnyílás (91, 91') a keverőkar mozgásával ellentétes irányba néz.

5. A 4. igénypont szerinti DT egység, amelynél az első és/vagy a második beömlőnyílás (91, 91') harang alakú.