Jan. 23, 1945. C. W. STRATFORD 2,368,049

ATOMIZING EVAPORATOR

Filed March 12, 1942

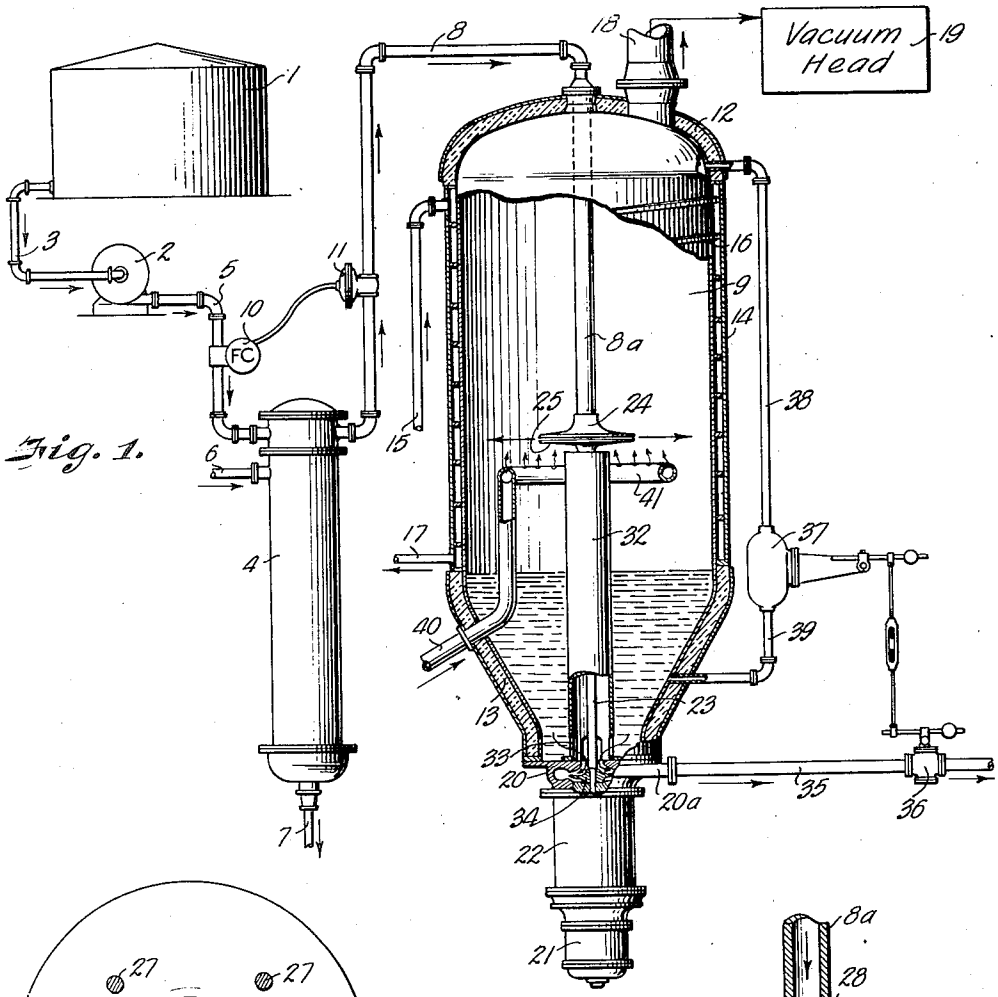

Fig. 1.

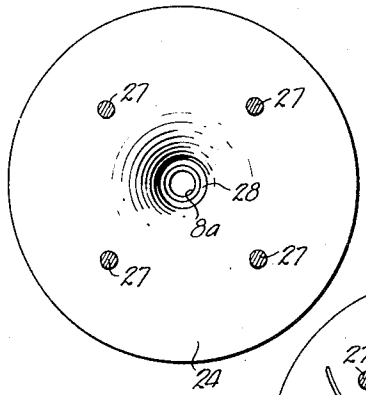

Fig. 3.

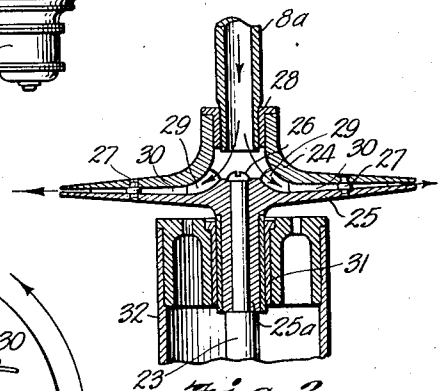

Fig. 2.

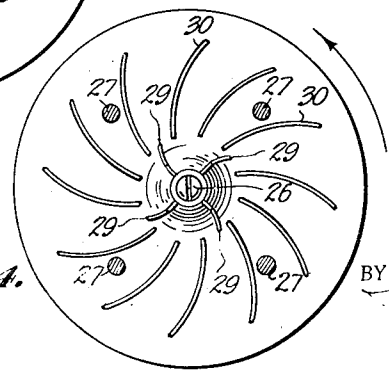

Fig. 4.

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ATOMIZING EVAPORATOR

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3 Claims. (Cl. 159—23)

This invention relates to improvements in a process and apparatus for evaporating mixed liquids of different boiling points, and refers more particularly to an atomizing evaporator capable of exhausting contained moisture from a mixture of fluids in which moisture is a constituent.

The invention contemplates as well the deodorizing or separation of objectionable volatiles from fluid mixtures such as sulphur dioxide from hydrocarbon oils.

The salient principle of novelty lies in the imparting of high rotative velocity or energy to a fluid mixture by means of an atomizing disc, consisting of a liquid accelerating disc and a shrouding disc spaced apart to form a narrow annular space therebetween. The fluid mixture to be separated is introduced to the annular space between the discs and is projected at high velocity from its periphery. Separation of the constituents of the mixture is effected by imparting sufficient energy to atomize the mixed fluid in such a manner as to present a relatively maximum surface per unit volume of the fluid. This atomization takes the form of a continuous horizontal screen of minute particles extending from the rim of the energizing rotor to the inside wall of the enclosing vessel.

Certain prior art relating to the dehydration or bleaching of liquids is known and recognized, such as Patent No. 1,208,534, issued to L. J. Foret, on December 12, 1916; and Patent No. 1,501,876, issued to F. Wreesmann, on July 15, 1924. Neither of these patentees, however, recognized or accomplished the results obtained by the instant dehydrator.

One advantage of the device is the efficient utilization of power atomization to reduce the dimension of the particle size of the mixed liquids and to energize the fluid particles and thereby control their path of travel to prevent entrainment and promote complete coalescence of the unvaporized fluid by impingement on a coalescing surface.

A further advantage in this type of evaporator lies in its ability to freely evaporate liquids which, if heated in a body, would produce uncontrollable frothing owing to tenacity of the liquid film enclosing the bubbles of vapor.

Another advantage of the evaporator is the breaking up of the liquid mixture by mechanical energy and projecting it as a sheet or screen of highly energized particles of exceedingly small dimension, in which condition the volatiles may be more readily removed.

By imposing a high directional velocity and impinging the unvaporized liquid particles against the retaining cylinder in a manner to coalesce the residual unevaporated liquid permitting a complete separation of volatile constituents contained in the mixture, the volatiles can be removed with substantially no entrainment of the liquid particles.

Other and further advantages will appear from the specification.

In the accompanying drawing which forms part of the instant specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

Fig. 1 is a schematic flow diagram of a dehydrating system with the dehydrator shown in enlarged cross section.

Fig. 2 is an enlarged section of the shrouded disc atomizer.

Fig. 3 is a face view of the shrouding portion or disc viewed from below.

Fig. 4 is a top plan view of the liquid accelerating portion of the atomizing disc with the shrouding portion removed.

The system as shown in Fig. 1 consists of a supply tank 1, charging pump 2 connected to the tank by means of a line 3. A heat exchanger 4 is connected to the discharge line 5 from the charging pump. The exchanger is equipped with a steam supply line 6 and a steam condensate pipe 7. In place of steam any desired heating fluid may be employed. The heat exchanger is connected by a pipe 8 into the top of an upright cylindrical vessel 9. A flow control device 10 is interposed in the pipe 5 and is operatively connected with a control valve 11 in the connecting line 8.

The vessel 9 is insulated at the top, as shown at 12, and at the bottom as shown at 13. Around the central portion of the vessel is a jacket 14, to which is supplied a heating medium through pipe 15. The heating medium is circulated through the jacket in a spiral course from top to bottom by means of a spiral baffle 16, and is discharged from the lower portion of the jacket through pipe 17. Suitable valves may be interposed in the lines 15 and 17 to control the volume of heating medium circulated through the jacket.

Into the top of the vessel 9 is connected a vapor line 18, which may be connected to a vacuum head, if required, diagrammatically shown at 19. This vacuum head may be a vacuum pump or a steam jet arrangement for imposing subatmospheric pressure or high vacuum within the

vessel 9. To the bottom of the vessel connected by a flange is a centrifugal pump casing 20, and below the pump casing is a motor 21 and a sealing unit 22. The motor shaft 23 extends almost midway into the vessel and has mounted on the top thereof the atomizer, details of one type being shown in cross section in Fig. 3. The atomizer or atomizing disc mounted on the top of the motor shaft comprises an upper shrouding portion 24 and a lower liquid accelerating portion 25. The accelerating portion is held on top of the shaft by means of a holding screw 26 and the shrouding portion 24 is integrally united with the liquid accelerating portion 25 by means of rivets 27.

The shrouding portion of the atomizer is shaped with an upper axial opening which is fitted with a bearing 28. Into this bearing is fitted the open end of the feed pipe 8*a*, which is a continuation of the pipe connection from the heater to the top of the vessel 9. In the annular space between the upper shrouding disc 24 and the liquid accelerating disc 25, are so-called Francis-type screw shaped vanes 29 which extend but a short distance from the axis of the disc. Intermediate the vanes 29 and the outside edge of the discs are arranged distributing vanes 30. The hub 25*a* of the liquid accelerating disc has a bearing surface which rotates in a bearing sleeve 31, mounted near the top of the hollow cylindrical support 32. This cylindrical support is carried by the bottom of the vessel and adjacent the bottom of the vessel are passageways 33, cut through the support permitting liquid which accumulates in the vessel to enter the inlet or throat of the centrifugal pump rotor 34, mounted upon the shaft 23 and positioned in the pump casing 20. The discharge nozzle 20*a* of the pump casing is connected to a liquid withdrawal line 35. In this withdrawal line is a valve 36, operated by a liquid level control 37 connected into the side of the vessel by pipes 38 and 39.

In operation, liquid is supplied from the tank 1 by means of the pump 2, to the heater 4 through pipe 5. A constant and uniform flow of liquid to the atomizing disc in the vessel 9 is fed by the flow control 10 and control valves 11 interposed in the lines 5 and 8, respectively.

The liquid passing through the pipe 8*a* is introduced to the throat of the atomizing disc in the annular space between the upper shrouding portion and the lower liquid accelerating portion. In the throat of the disc the liquid is picked up by the screw vanes 29 and uniformly distributed to the accelerating vanes 30. From the annular space at the outer rim of the atomizing disc the liquid is projected at high velocity in the form of a thin uniform film which immediately disintegrates in fine particles in traveling from the rim of the disc to the point of impingement. The volatile constituents are completely evaporated from the finely divided energized particles during this trajectory.

Steam or any other inert gas may be supplied to the vessel through pipe 40 and is introduced beneath the atomizing disc through a hollow perforated ring 41. This carrier gas rising through the screen of finely divided particles, reduces the boiling point of the volatile constituents by partial pressure and passes off with the volatiles through vapor discharge pipe 18. As suggested, vacuum conditions may be imposed upon the vessel by means of the vacuum head 19. Recovery of the condensed volatile constituents so removed may be accomplished in any conventional manner.

The unvaporized constituents coalesced upon the inner surface of the vessel and accumulated in the bottom, pass out through the apertures or passageways 33 in the bottom of the cylindrical support 32 and are forced by means of the centrifugal pump through the discharge line 35.

The finely dispersed liquid particles which are coalesced to form the withdrawn liquid are projected from the atomizing disc and strike the surface of the container at an angle somewhat less than 90° to a tangent drawn to the circle formed by the container. Projecting the particles at this angle avoids splattering and produces coalescence to a liquid condition over the surface of the retaining cylinder. Furthermore, it would appear that the directional energy given to these particles by the rotating disc is in excess of the explosive energy inherent to the particles of mixed liquid owing to their content of volatile constituents.

It is contemplated that using an atomizing disc of approximately 20 inch diameter and rotating it to a rim velocity of 150 feet per second, there will be imparted to the liquid particle a radial velocity somewhat below the maximum rim velocity. Maximum permissible temperatures of 110° are allowed on some material. Consequently it may be necessary to utilize subatmospheric conditions within the vessel.

For example, this invention is especially well adapted to the removal of water in oil in an emulsified condition, the removal of dissolved SO_2, or mercaptans of objectionable odor in solution in various oils, or for the removal of some portion of the water in soap solutions during the manufacture of certain soaps which are supersensitive to chemical reversion above critical temperatures.

Using this apparatus for the removal of a certain percentage of water in soap solutions, the soap solution would be fed to the atomizing disc which would project it in finely divided form horizontally to the enclosing vessel. The temperature when removing water from sensitive soaps might be limited to a maximum of, say 110° F., which is far below the boiling point of water at normal atmospheric pressure. Therefore, in order to evaporate the water in portion, or en toto, the pressure within the enclosing vessel is maintained by means of a vacuum head at such an absolute pressure as to lower the boiling point of water to any desirable degree for the removal of a portion of said water or all of it as may be desired. Under these conditions, the soap in solution being supersensitive to temperatures above, say a critical of 110° F., would not suffer chemical change under these operating evaporative conditions.

Above there have been suggested uses for the apparatus in the extraction of volatile materials from liquids. In addition to those uses, the apparatus may be employed as well for the absorption of selected components from gases introduced below the atomizing disc into a liquid atomized by the disc. As an example of this latter use in the alkylation of hydrocarbons, it may be desirable to absorb certain selected constituents from a hydrocarbon gas such as olefins into a condensation catalyst such as sulfuric acid, hydrofluoric acid and the like. This may be accomplished in the apparatus shown by introducing the olefin-bearing hydrocarbon in a gaseous state through the inlet header below the atomizing

disc, at the same time introducing the condensation catalyst in liquid form into the atomizing disc. The hydrocarbon rising upwardly through the container will pass through the screen of finely divided particles of condensation catalyst and the olefins will be absorbed from the hydrocarbons into the catalyst.

An additional application of this apparatus in the same art, namely the alkylation of hydrocarbons, is its use for chilling a condensation catalyst by first mixing with the condensation catalyst a volatile hydrocarbon such as iso-butane or normal butane in liquid form and introducing the liquid mixture into the atomizing disc. Again the liquid introduced to the disc is atomized and the volatile components are freed to vaporize therefrom. In this case the vapors would be removed through discharge pipes 18 to a compressor in place of a vacuum head, shown in the drawing. The temperature to which the catalyst is chilled can be controlled as desired, either by limiting the amount of liquid hydrocarbon mixed with the catalyst or by the evaporating pressure maintained in the vessel, or both.

It is contemplated that either of the methods suggested for use in connection with the alkylation of hydrocarbons may be employed separately or together.

While the method has been explained with respect to dehydration of fatty acid for the manufacture of soap, it is contemplated that the evaporator may be used as well as a deodorizer in the removal of objectionable volatiles from oil and innumerable other liquids, by atomizing the liquid at sufficient velocity to vaporize the lower boiling point or volatile constituents and separate after atomization the vapor from the coalesced liquid.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of my claims. It is further obvious that various changes may be made in details within the scope of my claims without departing from the spirit of my invention. It is, therefore, to be understood that my invention is not to be limited to the specific details shown and described.

Having thus described my invention, I claim:

1. An apparatus for separating mixed fluids comprising a vessel, separate liquid and vapor withdrawal pipes connected thereto, an atomizing disc including spaced apart liquid accelerating and shrouding portions, means for introducing fluid axially into the inlet throat of the disc and between the accelerating and shrouding portions, means for introducing a carrier gas beneath the atomizing disc, a power source mounted below the vessel and connected to the atomizing disc by a shaft to give the disc a high rotative velocity, means interposed in the liquid level withdrawal pipe for controlling the liquid discharged from the vessel and means controlled by the level of liquid in said vessel for actuating said last mentioned means.

2. An apparatus for separating mixed fluids comprising a vessel, separate liquid and vapor withdrawal pipes connected thereto, an atomizing disc including spaced apart liquid accelerating and shrouding portions, means for introducing fluid axially into the inlet throat of the disc and between the accelerating and shrouding portions, means for introducing a carrier gas beneath the atomizing disc, a power source mounted below the vessel and connected to the atomizing disc by a shaft to give the disc a high rotative velocity, a centrifugal pump mounted on the shaft below the disc and having its discharge through the liquid withdrawal pipe for eliminating liquid which accumulates in the vessel.

3. An apparatus for separating mixed fluids comprising a vessel, separate liquid and vapor withdrawal pipes connected thereto, an atomizing disc including spaced apart liquid accelerating and shrouding portions, means for introducing fluid axially into the inlet throat of the disc and between the accelerating and shrouding portions, means for introducing a carrier gas beneath the atomizing disc, a power source mounted below the vessel and connected to the atomizing disc by a shaft to give the disc a high rotative velocity, a centrifugal pump mounted on the shaft below the disc and having its discharge through the liquid withdrawal pipe for eliminating liquid which accumulates in the vessel, and means for controlling the rate of liquid withdrawal.

CHARLES W. STRATFORD.