

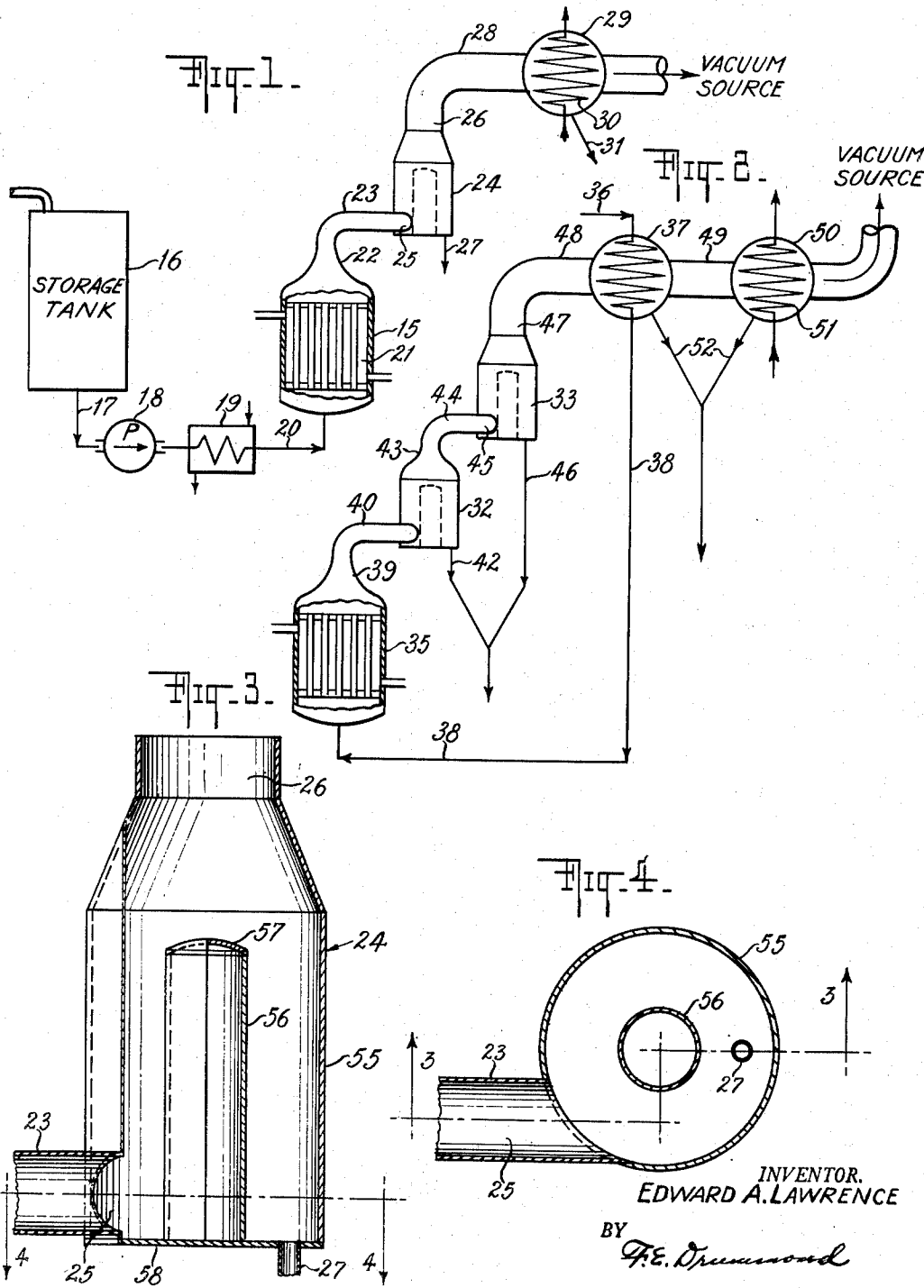
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DISTILLATION OF FATTY ACIDS

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## DISTILLATION OF FATTY ACIDS

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This invention relates to improvements in the art of distillation and the refining of liquids, and more particularly to a method and apparatus for distilling high boiling liquids, particularly fatty acids.

Although the invention will be described as applied to the distillation of fatty acids to produce acids of superior quality and color, and such as may be employed directly in the making of soaps, it will be understood the invention is not limited to this particular use and that the new process and apparatus may be advantageously employed in the distilling and refining of glycerine and other liquids including, for example, the distillation and fractionation of petroleum.

Various methods and many different types of apparatus have been proposed for use in the distillation of high boiling liquids, and certain of these have been employed with some degree of success in the distillation of fatty acids and the like material. However, prior to this invention, in so far as known, no commercially practicable method and apparatus has been devised for distilling fatty acids at a relatively high rate while effecting the substantially complete removal of the non-volatile impurities entrained in the vapors, whereby a fatty acid distillate which is practically free from coloring matter or of very light color is produced. The present invention provides such a method and apparatus for accomplishing these desired results.

There are a number of factors known to adversely affect the quality of the distillate obtained by the distillation of fatty acids. Such factors include the use of high temperatures; the presence of atmospheric air; the prolonged heating of the fatty acid material; and the presence of entrained impurities in the vapors leaving the vaporizer or still which if not satisfactorily removed result in the production of a dark colored distillate. In order to lessen the deleterious effects caused by the use of relatively high temperatures and protracted heating of the fatty acid material and to prevent the material from being exposed to air at such elevated temperatures it has been the practice, in general, to carry out the distillation under subatmospheric pressure conditions. Also, it has been common to introduce steam at low absolute pressure into the system to lower the effective temperature at which the distillation may be carried out, and to assist in preventing air from contacting the heated fatty acid material, thus avoiding its harmful influence. Flash distillation methods likewise have been employed wherein the fatty acid material is heated to high temperatures in an enclosed pipe for a short time to store up in the liquid enough heat to convert it into a vapor immediately upon relieving the pressure on the heated liquid material, for example, as by spray-

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ing the heated material into a low pressure chamber. While this treatment avoids some of undesirable effects produced when the fatty acid material is heated at lower temperatures for long periods of time, the high temperatures and pressures to which the fatty acid material is subjected, even for short periods of time, tend to cause more or less polymerization, cracking and the formation of a certain amount of tar-like residues which is undesirable.

The treatment of the fatty acid vapors passing from the vaporizer to the condenser has also received considerable attention heretofore by different investigators. These vapors are never pure and always contain entrained unvaporized liquids and/or solids which substances are usually colored so that if they are permitted to pass along in the vapor stream to the condenser a darker colored distillate results than otherwise would be the case. Such color-bearing impurities comprising unvolatilized liquid particles are unavoidably projected into the upwardly moving vapor stream as the fatty acid material distills and becomes entrained in the vapors.

Various devices and methods have been employed in attempts to separate the entrainment from the vapors before the same are condensed. In general, such devices and methods have involved more or less abrupt changes in the directional movement of the vapors for the purpose of throwing entrained material out of the vapor stream. Use has been made, for example, of cyclone separators, baffles, spiral ribs, multiple concentrically arranged walls or cones positioned in the path of the vapor stream to present a tortuous path for the vapor to travel so that entrained particles are caused to separate from the vapor before the same is condensed. These devices have not proven entirely satisfactory principally because to obtain the best results a high resistance to the vapor flow is required, which increase in resistance produces a high pressure drop in the system with accompanying low optimum feed rate. Furthermore, although such high resistance to vapor flow is effective for removing the bulk of the entrained particles, it has not been found to be particularly effective in bringing about the separation of the small percentage (usually from one to three per cent) of undistilled or undistillable relatively minute liquid particles which are held in suspension and widely dispersed in the rising vapors. In the distillation of higher fatty acids, the acid vapor is impure because of such entrainment and, as aforementioned, if this entrained material is not removed, or at least substantially reduced in concentration, the distillate produced therefrom will be of inferior color and quality.

It has now been discovered that a very satisfactory and highly efficacious method of remov-

ing entrainment from fatty vapors, without interfering with the vapor flow to any great extent, comprises distilling such fatty acid material and passing the resulting fatty acid vapors formed into a zone wherein the vapors are caused to attain substantially the acoustic velocity and are then subjected to a centrifugal purifying action to bring about the separation of entrained impurities from the vapor stream. The acoustic or critical velocity, expressed in feet per second, is equal in magnitude to the velocity of propagation of a pressure wave in the fluid under the conditions imposed. The acoustic velocity will, of course, vary somewhat with different fatty acids or fatty acid mixtures, being a function not only of the temperature, conversion factor and gas constant per mole, but also the molecular weight, varying inversely with respect to the square root of such molecular weight. In the distillation of crude fatty acids, for example, red oil, tallow acids, coconut oil acids, and the like commercial fatty acids, the improved results are obtained in accordance with this invention when the velocity of the fatty acid vapors are made to reach or approximate the maximum or acoustic velocity at the entrance to the separator. For split tallow fatty acids, such for example obtained by counter current hydrolysis in known manner, the acoustic velocity under the conditions maintained was on the order of 400 to 450 ft./sec. In the case of coconut oil fatty acids which comprise lower molecular weight acids the acoustic velocity under the conditions imposed was on the order of 480 to 500 ft./sec.

In accordance with the invention this high vapor velocity requirement is accomplished by suitably carrying out the distillation and passing the acid vapors through a centrifugal separator, for example of the cyclone type, the separator being constructed and arranged in the system so that under normal operating conditions of temperature and pressure the velocity of the vapor passing from the vaporizer to the separator will be increased substantially so that at the inlet to the separator it will at least approximate the acoustic velocity. The highest velocity will normally occur in the system at the lowest pressure point in the line having the smallest cross-sectional area, and accordingly the fatty acid vapor may be made to flow at the acoustic velocity as it enters the separator by enlarging the cross-sectional area of the outlet with respect to the area of the inlet to the separator, and operating the system under a sufficiently high vacuum so that the vapors will attain acoustic velocity at the separator inlet.

One or more centrifugal separator units may be used, such as illustrated in the drawings, and the improved results are obtained in accordance with this invention where the system is constructed and operated so as to provide acoustic velocity of the vapor at the inlet to at least one of the separators, and preferably, where two or more separators are employed, the last separator in the series and from which the purified vapors may be conducted to other processing apparatus for use as such, or may be passed to a condenser and recovered as distillate.

A significant advantage of the invention is that the improvement in entrainment removal is accomplished without creating a great resistance to the free passage of the vapors with accompanying high pressure drop, whereby the feed rate can be maintained at a high level, and such as heretofore it has not been possible to attain without a

sacrifice in the efficiency of entrainment removal.

In order to provide a clearer understanding of the invention reference may be made to the drawings forming a part of this application wherein there is illustrated an apparatus embodying the principles of the invention and one manner in which the improved process may be carried out.

Fig. 1 illustrates more or less diagrammatically a distillation and entrainment removal system including a vaporizer and an acoustically operating separator which is constructed and operated in accordance with this invention, a part of the vaporizer being broken away to indicate the heating arrangement;

Fig. 2 is a similar distillation system as shown in Fig. 1 wherein two centrifugal separators are employed, being connected in series with the last one arranged to operate at acoustic velocity at the separator inlet;

Fig. 3 is an enlarged vertical section through a separator embodying the novel features of the invention taken on the line 3—3 of Fig. 4 and looking in the direction of the arrows;

Fig. 4 is a similarly enlarged horizontal section view of the separator taken on the line 4—4 of Fig. 3 and looking in the direction of the arrows.

In Fig. 1 there is illustrated a distillation system wherein a single acoustically operating centrifugal separator is utilized to remove entrainment. In the system illustrated in Fig. 2, two centrifugal separators are used as generally preferred in commercial operation, the separators being connected in series with the second or last separator constructed so as to establish acoustic velocity of the vapor as the same enters the separator.

Referring to the drawings, the vacuum distillation system shown in Fig. 1 comprises an up-flow vaporizer or still 15 into which the crude fatty acids to be distilled are introduced, as for example acids obtained by countercurrent hydrolysis, or from any other source, and which preferably are substantially free from dissolved and emulsified water. The crude acids are suitably accumulated in a storage receptacle 16, being withdrawn therefrom for transfer to the vaporizer 15 through the pipe line 17 by means of pump 18 connected in line 17. From the pump the fatty acid material passes to a suitable heat exchanger 19 which preheats the fatty acids as they are fed to the vaporizer 15 through pipe line 20, the vaporizer being suitably heated as by means of hot diphenyl vapor introduced into the chamber 21. Other suitable means for heating the vaporizer may be used such as steam, etc. The temperature of the fatty acid material in the vaporizer 15 is increased to about 250° C. by the heating fluid so that the acids are readily volatilized under the vacuum conditions employed. Acid vapors produced in the vaporizer pass upwardly through the neck 22 and connecting pipe 23 which is connected to the acoustical separator 24, the pipe 23 being arranged to introduce the vapors tangentially into the lower part of the separator through inlet 25. Figs. 3 and 4 show in more detail the construction of the acoustical centrifugal separator and wherein the outlet 26 is made larger than the inlet 25 to cause the velocity of the vapors to be increased so as to reach the acoustic velocity at the inlet to the separator. The entrainment thrown out of the vapor stream in separator 24 is collected in the bottom part of the separator and may be removed through a

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suitable outlet line as indicated at 27 while the purified vapors pass upwardly and are discharged through the enlarged outlet opening 26. Vapors so discharged from the separator 24 are carried through duct 28 to the condenser 29 which is, in turn, connected to a vacuum creating means (not shown). The condenser 29 is operated at a temperature low enough to bring about condensation of the volatilized fatty acids but is not so low as to cause solidification of the fatty acid distillate. Generally a temperature of about 50° C. is maintained in the condenser by circulating cooling water, or other suitable refrigerant, through the pipe line or coils as indicated at 30. The fatty acid distillate recovered in the condenser 30 may be suitably drawn off through a distillate discharge line as diagrammatically illustrated at 31.

In the vacuum distillation system illustrated in Fig. 2, two centrifugal up-flow-separators 32 and 33 connected in series are used instead of a single separator, and the second or last separator 33 is constructed similar to separator 24 in Fig. 1 to cause the vapors to reach acoustic velocity at the inlet thereto during operation. Referring to Fig. 2, the distillation system shown comprises a vaporizer 35, which is constructed and heated in like manner as the vaporizer 15 of Fig. 1. The crude fatty acid fed to the vaporizer through line 36 is arranged to flow through the heat exchanger or auxiliary condenser 37 and thence through line 38 to the vaporizer 35. During operation the hot fatty acid vapors discharged from the separator 33 pass through the heat exchanger 37, the heat being thus utilized to preheat the fatty acids fed to the vaporizer through lines 36 and 38. The temperature of the crude fatty acids may thus be raised to about 170° C. before entering the vaporizer where the temperature is further increased to around 250° C. or above whereby the acids are readily volatilized under the reduced pressure conditions maintained.

Operating under a vacuum of from 10 to 30 mm. Hg absolute at the vaporizer outlet the fatty acid material fed to the vaporizer is volatilized under the heat and low pressure conditions, the vapor being conducted upwardly and out through the neck 39 and connecting pipe 40 to the centrifugal separator 32, the vapor entering tangentially into the bottom portion of the separator. Centrifugal forces acting on the vapors as they whirl upwardly through the separator 32 cause a large portion of the heavier liquid entrained in the vapor to be thrown out of the vapor stream, being collected in the bottom portion of the separator where the same may be suitably drawn off through a liquid discharge line as indicated at 42. The treated vapor then passes upwardly out of the separator 32 and is discharged through the outlet 43 into the connecting pipe 44 which forms the inlet to the acoustic velocity separator 33. The inlet pipe 44 is arranged to introduce the vapors tangentially into the lower part of the separator 33 similarly as in the case of separator 32. Separator 33 is an acoustically operating separator as separator 24 (Fig. 1) whereby under the vacuum conditions of operation the velocity of the vapor is made to reach the acoustic value at its inlet 45. The entrainment thrown out of the vapor stream in the acoustic separator 33 is collected in the bottom part of the separator and may be drawn off through a liquid discharge line as indicated at 46 while the purified vapor passes upwardly and is discharged through the large outlet opening 47. Vapor so discharged from the separator 33 is conducted to the heat exchanger 37 through a connecting pipe 48 and thence

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through duct 49 to the primary condenser 50 which is in communication with a vacuum creating means, not shown.

Heat exchanger 37 is preferably arranged to preheat the fatty acid feed, as described, and to function as a surface condenser for fatty acid vapor which will condense at temperatures of about 160-180° C. The primary condenser 50 is operated at a temperature such as to cause the uncondensed fatty acid vapor discharged from the auxiliary condenser 37 to be condensed to a liquid. The temperature of the condensing surfaces for tallow fatty acid distillation is preferably maintained at about 50° C., as by circulating cold water, or the like cooling fluid, through suitable coils or pipes as indicated at 51. The fatty acid distillate which collects in condensers 37 and 50 may be suitably drawn off through distillate discharge lines 52 which may be joined as diagrammatically illustrated in Fig. 2.

Referring to Figs. 3 and 4 wherein the general construction of an acoustical velocity separator, such as employed in the fatty acid distillation systems shown (Fig. 1 and Fig. 2, separators 24 and 33 respectively), the separator comprises a cylindrical shell 55 having a central hollow drum which is closed at the top by the cover 57 and arranged in the bottom section 58. Although the particular dimensions of the separator may vary depending upon the capacity desired, in a typical distillation system the outer diameter of the central drum 56 was approximately one-third the inner diameter of the separator and of a length equal to about three times the diameter of the inlet 25 as measured from a center line passing through the central axis of the inlet pipe 23, the drum being accurately positioned so as to provide substantially equal space around it and the wall of the separator. The inlet 25 and outlet 26, as shown, are of circular cross-section, however, they may be rectangular or other geometric shape. Also the outlet may be provided with cross or straightening vanes if desired. In the example illustrated in Figs. 3 and 4 the diameter of the inlet is approximately one-third the inside diameter of the separator or shell 55. Further, while the preferred construction of the separator includes the central drum member 56, the same may be omitted as not being essential to the attainment of acoustic velocity of the vapor at the inlet to the separator.

To cause the vapor to attain acoustic velocity at the inlet 25 (Figs. 3 and 4) of the separator, the outlet 26 is made sufficiently larger in cross-sectional area than the inlet 25 to cause a low pressure point to be established at the inlet to the separator during operation rather than at some other point in the system. The cross-sectional area of the outlet and inlet of the acoustical velocity separator in any given case will depend upon the size or capacity of the separator and material being treated. The size of the outlet may be made as large as economically feasible inasmuch as there is no critical maximum size. In a typical distillation run wherein split tallow fatty acids were distilled in accordance with this invention and wherein an acoustical cyclone type separator was used to treat the fatty acid vapor prior to condensing as described herein, it was found that operating under a vacuum of approximately 25 mm. Hg absolute at the vaporizer outlet that the velocity of the vapor could be made to reach the acoustic value by making the diameter of the outlet about twice and preferably three times the diameter of the separator inlet.

In the design of a system, such as that described and illustrated in the drawings, knowing the desired mass flow rate of vapor through the system and the pressure obtainable by the vacuum source, the resistance to flow caused by the condensers and vapor lines back to the body of the acoustical separator may be calculated. For use in making such calculations reference may be made to the "Chemical Engineer's Handbook" by J. H. Perry, 2nd edition. The design of the parts connected downstream of the acoustical separator should be such as to keep the pressure drop in these parts low. This will require lines having large cross-sectional areas relative to that which will be used upstream of the separator. Changes in pressure with the use of any particular system and equipment size may be determined using the method described by C. E. Lapple in "Amer. Inst. of Chemical Engineers," vol. 39 (1943), page 385 et seq.

The resistance to flow caused by the body of the separator and corresponding total pressure drop through the separator has been found experimentally to be quite low and for most purposes may be neglected. Referring to the pressure in the acoustical separator by the term  $p_2$  and the pressure in the inlet pipe, as at 23 (Fig. 3) by the term  $p_1$  the cross-sectional area of the inlet 25 which will establish acoustic velocity at the inlet at a specified mass flow rate may be calculated. In order to cause the linear velocity of the vapor to reach acoustic at the inlet 25 of the separator the value of  $p_2$  (pressure at the inlet point 25) must be equal to  $p_c$  (representing the critical pressure and corresponding to the maximum mass discharge rate for a pipe of constant cross-section). Where the mass flow rate of the vapor is increased while the cross-sectional area at the inlet point 25 is held constant, the linear velocity of the vapor at that point will remain constant at the velocity of sound,  $p_2$  will remain equal to  $p_c$  but will also rise while  $p_3$  and all pressures downstream of this point will be relatively unaffected since the size of the equipment and capacity for handling the vapor from the acoustical separator as described will be much larger than that upstream of the separator, and the pressure drop will be low. If on the other hand the mass flow rate is reduced below the value required to produce acoustic velocity at a particular size inlet as calculated then, of course, the linear velocity will fall below the acoustic value.

The acoustic velocity of a vapor mass for adiabatic flow can be expressed by the following equation as set out by Lapple in the publication supra.

$$C^2 = kg_c p_c v_c \quad (1)$$

which for an ideal gas can be expressed as

$$C^2 = kg_c \frac{RT}{M_w} \quad (2)$$

where

$C$ =acoustic velocity, ft./sec.

$k$ =ratio of specific heats, dimensionless= $c_p/c_v$

$g_c$ =conversion factor  $32.17 \frac{\text{lb. mass. ft.}}{\text{lb. force, sec.}^2}$

$p$ =absolute pressure of fluid, lb. force/sq. ft.

$v$ =specific volume of fluid, cu. ft./lbs. mass

$R$ =gas constant per mole or 1546 ft. lb. force/lb. mole., °F.

$T$ =absolute temperature of fluid, °F. absolute=°Rankine

$M_w$ =molecular weight of fluid, lb. mass/lb. mole;

subscript  $c$ =conditions at end of pipe corresponding to conditions of maximum mass flow.

For gases at very low pressures, the ideal gas law holds quite well so that the acoustic velocity ( $C$ ) can be determined. The ratio of specific heats ( $k$ ) is low for fatty acids and if the flow is isothermal this term drops out regardless of its value. To illustrate the order of magnitude of the acoustic velocity for say tallow fatty acids (taking the average molecular weight for the fatty acids as equal to 274), and wherein conditions for Equation 2 are assumed, then ( $C$ ) the acoustic velocity may be calculated as follows:

where

$$C^2 = kg_c \frac{RT}{M_w}$$

assuming

$$k=1$$

and

$$t=250^\circ \text{ C. (482}^\circ \text{ F.)}$$

$$T=942^\circ \text{ Rankine}$$

$$M_w=274$$

Then

$$C^2 = (32.17) \times \frac{1546 \times 942}{274} = 170,986$$

$$C = 413.5 \text{ ft./sec.}$$

In operating the distillation system as herein illustrated and described, the crude fatty acid material is fed to the vaporizer at such a rate as to produce a light-colored fatty acid distillate. The feed rate, however, must not be so low that acoustic velocity at the separator cannot be produced in accordance with the invention. Further, where two or more centrifugal separators are employed it is preferable to make one in the series, and preferably the last one, operate at acoustic velocity at its inlet, however, if desired more than one of the separators may be designed to operate at acoustic inlet velocities.

The following table shows the results of a number of distillation runs made using Twitchell split #4 tallow fatty acids (having a color of about 14 red and 100 yellow as measured on a 1/4 inch Lovibond scale), and using a system such as illustrated in Fig. 1, the separator having two-inch diameter inlet and a six-inch diameter outlet, which outlet was approximately equal to the inner diameter of the separator, the central drum having a diameter of two inches and a length of approximately seven inches. The system was operated under a vacuum of approximately 30 mm. Hg absolute pressure at the vaporizer outlet:

Table I

| Run No. | Feed Rate lb./hr. | Velocity at inlet to separator | Velocity at outlet of separator ft./sec. | Color of fatty acid distillate 5/16" Lovibond Cell |
|---------|-------------------|--------------------------------|------------------------------------------|----------------------------------------------------|
| 1-----  | 76                | Acoustic--                     | 91                                       | 4.9R-35Y                                           |
| 2-----  | 100               | ...do....                      | 115                                      | 5.0R-35Y                                           |
| 3-----  | 141               | ...do....                      | 158                                      | 4.0R-25Y                                           |

In the above table the velocity values were calculated from measured pressures and the acoustic velocity thus found was on the order of 400 to 450 ft./sec. Where the velocity of the vapor at the inlet to the separator was decreased so that it fell substantially below the acoustic value it was observed that the color of the distillate became too dark to evaluate on 5/16" Lovi-

bond cell indicating the efficiency of entrainment removal was lowered.

Similar runs (4 to 11) were made with #4 tallow split fatty acids using two centrifugal separators connected in series as in the system illustrated in Fig. 2. In runs 4 through 7 the separators employed were of the same capacity as the acoustically operating separator used in carrying out runs 1 to 3 except that in this instance the inlet and outlet of the separators were of equal cross-sectional area, each having a diameter of two inches. In runs 8 through 11, however, the second separator was modified by increasing the diameter of the outlet from two inches to six inches while retaining the diameter of the inlet at two inches so that acoustic velocity would be attained at the inlet to the second separator. Accordingly, in runs 4 through 7 the velocity of the vapor at the inlet to the separator was below acoustic, whereas in the case of runs 8 through 11 the velocity of the vapor was made to reach the acoustic value at the inlet to the second separator. The results obtained are shown in the following table:

Table II

| Run No. | Feed Rate lb./hr. | Velocity of Vapor at Separators |                   |                    | Color of distillate 5 1/4" Lovibond Cell |
|---------|-------------------|---------------------------------|-------------------|--------------------|------------------------------------------|
|         |                   | Inlet #1 ft./sec.               | Inlet #2 ft./sec. | Outlet #2 ft./sec. |                                          |
| 4       | 59                | 97                              | 169               | 336                | 13R-70Y.                                 |
| 5       | 141               | 112                             | 176               | 389                | Too dark to read.                        |
| 6       | 105               | 106                             | 178               | 410                | Do.                                      |
| 7       | 72                | 113                             | 182               | 294                | 17R-70Y.                                 |
| 8       | 73                | 164                             | acoustic          | 63                 | 3.0R-30Y.                                |
| 9       | 104               | 166                             | do                | 48                 | 3.2R-30Y.                                |
| 10      | 140               | 156                             | do                | 111                | 2.9R-29Y.                                |
| 11      | 143               | 172                             | do                | 103                | 3.3R-35Y.                                |

As will be observed from the data of Table II the most efficient separation was effected utilizing the centrifugal separating system wherein critical or acoustic velocities of the fatty acid vapor were attained at the inlet to the second separator.

It has further been observed that operating the system so that the fatty acid vapor reaches acoustic velocity at the inlet to the centrifugal separator the system is relatively insensitive to changes in feed rate. For example, no appreciable variation in the efficiency of entrainment removal, as shown by the change in color of the distillate, is observed as the result of varying the feed rate over a range of about 75 to 200 lbs./hr. Sensitivity to changes in feed rate has been one of the disadvantages encountered heretofore in distillation systems.

In the foregoing runs Twitchell split tallow (#4 grade) acids were used since variations in the amount of entrainment present gave a much more noticeable change in the color of the resultant distillate. Similar runs made using a commercially distilled grade of red oil gave a distillate of lighter color and indicated that the improved results of the invention may be obtained with different substances when the vapors are treated as described. The acoustical separator of the invention may be used with different vaporizers, stills or the like and in systems operating under different pressure and temperature conditions. A distillation apparatus, such as for example disclosed in the patent to Ittner 2,202,007, may be used if desired instead of the vaporizer herein illustrated and described.

Centrifugal force, of course, has long been employed to separate substances of different densities, and more recently multiple stage centrifugal separator units have been proposed for use in purifying petroleum vapor fractions. In so far as known, however, no one heretofore has devised a distillation system wherein the vapor is purified by a method in accordance with this invention which comprises (a) increasing the velocity of the vapor until it reaches acoustic velocity then (b) subjecting it to centrifugal action to cause substantially complete separation of entrained material.

Although it is preferred to employ in the distillation system one or more up-flow cyclone type separators having a central drum or column with a vapor discharge outlet arranged at the top of the separator, the distillation system may be operated using down-flow centrifugal type separators when arranged and operated so that the acoustic velocity of the vapors is attained at the separator inlet.

While a particular distillation system and separator means has been shown and described, it will be understood that the process of the invention is not to be restricted to any one structure but that other apparatus within the scope of the disclosure and claims may be employed in practicing the invention. It will also be understood that the process is capable of being carried out with suitable modifications, for example with or without preheating of the feed stock to the still. Further, the process may be carried out under varying temperature and pressure conditions, and utilizing different types of vaporizers, condenser and auxiliary equipment as heretofore pointed out.

What is claimed is:

1. In the distillation of high boiling liquids under vacuum without substantial chemical change, a process comprising the steps of (a) vaporizing under vacuum said liquid, (b) moving the vaporized mass under vacuum at a velocity substantially equal to the acoustic velocity, and (c) subjecting said acoustic velocity vapor to centrifugal action while maintaining said vapor under vacuum to cause separation of entrained material.

2. In the distillation of higher fatty acids without substantial decomposition, a process which comprises the steps of distilling the fatty acid material under reduced pressure, passing the resulting vapor into a zone wherein said vapor under reduced pressure is caused to attain substantially acoustic velocity, and subjecting said acoustic velocity vapor to a centrifugal purifying action while maintaining said fatty acid vapor under reduced pressure to cause the separation of entrainment from the vapor stream.

3. In the distillation of high boiling liquid without substantial chemical change, a process which comprises the steps of volatilizing the liquid under reduced pressure, passing the resulting vapor into a zone wherein said vapor under reduced pressure is caused to attain substantially acoustic velocity, thereafter subjecting the high velocity vapor to a centrifugal purifying action while maintaining said vapor under reduced pressure wherein said vapor moves along while twisting spirally about a central axis, and discharging the purified vapor along said axis without change in the direction of flow.

4. In the process of producing light colored fatty acids which comprises distilling said fatty acids and subjecting the vapors to a centrifugal purifying action to bring about the separation

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of reentrainment therefrom, the improvement which consists in causing said vapors while under reduced pressure to reach substantially acoustic velocity just prior to subjection of the vapors to said centrifugal purifying action while maintaining said fatty acids in the vapor state under reduced pressure.

5 5. The process of distilling fatty material which comprises heating the same under low absolute pressure to volatilize a major portion of said fatty material, moving said volatilized mass of fatty vapor under low absolute pressure at acoustic velocity, and thereafter subjecting said vapor to a centrifugal purifying action while maintaining said vapor under low absolute pressure whereby said vapor is substantially freed of unvolatilized matter entrained therein.

6. A process of treating a vapor stream of fatty material carrying entrained liquid particles to purify said vapor comprising moving the vapor under reduced pressure at a velocity substantially equal to the acoustic value, and after said vapor is moving at acoustic velocity subjecting the same to a centrifugal purifying action while maintaining said vapor under reduced pressure to cause said entrained liquid particles to separate from the vapor stream.

EDWARD A. LAWRENCE.

## 12

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