United States Patent [19]

Hindman

[11] **3,923,644**

[45] **Dec. 2, 1975**

[54] **PROCESS AND APPARATUS FOR RE-REFINING USED PETROLEUM PRODUCTS**

[75] Inventor: **George J. Hindman,** Pottstown, Pa.

[73] Assignee: **Petrocon Corporation,** Valley Forge, Pa.

[22] Filed: **Oct. 11, 1974**

[21] Appl. No.: **514,176**

[52] **U.S. Cl.** **208/186;** 208/179; 208/184; 196/46.1; 159/2; 208/187; 210/184

[51] **Int. Cl.²** **C10M 34/00;** C10G 33/00; C10C 1/20

[58] **Field of Search** 208/179, 182, 184, 186, 208/187

[56] **References Cited**

UNITED STATES PATENTS

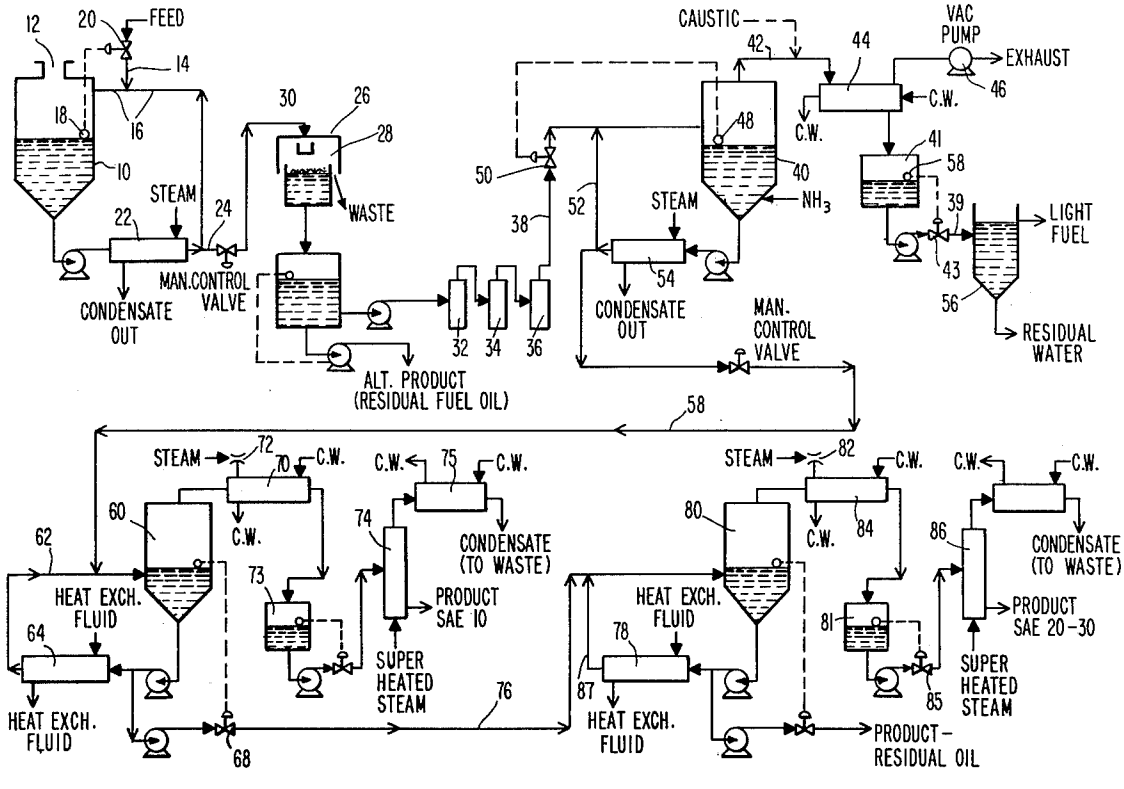
2,799,628	7/1957	Barr et al	208/179
3,173,859	3/1965	Chambers	208/184
3,198,241	8/1965	Baird	23/276
3,304,255	2/1967	Katsuta et al.	208/179
3,489,676	1/1970	Hu et al.	208/179
3,625,881	12/1972	Chambers	208/179
3,791,965	2/1974	Fitzsimons et al.	208/179

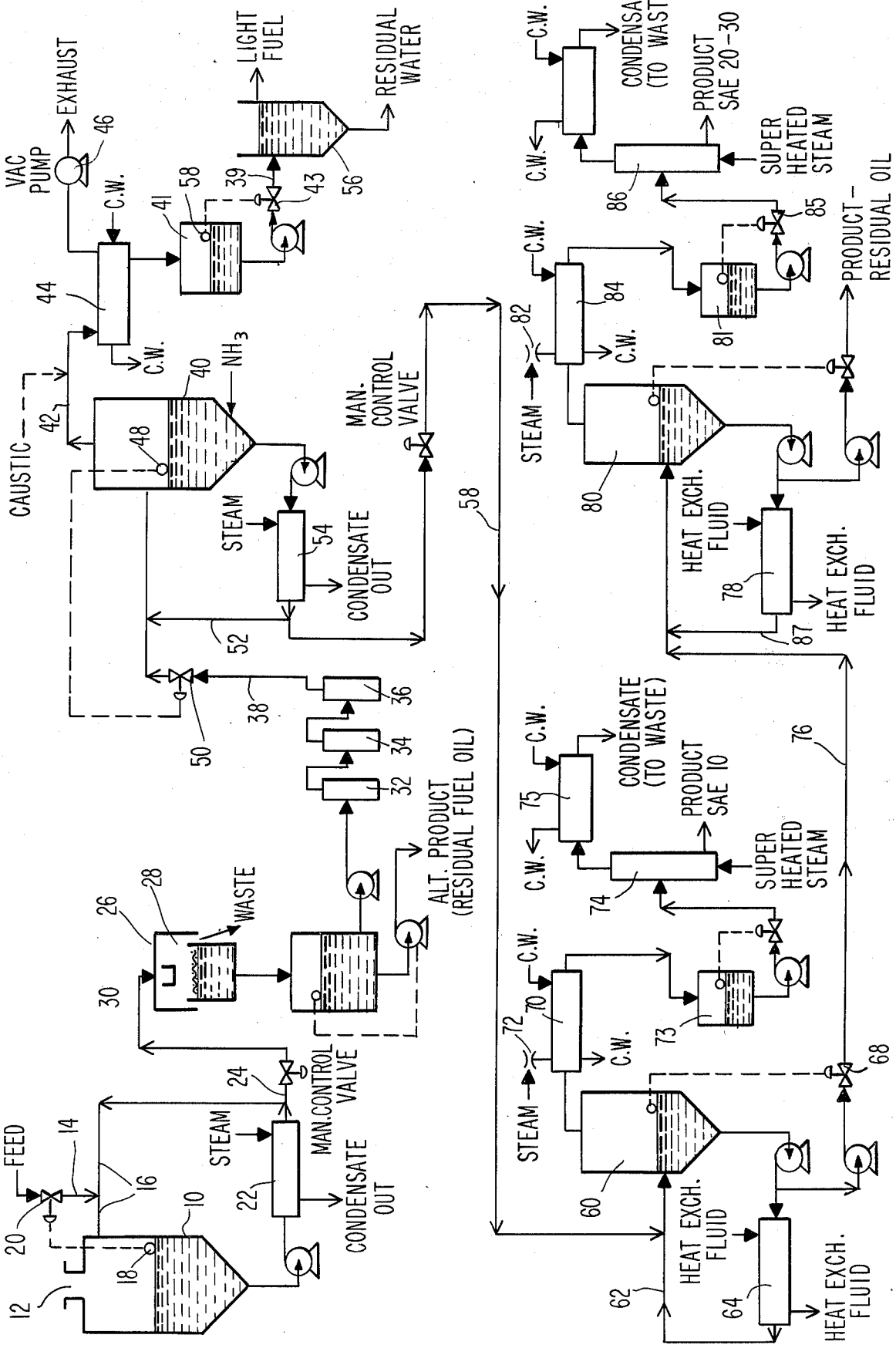
Primary Examiner—Delbert E. Gantz
Assistant Examiner—Juanita M. Nelson
Attorney, Agent, or Firm—Miller, Frailey & Prestia

[57] **ABSTRACT**

Used petroleum products, such as crankcase oils, are reclaimed by an initial treatment step consisting of flash vaporization with continuous recirculation of a substantial portion of the unvaporized liquid. At atmospheric pressure and 210°–240° F, water comprises substantially all of the overhead product and this may be vented to the atmosphere. The unvaporized liquid product is mechanically filtered through a vibratory filter and then successive cannister filters to produce a product which may be used as a fuel oil or further refined into various fuel and/or lubricant products in successive flash distillation stages. In the preferred embodiment, three such stages are operated, respectively, at 300°–400° F and 24–28 inches mercury, 600°–650° F, and 7 torr, and 630°–680° F and 1½–3 torr.

7 Claims, 1 Drawing Figure




FEED
STEAM
CONDENSATE OUT
MAN.CONTROL VALVE
WASTE
ALT. PRODUCT (RESIDUAL FUEL OIL)
CAUSTIC
NH_3
STEAM
CONDENSATE OUT
MAN. CONTROL VALVE
VAC PUMP
EXHAUST
C.W.
LIGHT FUEL
RESIDUAL WATER
HEAT EXCH. FLUID
HEAT EXCH. FLUID
STEAM
C.W.
CONDENSATE (TO WASTE)
PRODUCT SAE 10
SUPER HEATED STEAM
HEAT EXCH. FLUID
HEAT EXCH. FLUID
STEAM
C.W.
CONDENSATE (TO WASTE)
PRODUCT SAE 20-30
SUPER HEATED STEAM
PRODUCT-RESIDUAL OIL

PROCESS AND APPARATUS FOR RE-REFINING USED PETROLEUM PRODUCTS

This invention pertains to an improved process and apparatus for re-refining used oils through a sequential flash evaporation process. More specifically, it relates to improved process and apparatus wherein saleable products are obtainable at any one of various stages including a very early stage, whereby useful product may be reclaimed from used oils with a minimum of apparatus and treatment.

Heretofore, a variety of processes and apparatus have been suggested for re-refining crankcase oil and other types of used petroleum products. One disadvantage of many of these processes is their reliance on complex fractionation columns as a means of separating various components in the used petroleum products. Impurities in these products, typically including solid carbon particles, tarry solids and oxidation products of both petroleum components and additives, tend to collect and to interfere in the complex plumbing associated with a multi-stage distillation column.

Thus, as an improvement on the crankcase oil refining process disclosed in U.S. Pat. No. **3,173,859** to Chambers, one notes the flash vaporization pretreatment for that process disclosed in U.S. Pat. No. **3,625,881** to Chambers.

Similarly, in the re-refining process of U.S. Pat. No. **3,791,965** to FitzSimons et al. (of common assignment herewith) a complex evaporator used in the initial treatment of the used petroleum products was found to interfere with process efficiency, due to fouling and coking, as solid and semi-solid impurities in used oil built up on the various mechanical components in the device referred to in that patent as the "stripper."

Having in mind these problems, it is the general objective of the present invention to provide an improved process and apparatus for refining used petroleum products.

A more specific object of this invention is to provide a sequential flash evaporation process and apparatus which is efficient, dependable and flexible in its mode of operation.

Still another object of this invention is to provide a relatively simple apparatus and process for reclaiming lower grade, though saleable, petroleum products, from used petroleum products, such as crankcase oil, with a minimum of apparatus and treatment.

These and other objects, which will be apparent in the course of the subsequent description, are met, briefly, by a process and apparatus wherein a used oil feed stream is flash vaporized at atmospheric pressure and **210°** – 240° F; fine solids are then mechanically separated from the unvaporized bottom stream to produce a saleable fuel oil. In the preferred embodiments of this invention, this residual fuel oil is further refined in a second flash evaporator operated at **300°–400°** F, and **24–28** inches mercury. The overhead from this second flash evaporator is condensed and decanted to remove residual water, the product being a kerosene-like fuel. The bottom liquid from the second flash evaporator may be passed on successively to third and fourth flash evaporators operated, respectively, at **600°–650°** F and **7** torr, and at **630°** – 680° F and **1½** – 3 torr.

The mechanical filtration associated with the liquid bottom product from the first flash evaporation stage consists primarily of a vibratory filter with a horizontal

screen having openings on the order of **40–45** microns from which waste material is removed at the edges. The filter product proceeds through the screen to successive cartridge filters having a final filtration range (i.e., filter element capable of removing) of **3** microns in size.

Preferably also, one or more, and most preferably all, of the flash evaporators are operated by continuously heating and recirculating unvaporized bottom liquid from a specific evaporator to the vapor space above a liquid level in the same evaporator. At the same time, feed to the respective flash evaporator is added to the recycled liquid as it is introduced, almost simultaneously with this mixing, into the evaporator (in a manner similar to that disclosed in U.S. Pat. No, **2,799,628**).

This invention may be better understood by reference to the claims appended hereto and the following detailed description, taken in conjunction with the accompanying FIGURE, which is a schematic view of the process and apparatus of the preferred embodiment of the present invention.

Referring more specifically to the FIGURE, there is shown first flash evaporator **10,** including atmospheric vent **12.** A feed stream of used petroleum products (such as crank-case oil) introduced through feed line **14,** is combined with recycled liquid from evaporator **10,** near the terminus of recycle line **16.** A predetermined liquid level in flash evaporator **10** is maintained by liquid level controller **18** operating valve **20** in feed stream line **14.** A temperature on the order of **210°–240°F** is maintained in flash evaporator **10** by heating the recycled liquid from the bottom of flash evaporator **10** in heat exchanger **22,** wherein the heating medium is preferably steam at a pressure of **100–150** lbs./sq.in.

Product draw-off line **24** passes a portion of the unvaporized liquid in flash evaporator **10** to a mechanical filtration system comprising, in the preferred embodiment of this invention, a vibratory filter **26** having a horizontally vibrating screen filter element **28,** with screen openings less than **100** microns and preferably on the order of **40** to **45** microns, and a feed dispersing member **30** located above filter element **28.** Waste sludge containing heavy particle contaminants and insolubles is removed at the periphery of vibrating screen element **28** while the filtrate passes through to the bottom of filter **26** and to a surge tank, from which a product saleable as a residual fuel may be withdrawn. Alternatively, this liquid may be forwarded for future processing to a sequence of pairs **32, 34** and **36** of cartridge filters of successively smaller pore size in the filter elements. Preferably, these cannister filters house filter elements ranging progressively from **25** microns to **15** microns to **3** microns in maximum pore size.

The initial removal of water at relatively low temperature and the subsequent filtration comprises a practical process which may be operated for extended periods of time without equipment fouling and relatively low energy consumption to produce a useful product. Similarly, a still more refined (and valuable) product is produced in the final filter train. This product may be sold, for example, as a cutting oil or as a quench oil.

With respect to the operation of this apparatus, it should be noted that the used oil feed stream may comprise from **0** to **40** percent water; this more typically lies in the range of **1** – 15 percent. In any event, this sys-

tem is designed for a relatively low proportion of that feed stream to be combined with the recycled liquid entering flash evaporator **10** in order to maintain a relatively constant temperature there and thereby to operate flash evaporator **10** with a high degree of efficiency. The proportion of this mixture will therefore change depending on water content of the feed stream in order that the heat contributed by heat exchanger **22** will balance the heat loss through evaporation of water in flash evaporator **10.**

Another important factor in maintaining the equilibrium in flash evaporator **10** is the mixing of the feed stream and recycle liquid just as these materials are introduced into the flash evaporator in the vapor space above the liquid level therein.

Vapors leaving flash evaporator **10** through atmospheric vent **12** are predominantly water, and may ordinarily be released to the atmosphere. This is a further advantage of the simple reclamation technique described to this point. However, in some situations, it may be necessary or desirable to collect the vapors exiting vent **12** and perhaps to remove or to recover residual non-aqueous contaminants in the vapors.

While an apparatus and process as described, consisting of a single flash evaporator, associated heat exchanger and a mechanical filter or filter train, provides a practical and economical approach to the re-refining of used petroleum products, such as crankcase oil, this apparatus and process is combined, in the preferred embodiments of the present invention, with one or more subsequent flash evaporation stages. Each of these additional stages further upgrades the filtered atmospheric pressure flash evaporated filtrate stream described above.

Thus, the filtrate stream from cartridge filters **32, 34** and **36** passes through filtrate line **38** to a second flash evaporator **40.** Evaporator **40** is similar to flash evaporator **10,** both in design and operation, but differs in design operating conditions and in the absence of an atmospheric vent.

More specifically, flash evaporator **40** includes overhead removal line **42** through which collected vapors from evaporator **40** are passed to condenser **44.** In condenser **44,** a cooling medium, such as cold water, cools the vapors and causes them to condense. Vacuum pump **46,** in communication with the vapor space in condenser **44,** maintains a pressure of about **24–28** (preferably about **26**) inches mercury in evaporator **40.** Liquid level controller **48** associated with valve **50** on filtrate line **38** holds the liquid level in evaporator **40** at a predetermined point, maintaining a vapor space of some vertical height in evaporator **40.** Into this vapor space is introduced the combined filtrate stream from line **38** and, in a much larger proportion, heated recycled liquid from the bottom of flash evaporator **40.** Recycle line **52** carries heated recycle liquid after its passage through a heat exchanger **54** wherein steam at **130–150** psi (preferably **150** psi) provides the necessary heat input to maintain a temperature level in the second flash evaporator **40** on the order of **300°–400°F,** and preferably about **350°** F. To prevent excess acidity (and possible corrosion) anhydrous ammonia may be injected into the liquid phase in evaporator **40.**

Condensate from overhead condenser **44** is collected in an accumulator **58** and then pumped to decanter **56** through line **39.** The liquid level is determined by level control **41** controlling a valve **43** in line **39.** A small amount of residual water is removed from decanter **56.** The pH of this residual water is controlled at or near **7.5** by the addition of caustic soda to the vapors in line **42.** The remaining product stream may be sold or used inplant as a fuel. The volatility of this product stream is generally comparable to that of kerosene. The bottom liquid drawoff not recycled to evaporator **40** may also be sold as a fuel oil product, but preferably it is further upgraded by passage to subsequent flash evaporation stages.

More specifically, bottom liquid draw-off product passes through line **58** to a third flash evaporator **60** where it is introduced into the vapor space, along with recycled and heated liquid from recycle line **62** and heat exchanger **64,** (wherein a hot heat exchange liquid, such as "Dowtherm" liquid, a commercial product of the Dow Chemical Co., is the heating media), which provides the heat input to evaporator **60.** Again, as in the previous evaporator stages, recycle liquid in line **62** is combined with stage feed in line **58** just prior to release in the vapor space of evaporator **60.** The liquid is maintained at a predetermined level in evaporator **60** by liquid level controller **66** associated with a stage output valve **68.** Overhead vapors are collected and condensed in a cooler **70,** usually with cold water as the cooling fluid, to which a steam aspirator **72** is connected to maintain the pressure in evaporator **60** at **6–8** torr, preferably about **7** torr. The recycled liquid drawoff is heated in heat exchanger **64** to a temperature in the range of **600°–650°F** (preferably **625°F**) to maintain a temperature in evaporator **60** on that order.

Condensate product from cooler **70** after passing through accumulator **73** is steam stripped in stripper **74,** the overhead vapors of which are condensed in cold water cooler **75.** The bottom product of steam stripper **74** is a lube oil within the range of SAE **10.** The bottom liquid draw-off of evaporator **60** may also be used or sold as fuel oil (with volatility characteristics comparable to to that of Number **5** or **6** fuel oil). However, it is preferably fed through line **76** to fourth flash evaporator **80.** A cold water condenser **84** receives and condenses the overhead product from evaporator **80** and passes the condensate through accumulator **81** to steam stripper **86.** The product of stripper **86** is a lubricant within the viscosity range of SAE **20** or **30** oil. Steam aspirator **82** in connection with the vapor side of condenser **84** maintains the pressure in evaporator **80** at about **1½ – 3** torr. Liquid level controller **83** in accumulator **81** controls valve **85** to draw-off condensate from accumulator **81** to steam stripper **86.** Unvaporized liquid from evaporator **80** is drawn off and may be sold as a high boiling point residual oil product or for other purposes where a heavy petroleum fraction is required. A substantial proportion of the liquid drawn off from evaporator **80** is recycled through recycle line **87** to evaporator **80,** after passing through Dowtherm-heated heat exchanger **78.** In heat exchanger **78,** the liquid is heated to **630°–680°F** to maintain a temperature in that range, and preferably about **650°F,** in evaporator **80.**

While this invention has been described with respect to its essential components, it should be understood that some variation and modification of these components may be made by those skilled in the art without departing from the scope of the invention.

As indicated throughout the description, many of the intermediate streams in the preferred embodiment of

this invention may be withdrawn in whole or in part as product streams. In particular, the filtered product stream from the first flash evaporation stage is, it should again be noted, a useful saleable product. A feasible used oil refining process and apparatus may therefore encompass the first flash evaporation stage and subsequent filter alone.

It should be further noted that some preliminary filtration of the feed stream introduced in flash evaporator **10** may be desirable, and in some cases necessary, depending on the degree of contamination in the used oil supply. Similarly, any one or more of the products of this invention may be further refined and treated, such as by clay percolation to pick up color bodies.

I claim:

1. In a process of refining a used hydrocarbon oil wherein a used oil is distilled and filtered for re-use, the improvement comprising flash vaporizing said used oil in an evaporator in which the internal conditions are maintained at atmospheric pressure and **210°–240°** F, and continuously separating a vaporized portion from an unvaporized liquid portion and continuously removing said unvaporized liquid portion from the bottom of said evaporator, and then mechanically filtering at least a portion of the unvaporized liquid removed from said evaporator.

2. A process for re-refining a used hydrocarbon oil, as recited in claim **1,** wherein at least a portion of unvaporized liquid removed from the bottom of said evaporator is passed at relatively low pressure through a vibratory filter having a horizontally disposed screen filter element having openings on the order of **40–45** microns.

3. A process of re-refining a used hydrocarbon oil, as recited in claim **2,** wherein the filtrate from said vibratory filter is further filtered to remove remaining particles having a maximum dimension larger than **3** microns.

4. A process of re-refining a used hydrocarbon oil wherein said filtered liquid is subsequently flash vaporized at **24–28** inches Hg and **300°–400°** F.

5. The process, as recited in claim **4,** wherein the overhead vapor stream from said subsequent flash vaporization is condensed and water therein is separated by gravity separation.

6. The process, as recited in claim **5,** wherein unvaporized liquid removed from said subsequent evaporator is heated to **600°–680°** F and successively flash evaporated at **7** torr and **1½** – 3 torr, the vaporized overhead streams from said **7** and **1½** – 3 torr evaporation steps being condensed and steam stripped.

7. The process, as recited in claim **1,** wherein the fresh feed stream of said used oil is mixed with a substantially larger quantity of recycled, heated, unvaporized liquid removed from the bottom of said flash evaporator, said mixing taking place as said fresh feed stream is introduced into the vessel where said **210°–240°F,** atmospheric pressure flash evaporation occurs.

* * * * *