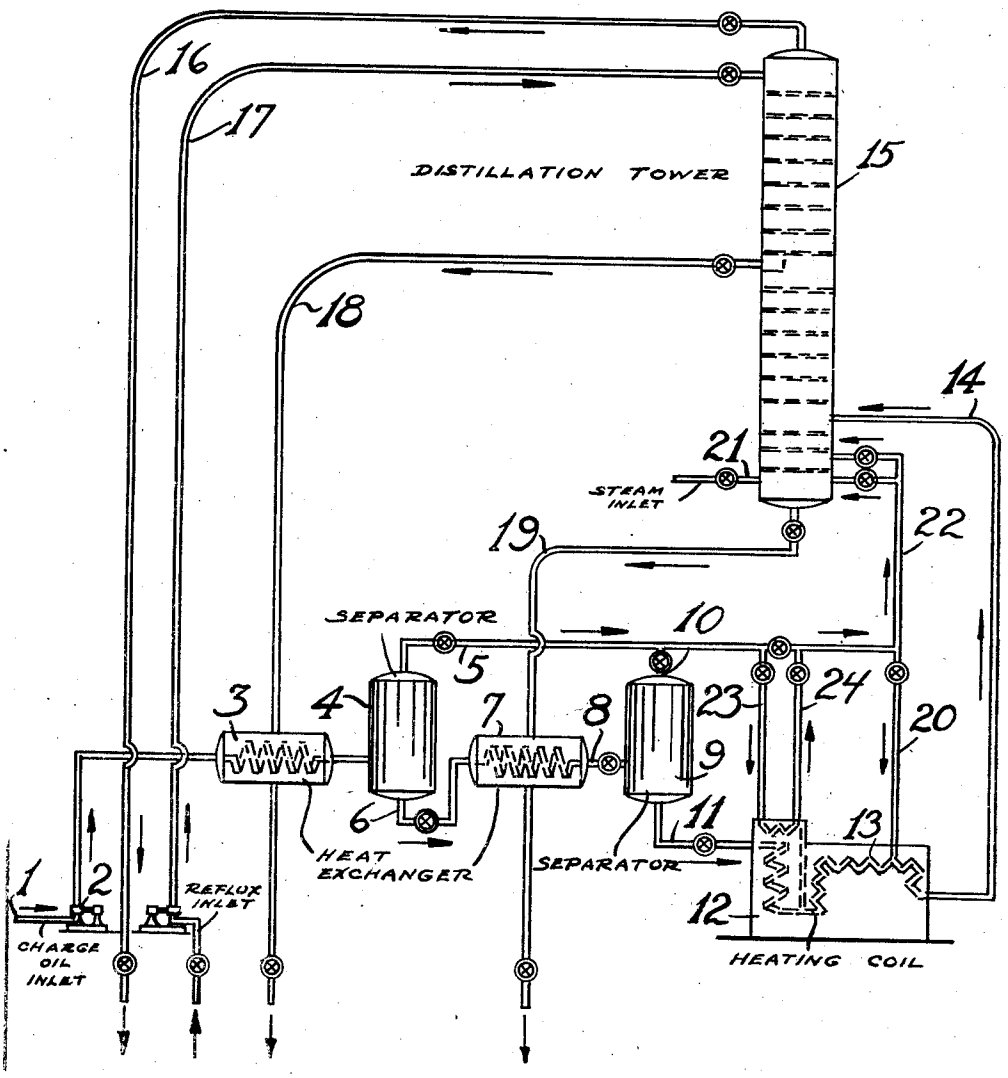
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DISTILLATION PROCESS

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DISTILLATION PROCESS

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The present invention relates to an improved distillation process. The invention especially relates to a distillation process in which vapors in the heating system are separated from the liquid and in which heating is continued on the separated products. Separated vapors are then reintroduced into subsequent stages of the liquid heating circuit so that the desired vaporization is secured at an optimum minimum temperature. The heated products are then withdrawn from the liquid heating circuit and introduced into a distillation tower.

It is well known in the art to separate petroleum oils into different boiling fractions and into their respective constituents by various distillation operations. It is also known in the art to change the principal characteristics of various petroleum fractions by subjecting said fractions to so-called cracking operations. In these operations, the petroleum oil is gradually raised to a predetermined temperature, usually in a series of heating stages. As the temperature is gradually raised, vapors are evolved which are usually conducted through the entire heating system in the presence of unvaporized materials. The vapors thus formed result in higher linear velocities with attendant undesirable high pressure drops or necessitate the use of unduly large and expensive equipment. Furthermore, high pressure drops cannot be readily circumvented by decreasing the velocities since detrimental coke formations increase considerably with lower mass velocities. Various modifications of distillation processes have been suggested in order to overcome these difficulties and to secure a more efficient and economic process. For example, it is known to remove vaporized water from an intermediate point in the heating circuit. It is also known to remove fixed gas as well as lower boiling products from an intermediate point in the heating circuit and to introduce the separated products into a distillation tower. This latter process has not been entirely satisfactory for various reasons. For example, the separated vapors are relatively cool as compared to the products removed from the final stages of the heating circuit which has a detrimental effect on the efficiency of the distillation step. Furthermore, by removing the relatively lower boiling products it will be necessary to raise the remaining liquid products to a considerably higher temperature in order to secure the desired vaporization in the final stages of the heating circuit. This is undesirable since the tendency of the oil to deteriorate, crack, and form deleterious carbon deposits is greatly enhanced by the relatively higher temperatures made necessary by the removal of the vaporous products. I have now discovered a process by which it is possible to use optimum equipment design in a distillation process without undue pressure drops and simultaneously secure in the final heating stages the desired vaporization of the oil at a minimum optimum temperature.

In accordance with the process of my invention vaporized materials are removed from the unvaporized materials at an intermediate stage or stages and are recombined with the unvaporized materials in the latter stages of the liquid heating system. This eliminates the relatively high pressure drops heretofore secured in distillation operations, secures the desired vaporization of the liquid product at a minimum optimum temperature and results in additional desirable benefits. The process of my invention may be readily understood by reference to the attached drawing illustrating one modification of the same.

For the purpose of illustration, it is assumed that the food oil is a petroleum oil which vaporizes over a relatively wide temperature range. The charge oil is introduced into the system by means of feed line 1 and charge pump 2. The oil, after leaving charge pump 2, is passed through heating unit 3 which, for the purposes of illustration, is shown as a side stream to feed, liquid to liquid, heat exchanger. The heated oil product is then passed into separator 4 in which vaporized products are removed overhead by means of line 5. The unvaporized products are removed from separator 4 by means of line 6 and introduced into heating unit 7 which for the purpose of illustration is likewise assumed to be a bottoms to feed, liquid to liquid, heat exchanger. It is to be understood that other heating means, as for example, steam coils or the like may be substituted for or used in combination with the heat exchanging units illustrated. The heated product is withdrawn from heating unit 7 by means of line 8 and introduced into separator 9. The vaporized products are removed from separator 9 by means of line 10 while the unvaporized products are removed from separator 9 by means of line 11. The unvaporized products are then introduced into heating coil 13 in which the temperature is raised to the desired degree in order to secure the desired vaporization of the residue removed from the separator 9. It is to be understood that every effort is made to secure the desired vaporization of the oil at a minimum tem-

perature. Prior to withdrawal of the products from heating coil 13 vapors removed from separators 4 and 9 are reintroduced into the residual stream by means of line 20. The separated vapors are preferably preheated in heating unit 12 by passing the same through lines 23 and 24. It is to be understood that equivalent heating means may be employed. These vapors serve to vaporize the relatively higher boiling constituents of the residual stream at a minimum temperature, thus substantially reducing coke formations and the like. At the same time a positive temperature control may readily be secured on the oil leaving the final stages of the heating circuit. This will greatly facilitate the handling of the products in the distillation tower and will result in higher quality products and a more efficient operation. The feed oil is withdrawn from heating unit 12 by means of line 14 and introduced into distillation tower 15. A light product is removed overhead from tower 15 by means of line 16 and reflux introduced into tower 15 by means of line 17. An intermediate product is withdrawn from tower 15 by means of line 18 and a bottom product withdrawn by means of line 19. Although it is preferred to introduce the entire quantity of the separated vapors into the latter stages of the liquid heating system, it may be desirable under certain conditions to introduce a portion of the vapors removed from separators 4 and 9 into tower 15 by means of line 22. The separated vapors are preferably superheated so that their temperature increases to the temperature of the residual stream at the point at which the vapors are reintroduced into said stream. However, under certain operating conditions, vapors may be bypassed around the vapor heating circuit and introduced directly without superheating into the residual stream.

The process of the present invention may be widely varied. The process may be applied in the distillation of any feed oil which vaporizes over a relatively wide temperature range at a given pressure or which contains a foreign material which vaporizes at a relatively low temperature as compared to the rest of the material. The invention is particularly applicable in distillation operations in which it is desirable to avoid large pressure drops through the heating system and in which a uniform pressure drop is desired through the heating system and into the distillation tower. Thus, the preferred adaptation of the present invention comprises a charging pump prior to the heating system and a uniform pressure drop of both the liquid and the vapors from the feed pump through the system up to the distillation tower.

The temperatures and pressures employed on any particular system will depend upon the particular feed oil being used, the products desired, and upon the specific and latent heat of the products being vaporized. In general, the process is applicable in the treatment of stocks in which it is necessary to raise the temperature in the range from 600° F. to 800° F. in order to secure the desired vaporization of the products and in the treatment of stocks having a tendency to form excessive coke deposits. The process is particularly applicable in crude distillation operations, especially in the distilling of crudes containing considerable amounts of relatively lower boiling hydrocarbons. In these operations, the crude is passed through an initial heating stage comprising usually from 2 to 6 heat exchangers in series. In the initial stage, the temperature of the crude is usually raised to about 300° F. to 500° F. Separators may be placed between each heat exchanger, although satisfactory operations are secured by placing one separator after the entire series of heat exchangers. After removal of the vaporized constituents from the liquid in the separator, the crude is then raised in a second heating stage comprising a heating coil to a temperature in the range from about 650° F. to 700° F. Vapors removed in the separator are preferably super-heated in a vapor heating circuit to about 600° F. to 650° F. and then reintroduced into the liquid heating circuit at the point at which the temperature of the oil is substantially 600° F. to 650° F.

The number of vapor-liquid separators used will depend upon the particular oil being treated, the characteristics of the oil with respect to coking tendencies and the like, and the temperature to which it is desired to heat the feed stock, as well as upon the maximum pressure drops allowable. In most instances, it is sufficient to employ only one separator and generally not more than two, although a larger number may be utilized in distilling petroleum oil containing hydrocarbons boiling below 500° F. and under conditions in which it is desired to introduce the petroleum oil into a distillation tower at a temperature of about 750° F. to 850° F. Satisfactory results are secured by providing one vapor liquid separator for about every 300 or 400° F. rise in temperature. Vapors are reintroduced preferably in the final heating stage in which the temperature is raised to the maximum. The excess vapors not needed to secure the desired vaporization of the remaining liquid in the final heating stage may be introduced into the bottom of the distillation tower and thus act as a stripping medium. The preferred method of operating, however, is to preheat the separated vapors and to introduce the entire quantity into the final stage of the liquid heating circuit. In accordance with the process of the present invention, it is to be noted that the preferred operation utilizes a single charging unit which is located before the first separator and that no further pumping means are employed between the separator and the distillation tower. It is also to be noted that the vapors should not be introduced into the system at a point between the final heating coil and the distillation tower since this would cause further vaporization of liquid products and would materially decrease the temperature of the products passed to the distillation tower.

An application of the present invention is in the distillation of a hydrocarbon crude oil containing water. In a normal design, the mixture would be pumped through heat exchangers and finally through a tubular heater and then to the fractionating tower. The water would be vaporized when part-way through the heating system. Due to the low specific volume of the vapors formed, they would give high linear velocities and corresponding high pressure drops. In accordance with the present invention, these water vapors, along with the relatively lower boiling hydrocarbons would be removed in a separator installed in the flow line, preferably between the last exchanger and the furnace. The vapors would be separated from the liquid in this vessel and the liquid would then flow through the furnace tubes. The separated vapors would be preheated and reintroduced into the liquid heating circuit in the manner described above. In this

operation, the pressure drops would be low, the mass velocity of the flow could be maintained at a normal value, and the partial pressure effect of the light vapors would be utilized to help vaporize the relatively heavier high boiling components at a minimum temperature by the process of reintroducing these vapors into the main flow line. If a salt were present, the precipitation of salt in the heating elements could be eliminated or reduced by maintaining pressure on the system before the separator. If the pressure is reduced at the inlet to the separator, the water vapors would be removed thus causing the deposition of the salt in the separator.

In accordance with the present process, the normal flow pressure is maintained on the separator or separators so that the liquid residue will flow through the remainder of the heating system under its sustained pressure and the vapors will flow to a latter point in the distillation system under their sustained pressure. The advantage of this process is that only one charge pump is required in the crude preheating and heating systems and that the vapors separated are under sufficient pressure to introduce them into the system at any point in the line of flow after the separator.

The process of the invention is not to be limited by any theory or mode of operation but only by the following claims in which it is desired to claim all novelty insofar as the prior art permits.

I claim:

1. Distillation process comprising the steps of heating the feed oil in stages, separating and removing vapors formed in each stage from the remaining liquid, mixing said separated and removed vapors with the liquid during heating in a subsequent heating stage prior to introducing the oil into a distillation tower, and passing the heated mixture from said last mentioned heating stage to a distillation tower.

2. Process in accordance with claim 1 in which a uniform pressure drop on both the liquid and vapor phase is maintained between the initial heating stage and the distillation tower.

3. Process in accordance with claim 1 in which said separated and removed vapors are heated to a temperature substantially the same as the temperature of the liquid into which they are introduced.

4. Distillation process comprising heating a petroleum oil boiling under a relatively wide range in several stages, separating and removing the vapors formed in each of the initial heating stages from the unvaporized liquid, then combining and mixing said vapors with the liquid during heating in the final heating stage and then introducing the oil-vapor mixture into a distillation tower.

5. Process for the distillation of crude oil comprising heating said oil in an initial stage to a temperature in the range from about 300° F. to 500° F., separating vaporized constituents from unvaporized constituents, separately heating the separated products to a temperature of about 600° F. to 800° F., recombining the separated products in a subsequent heating stage and passing the same to a distillation tower.

6. Process in accordance with claim 5 in which a uniform pressure drop is maintained between said initial heating stage and the distillation tower.

7. Distillation process comprising passing a feed oil through a heating system comprising successive heating stages and into a distillation tower, segregating vapors formed in an initial heating stage from the liquid feed oil, heating the vapors and introducing a portion thereof into the liquid feed in a subsequent heating stage prior to said distillation tower and introducing another portion of the heated vapors into said distillation tower at a point below the point of introduction of the feed oil from the final heating stage.

8. A process for removing light constituents from a relatively heavy hydrocarbon oil which comprises passing normally liquid hydrocarbons through a plurality of successive heating stages, separating vapors formed in each heating stage from unvaporized hydrocarbons, removing the unvaporized hydrocarbons from the last heating stage and passing them through a heating coil for further heating them, introducing at least a portion of the separated vapors into the latter portion of said heating coil to assist in vaporizing heavy hydrocarbons therein and then passing the heated mixture from said heating coil to a distillation tower.

9. A method according to claim 8 wherein another portion of the separated vapors is heated and introduced into the bottom portion of said distillation tower as a stripping medium below the point of introduction of the heated mixture.

10. A method according to claim 8 wherein the separated vapors are heated before being introduced into said heating coil.

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