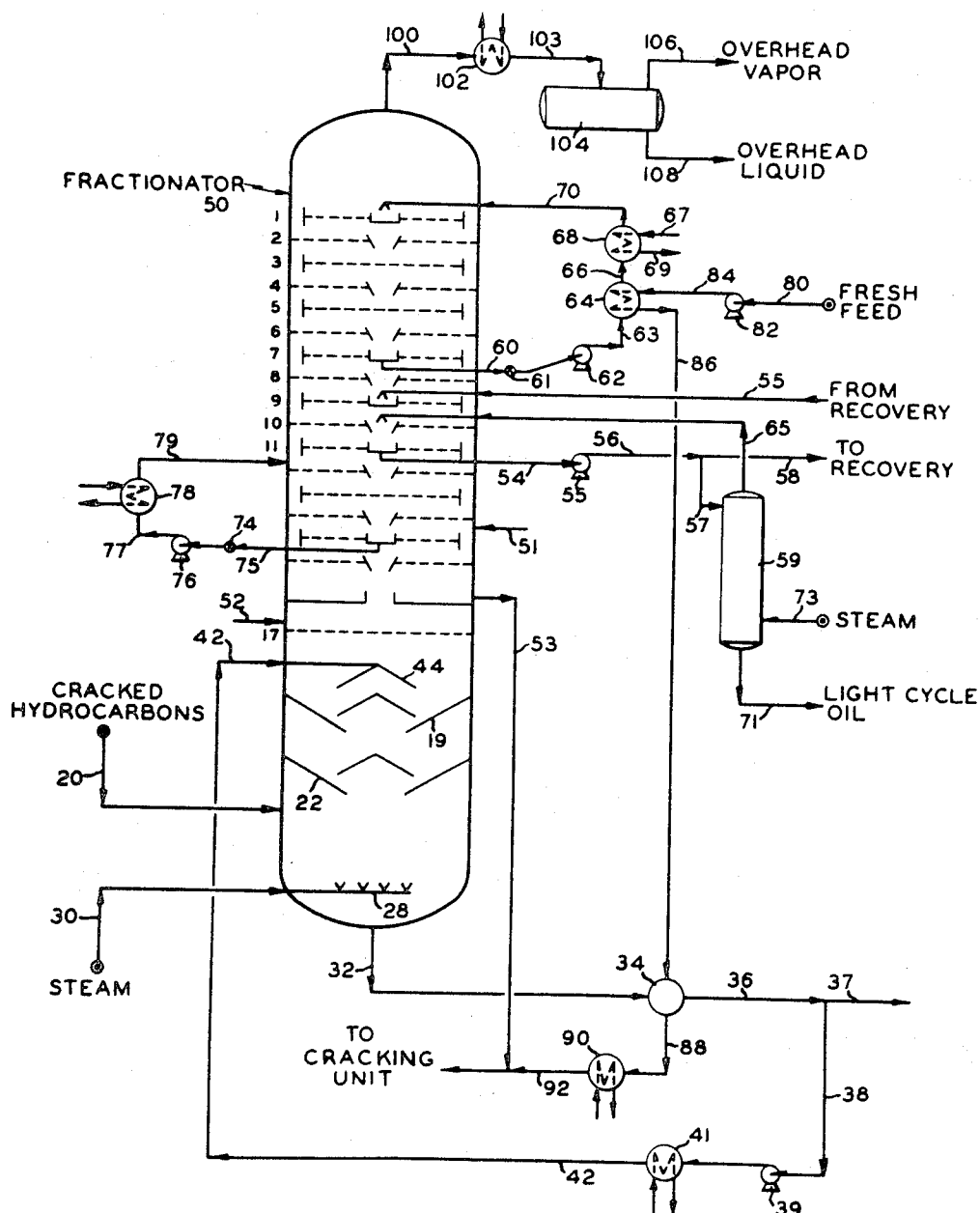


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FRACTIONATING HYDROCARBONS

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FRACTIONATING HYDROCARBONS

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ABSTRACT OF THE DISCLOSURE

A method is disclosed for providing circulating reflux to a fractionation zone within a trayed fractionation vessel employed in the separation of a multicomponent mixture of hydrocarbons. The products withdrawn from the fractionation zone consist of a vaporous low boiling overhead product and a liquid high boiling product. Circulating reflux is obtained by withdrawing an intermediate boiling liquid stream at least 5 trays below the overhead drawoff and preferably from about tray 6 and about tray 9 but above the drawoff of the high boiling product, cooling the intermediate boiling liquid to a temperature between about 70°–180° and preferably between about 100–150° F. below the temperature of the vaporous overhead and returning the cooled liquid to the topmost tray within the fractionation zone. Particular application to the fractionation of catalytically cracked hydrocarbons for the production of gasoline is disclosed.

This application is a continuation-in-part of copending application Ser. No. 244,035 filed Dec. 12, 1962 now abandoned.

The present invention relates to the fractionation hydrocarbons. More particularly, it relates to circulating reflux systems employed in the fractionation of multicomponent mixtures of hydrocarbons in the production of gasoline and other liquid hydrocarbon fuels.

Gasoline and other liquid hydrocarbon fuels are recovered by the separation of hydrocarbon feed into boiling range fractions. The separation is generally achieved in a multi-tray fractionation column wherein lower boiling fractions condense on trays disposed at successive elevations within the column, a vaporous fraction being withdrawn overhead and relatively higher boiling fractions being withdrawn from lower intermediate sections.

In order to accomplish separation into desired boiling range fractions within a section of a column having a given number of trays, reflux liquid must generally be introduced onto the uppermost tray within a section. The reflux liquid is contacted on the trays with upflowing vapor which is enriched by rectification whereby low boiling components in the liquid spontaneously diffuse into vapor in thermal equivalent with high boiling components which diffuse into the liquid by reason of direct heat interchange between the high and low boiling materials of the vapor and liquid phases.

Reflux is generally achieved in one of two ways generally known as (1) distillate reflux system wherein overhead vapors from the tower are condensed and returned in part to the top tray, and (2) circulating reflux systems wherein a portion of the liquid is withdrawn from the uppermost tray or tray adjacent thereto in a section of the tower, cooled by heat exchange generally with a feed stream preheated thereby and returned to the uppermost tray within the same section at a reduced temperature. In both systems, reflux liquid has always been provided having a boiling characteristic which is very similar to the boiling characteristic of the liquid residing on the tray where the reflux is returned. Many reasons have been advanced over the years to support the apparent necessity

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of such a practice including perhaps the primary reason that the return of higher boiling liquid would reduce product and points below desired levels and would destroy the quality of separation.

Circulating reflux systems have been found to be very desirable commercially for providing reflux liquid during the fractionation of hydrocarbon mixtures especially where it is desirable to extract large quantities of heat during fractionation. This type of reflux system has been adapted by the industry to the extent that many processes depend upon such systems for the extraction of heat to maintain fractionation and upon the heat thereby extracted for preheating other process fluids. Unfortunately, serious difficulties have been experienced in the operation of such circulating reflux systems, particularly in the operation of heat exchangers employed in top circulating reflux circuits. The low temperature of the liquid withdrawn to the circuit heat exchanges in addition to unexpected variations in column conditions during fractionation which result in even lower temperatures in the liquid, generally result in inadequate heat transfer and consequent reduction in process efficiency.

The primary object of the present invention is to provide a method of achieving reflux in the fractionation of hydrocarbons whereby difficulties experienced with circulating reflux systems known in the prior art are overcome and in particular, whereby problems inherent in prior methods of operation of heat exchanger circuits are eliminated.

Another object of the present invention is to provide a method of achieving reflux.

Another object of the present invention is to provide a method of achieving circulating reflux in the fractionation of hydrocarbons.

Other objects and advantages of the present invention will become apparent to those skilled in the art from the following description and disclosure.

The above objects are accomplished in accordance with the invention in a method for separating a multicomponent mixture of hydrocarbons wherein fractionation of said mixture is maintained in a fractionation zone containing fractionating trays which cooperate in the separation of components of said mixture according to their boiling characteristics, the products removed from said fractionation zone consisting of a low boiling vaporous hydrocarbon fraction leaving the topmost tray and being withdrawn overhead from an overhead drawoff and a high boiling liquid fraction being withdrawn below from a high boiler drawoff, the improvement which comprises maintaining a reflux drawoff at least 5 actual trays below said overhead drawoff and at least slightly above said high boiler drawoff to withdraw a liquid fraction for reflux purposes at a temperature substantially elevated above the temperature of said low boiling vaporous fraction and having a relatively high boiling characteristic, cooling said withdrawn fraction to a temperature between about 70 and about 180° F. below the temperature of said low boiling vaporous fraction and returning said cooled withdrawn fraction to said fractionation zone to the topmost tray.

This new method of operating a circulating reflux circuit and achieving reflux during fractionation is usually carried out in a fractionation vessel containing standard fractionation trays disposed within the vessel at successively elevated intervals, the uppermost tray being designated as tray 1. Normally, such vessels contain a sufficient number of trays to separate a feed comprising a multicomponent mixture of hydrocarbons into product fractions having desired boiling characteristics. The feed is usually introduced to the vessel as superheated vapor. Components of the feed condense according to their boiling characteristics as successively lower boiling fractions

having successively lower temperatures associated therewith on trays disposed at successively greater elevations within the vessel. Upflowing vapor is enriched by counterflowing reflux liquid achieved as further described herein; and a product stream is generally withdrawn overhead as vapor from tray 1 while heavier fractions are withdrawn as liquids from selected lower intermediate trays. By way of definition, a section of a fractionation vessel or a fractionation zone is a number of related trays or other suitable fractionation means situated between cooperating in the separation of only two product fractions which are withdrawn as a low boiling fraction from the top tray of the zone and a relatively higher boiling fraction withdrawn from the bottom tray of the zone.

The circulating reflux zone or circuit essentially comprises a reflux drawoff site and a reflux return site with heat exchange means situated therebetween. Pumping means is usually provided for the circulation of withdrawn reflux fluid to a higher elevation.

The drawoff site for a circulating reflux system in the present invention is very generally situated at a location which is between a point at least substantially below the lower boiling drawoff above and including the higher boiling fraction drawoff below. Depending upon the mixture being fractionated "substantially below" the lower boiling product fraction drawoff means situated at least about 5 actual trays below the overhead or lower boiling product drawoff. Preferably, the drawoff site is situated at a point intermediate between the low boiling fraction drawoff and the higher boiling fraction drawoff such that an intermediate boiling fraction is withdrawn from the fractionation zone to the circulating reflux system. A fraction withdrawn from such an intermediate site has a boiling characteristic which is high with respect to the same characteristic of the upper product fraction and at least slightly lower than the same characteristic of the lower product fraction withdrawn from that section, a boiling characteristic commonly employed in denoting hydrocarbon boiling point or ASTM boiling end point.

A reflux return site is generally situated within an upper portion of a fractionation zone. Preferably, reflux liquid is returned to the top tray of a fractionation zone, which is the location, also, of the lower boiling or overhead drawoff. Prior to the return of the reflux liquid, it is subcooled to an appreciable extent, substantially below the temperature of the overhead fraction by indirect heat exchange with a cooler process fluid. The process fluid is thereby heated for further process use.

Circuit heat exchange means comprises at least one heat exchanger having sufficient surface to reduce the circulating reflux to an appropriate level and concomitantly elevate cooler process fluid to a desired level. It is an important part of the present invention that a relatively high temperature fraction is provided at the approach of such a heat exchanger as compared with lower approach temperatures always provided in the past. A number of advantages are realized by virtue of providing greater approach temperature which advantages include the availability of a greater amount of heat at a higher and more useful temperature level for the heating of dependent process fluids, elimination of the problem of inadequate heat transfer in circuit heat exchangers and increased production capacity made possible by removal of greater quantities of heat during fractionation.

It is important in the operation of the present invention that heat be extracted from a fraction withdrawn from a fractionation zone in quantity sufficient to reduce its temperature to an appropriate level which level is substantially below the temperature of the low boiling or overhead fraction. If the temperature difference for a given amount of liquid returned to the fractionation zone is too small, insufficient actual reflux results; on the other hand, if the temperature difference is too large substantial condensation of low boiling material will occur and the desired boiling characteristics of the product fractions are

destroyed. It has been found that by maintaining said temperature difference between about 70° and about 180° F. and preferably between about 100° and about 150° F., the product quality requirements are met and the fractionation efficiency of the trays in the zone is maintained at a high level. The quantity of material in the fraction withdrawn to the circulating reflux system relative to the tower throughput, in addition to the temperature to which the withdrawn liquid is reduced, determines the amount of liquid actually achieved for rectification purposes within the fractionation zone. Generally, if said quantity is too small, insufficient reflux results and if said quantity is too large the vaporous overhead temperature is reduced and the necessary temperature difference between the cooled liquid returned to the fractionation zone and the overhead vapors in order to achieve fractionation rather than mere condensation is not maintained. The present invention is not, however, limited to a range of reflux ratios and those skilled in the art will recognize that this ratio can be determined for a specific fractionation.

It is apparent that the objects of the present invention are achieved, including the elimination of problems inherent in prior methods, particularly in that reflux is produced by introducing substantial quantities of relatively high boiling material to the top tray of a given section. It is, therefore, very surprising that product end point is maintained and a desired product separation is successfully achieved.

In a preferred embodiment of the present invention a desired product separation is maintained in a fractionation zone having a given number of actual trays by increasing the quantity of actual reflux achieved as downflowing liquid in the same fractionation zone in proportion to the boiling characteristic of the fraction withdrawn from the zone to the circulating reflux system. In other words, as successively higher boiling fractions are withdrawn from a lower tray within a fractionation zone, the actual reflux achieved in the fractionation zone can be proportionally increased in order to maintain fractionation by extracting an increased quantity of heat from the withdrawn fraction. The quantity of heat extracted can be increased either by increasing the flow rate of the withdrawn fraction to a circuit heat exchanger while maintaining a constant temperature gradient, or by increasing temperature gradient across the exchanger, or by a skillful combination of both methods.

The method of the present invention has particular applicability and is especially useful in the petroleum art wherein treated hydrocarbons are fractionated to recover gasoline and other motor fuels. Therefore, the present invention is described with reference to the operation of a fractionation vessel employed in the recovery of gasoline and other products from a feed mixture which comprises an effluent from a catalytic cracking unit. Such a fractionation vessel is shown diagrammatically in elevation in the drawing.

Referring to the drawing, a hydrocarbon mixture, pretreated by a cracking process, as later described herein, is introduced as feed to a lower portion of fractionator 50 by means of vapor line 20 for separation into boiling range fractions in accordance with the method of the present invention.

The hydrocarbon feed to fractionator 50 is a mixture of cracked vaporous hydrocarbons at a relatively low pressure and elevated temperature derived from a catalytic cracking unit.

Any number of catalytic cracking units can be employed, such as a fixed bed cracking unit or a moving bed catalyst unit employing relatively large catalyst particles or employing piled catalyst. A fluid bed catalyst unit is preferred, however, utilizing catalyst having a relatively small average size as later mentioned herein. During cracking, an elevated temperature is generally maintained, pref-

erably between about 850° and about 1000° F., with a catalyst to oil ratio being maintained between about 4:1 and 10:1. Carbonaceous material is deposited on the catalyst particles during cracking, and it is therefore necessary to regenerate the catalyst for further use. For this reason, catalyst particles are withdrawn from the cracking unit and passed to a regeneration zone wherein the carbonaceous deposits are burned off in the presence of oxygen. The catalyst particles are returned from the regeneration zone to the cracking zone at a temperature in excess of the cracking temperature and supply heat for further vaporization and cracking. The superficial velocity of the hydrocarbon vapors ascending through the cracking zone and the superficial velocity of the oxygen-containing gas extending through the regeneration zone is maintained, preferably between about 0.5 and 5 feet per second, in order to achieve proper fluidization. During regeneration, an elevated temperature is maintained in the regeneration zone, preferably between about 850° and about 1200° F.

Any suitable cracking catalysts may be employed, such as silica-alumina, silica-magnesia, silica-alumina-magnesia, acid treated bentonite clays and so forth. Fluid bed catalyst preferably employed has an average size between about 20 and about 100 microns with a major portion of catalyst being between about 40 and about 100 microns.

The feed in line 29 to fractionator 50 is superheated under a pressure which is at least high enough to insure flow into the fractionator. The pressure at the point of introduction of the feed is preferably maintained sufficiently above atmospheric pressure to insure above atmospheric pressure in the overhead condenser after allowing for the pressure drop in fractionator 50.

A fractionation vessel employed in the process of the present invention is generally an elongated, vertically disposed vessel adapted with appropriate means for the introduction and withdrawal of fluid confined thereby and being separated by means disposed therein. Standard fractionation trays of the bubble-cap or sieve tray variety or other suitable stage-contact achieving means are generally disposed within a fractionation vessel to accomplish separation of a multicomponent mixture confined therein. Circulating reflux achieving means, including fluid draw-off and return means having pumping and heat exchange means situated therebetween are provided at appropriate sections of the vessel.

In the figure, seventeen actual trays, numbered 1-17, adapted to permit vapor upflow through liquid retained thereon are disposed within an upper portion of the fractionator 50 for the purpose of accomplishing separation of the cracked hydrocarbon feed into an overhead gasoline fraction. Generally, the number of trays is determined by the quality of the separation desired and the ratio of reflux to product liquid achieved. Fractionators employed in the separation of cracked hydrocarbons ordinarily contain between about 15 to 30 trays although the invention is not limited thereby.

Shed baffles 19 and 22, or other such suitable baffle means are disposed within a lower portion of the fractionator 50 for contacting with superheated feed a heavy bottoms fraction, known as decanted oil, which collects in the bottom portion of fractionator 50, is withdrawn therefrom, and is recycled in part to an introduction site above the baffles where it is introduced by means of showerhead 44 at the terminal portion of liquid line 42. To prevent plugging at the drawoff to line 32, steam in line 30 is injected by means of sparger 28 into decanted oil which contains catalyst fines carried over in the feed 29.

In order to remove heat from the bottom portion of fractionator 50 decanted oil is withdrawn by means of line 32 and passed in indirect heat exchange in heat exchanger 34 with relatively cool fresh feed to a cracking unit. Cooled decanted oil is withdrawn by means of line 36, is withdrawn in part from the system in line 37, and the remaining portion is passed to recirculating pump 39

in lines 38 and 40. The decanted oil is further reduced in temperature by passage through heat exchange means 41 prior to passage to showerhead 44 in line 42.

The superheated vapors introduced to fractionator 50 flow upwardly in fractionator 50 through the trays by means of vapor risers situated therein countercurrently to the flow of liquid reflux flowing downwardly in that vessel. The fractions condense on the trays according to their boiling characteristics, successively higher boiling fractions being condensed on successively lower trays at correspondingly higher temperatures. Reflux is provided in the upper portion by circulating reflux systems as hereinafter described, and product fractions are withdrawn from sections of fractionator 50 as indicated below.

A heavy gas oil liquid is withdrawn from a lower intermediate section of fractionator 50 by means of trap out tray 18. The heavy gas oil fraction can be withdrawn wholly or in part as product, or returned through line 53 to a cracking unit, as shown in the figure. The heavy gas oil fraction has an end point boiling range of about 600-1000° F. and is withdrawn at a temperature in line 53 of between about 500° and about 700° F.

A circulating reflux system is provided, as shown in the figure, to remove heat and achieve reflux above the heavy gas oil drawoff. A liquid fraction from tray 14 is withdrawn as it flows into a drawoff situated in tray 15 by means of line 75 at a rate controlled by valve 74 situated thereon. Such liquid is returned on tray 12 in line 79 after heat is removed therefrom in circuit exchanger 73 situated in lines 77 and 79. Circulation is achieved by means of circuit pump 76 in lines 75 and 77.

Provision is also made by means of lines 51 and 52 for introducing relatively cool liquid onto plates 15 and 17, respectively, with respect to the liquid residing thereon.

A light cycle fraction is withdrawn from the bottom tray of a section of trays in which gasoline is separated from light gas oil. As shown in the figure, a light cycle fraction is withdrawn from a downcomer situated in tray 10 by means of a liquid receiver situated at the terminal portion of line 54 within plate 11. A light cycle fraction has an end point boiling range generally between about 450° and about 700° F. and is generally withdrawn at a temperature between about 350° and about 550° F. Location of the light cycle drawoff, in general, depends upon the number of trays necessary to achieve the desired separation, which in turn depends upon operational and design factors for a given fractionation. In the separation of cracked hydrocarbon mixtures the light cycle drawoff is situated generally between about the 8th and about the 20th tray and preferably between about the 10th and the 14th tray for fractionators in the size range between about 15 and about 30 trays.

At least a portion of the light cycle fraction in line 54 is passed by means of pump 55 in lines 54 and 56 to light-cycle stripper 59 through line 7, and a remaining portion is passed to a lean oil recovery section, not shown, in line 58. A mixture of liquid and vapor at a substantially reduced temperature is returned to plate 9 from the lean oil recovery section in line 55. In stripper 59, a light cycle fraction is stripped with open steam introduced in line 73, a light cycle oil product being withdrawn from the bottom of stripper 59 through line 71 and the stripper overhead being recycled in line 65.

An overhead fractionator product is withdrawn as vapor from a top portion of the fractionator 50 through vapor line 100, cooled by means of heat exchanger 102 and passed in line 103 to gas-liquid separating drum 104. Overhead liquid is withdrawn from a bottom portion of drum 104 in line 108 and vapors are withdrawn overhead in line 106.

Generally, the overhead liquid in line 108 has a boiling end point in the range of between about 300° F. and about 500° F., and preferably in the range of between about 375° and about 425° F. The temperature at which

the fractionator overhead vapor is withdrawn, i.e., the tower top temperature is normally substantially below the overhead liquid end point by reason of the presence of steam and other low boiling material.

A top circulating reflux system, operated in accordance with the method of the present invention is used to provide a reflux in the uppermost section of fractionator 50 in which section gasoline is separated from light cycle oil as previously described. This section includes 10 actual trays, as shown in the drawing, and a liquid fraction on tray 6 is withdrawn to the reflux circuit in line 60 from a liquid drawoff located in tray 7 at a rate controlled by valve 61. By means of pump 62 in lines 60 and 63, the liquid fraction is passed to preheater 64 in lines 63 and 66 wherein the liquid is cooled by indirect heat exchange with fresh feed in line 84 which is heated by such contact and withdrawn in line 86 as hereinafter described. The liquid fraction which has been reduced in temperature in preheater 64 is passed to heat exchanger 68 in line 66 wherein it is adjusted in temperature by indirect heat exchange with liquid in lines 67 and 69 to a suitable temperature level for introduction in line 70 to tray 1 in fractionator 50.

At the same time, fresh hydrocarbon feed to a cracking unit, not shown, is elevated in temperature to preheater 64 by indirect heat exchange with the relatively hot fraction in line 63 to which it is passed by means of pump 82 in lines 80 and 84. The fresh feed is thereafter withdrawn at an elevated temperature in line 86 and passed to heat exchanger 34 wherein it is further elevated in temperature by indirect heat exchange with decanted oil as hereinbefore described. The feed is thereafter elevated to cracking temperature in heater 90, in lines 88 and 92 which is generally gas heating means and passed to a cracking unit alone or along with heavy gas oil in line 53, as shown in the figure.

Speaking now of the drawoff site to the reflux circuit specifically for the separation of a catalytically cracked hydrocarbon mixture into an overhead gasoline fraction and a light cycle fraction in accordance with the present invention, the drawoff site is situated such that a liquid fraction is withdrawn from a tray situated at least substantially below the top tray but no lower than the light cycle drawoff itself. In general terms, this drawoff is from between about the 5th and about the 14th tray, and preferably between about the 6th and about the 9th tray, depending upon the number of trays in the gasoline-light cycle oil separation section. For example, in fractionator 50 having 10 trays in the separation section, the reflux drawoff is situated very generally between about the 5th and about the 10th tray, and preferably between about the 6th and 8th tray. In another example of a fractionator having 15 trays in the aforementioned separation section, light gas oil being withdrawn to a stripper from tray 15, the reflux drawoff site is situated generally from between about the 5th and about the 14th tray, and preferably from between about the 6th and about the 9th tray. A fraction so withdrawn is returned to tray 1 through a reflux circuit as described previously.

In prior methods, the liquid was withdrawn to the circulating reflux circuit from tray 2 or 3 at a temperature between about 250° and 300° F. such a liquid fraction having a boiling characteristic not substantially different from that of liquid or tray 1 or the overhead liquid fraction. In the present invention, however, a liquid fraction being withdrawn from trays 5-14, for example, has a temperature between about 325° and about 480° F. and has a boiling characteristic which is substantially above that of the fraction or tray 1 or the overhead liquid fraction. The increased temperature of the liquid fraction employed at the approach of the circuit heat exchanger eliminates problems associated with former operation of such heat exchangers and provides for the extraction of greater quantities of heat than by prior reflux methods.

The quantity of heat extracted in circuit exchangers 64 and 68 is increased by increasing the liquid rate through line 60 by means of valve 61 while maintaining a constant temperature in line 70 by transferring more heat to fluids in lines 67 and 84. In a preferred embodiment, the quantity of heat extracted from the withdrawn liquid is adjusted in accordance with a boiling characteristic of the liquid fraction to maintain a given fractionation, the amount of heat extracted being increased in proportion to an increase in the boiling characteristic. This feature of the invention is illustrated in Example 2. Having thus far described the invention in general terms, reference is now had to specific examples thereof which should not be construed as unduly limiting the scope thereof.

Example 1

Referring to the drawing, a cracked hydrocarbon mixture is fed in line 20 to fractionator 50. The feed rate, composition, and conditions are shown in Table I below:

TABLE I.—FEED TO FRACTIONATOR

Component	M.W.	M.p.h.	T., ° F.	P.s.i.g.
Hydrocarbon.....	122	9,305	885	12
Steam.....	18	2,082	885	12
Inert.....	31	378	885	12

The above mixture mixture is separated into boiling range fractions including an overhead fraction in line 100, a light gas oil fraction in line 54, a heavy gas oil fraction in line 53 and a bottom fraction in line 32. The overhead fraction is separated into overhead vapor in line 106 and overhead liquid in line 108 in gas-liquid separating drum 104. The light gas oil fraction is stripped with steam at a rate of 3840 lb./hr. of 50 p.s.i.g. steam, a light cycle stock being withdrawn in line 71. Heavy gas oil in line 53 is recycled to a catalytic cracking operation; and a portion of the bottom fraction in line 32 is recycled in line 42 while the remaining portion is withdrawn in line 37 as summarized in Table II below:

TABLE II.—PRODUCT FRACTIONS

Line	Mols/ hr.	Boiling Characteristics	Temperature, °F.
100.....	9,553	Steam, inerts and hydrocarbon.....	249
103.....	2,589	103° F. (IBP)-420° F. (EP)	66
54.....	3,480	Not measured.....	390
71.....	1,061	354° F. (IBP)-626° F. (EP)	363
53.....	1,470	392° F. (IBP)-760° F. + (EP)	540
32.....	3,790	9.6° API gravity.....	693
37.....	129	9.9° API gravity.....	395

A liquid fraction is withdrawn from tray 6 in line 60 to the top circulating reflux circuit shown in the figure, cooled and returned to tray 1 as summarized in Table III below:

TABLE III.—TOP CIRCULATING REFLUX CIRCUIT

Location	Boiling Characteristics	Temperature, °F.	Mols/ hr.
Line 60.....	228° F. (IBP)-523° F. (EP)	340	9,025
Line 70.....	228° F. (IBP)-523° F. (EP)	120	9,025
Line 100.....	Not measured.....	249	9,553

In the example, 143.0 MM B.t.u./hr. are extracted from the circulating fraction.

Example 2

Table IV, below, illustrates adjusting the quantity of heat extracted in accordance with a boiling characteristic of the liquid fraction in line 60. Feed and product fractions to and from fractionator 50 are maintained substantially as in Example 1, but the drawoff line 60 is situated as shown in Table IV.

TABLE IV

Liquid Drawoff Site	Boiling Characteristics	Temp. in Line 60, °F.	MM B.t.u./Hr. Extracted
Tray 5.....	208° F. (IBP)-503° F. (EP)-----	325	133.0
Tray 7.....	243° F. (IBP)-543° F. (EP)-----	355	153.0
Tray 8.....	268° F. (IBP)-563° F. (EP)-----	370	163.0

As shown in Table IV, a greater quantity of heat is extracted as the boiling characteristic of the liquid withdrawn in line 60 is increased and the fractionation is thereby maintained. Even though the drawoff tray is changed from tray 5 to tray 8, there is no substantial change in product streams which remain essentially as specified in Table II.

Having thus described the present invention with reference to specific examples of its operation, it is to be understood that the scope of the present invention should not be limited thereby and that many modifications and alterations will become apparent to those skilled in the art. For example, the design of fractionating vessels varies widely within the petroleum industry and, thus, the novel reflux achieving method should not be limited to any specific design including a specific number of trays and the like. The composition or source of the feed forms no limitation upon the invention, except as set forth in the claims, and the invention is useful in the separation of many multicomponent mixtures, such as crude petroleum and stocks pretreated by means other than catalytic cracking. Furthermore, the invention is not necessarily limited to top circulating deflux circuits, but is also employed for achieving reflux at intermediate portions of a fractionation vessel.

What is claimed is:

1. In a method for separating a multicomponent mixture of hydrocarbons wherein fractionation of said mixture is maintained in a fractionation zone containing fractionating trays which cooperate in the separation of components of said mixture according to their boiling characteristics, the products removed from said fractionation zone consisting of a vapor stream containing at least substantial quantities of a low-boiling hydrocarbon fraction having a desired low-boiling characteristic, said vapor stream leaving the topmost tray and being withdrawn overhead from an overhead drawoff and a high-boiling liquid fraction being withdrawn below from a high-boiling liquid drawoff, the improvement which comprises: maintaining a reflux drawoff at least 5 actual trays below said overhead drawoff and at least slightly above said high-boiling liquid drawoff to withdraw a liquid stream for reflux purposes at a temperature substantially elevated above the temperature of said vapor stream and having a relatively high-boiling characteristic, cooling said withdrawn stream to a temperature between about 70 and about 180° F. below the temperature of said vapor stream and returning said cooled withdrawn stream to said fractionation zone to the topmost tray.

2. A process according to claim 1 wherein the fractionation zone is located in the topmost section of a fractionation vessel maintained under conditions of at least atmospheric pressures and wherein the low-boiling hydrocarbon fraction having a desired low-boiling characteristic is a gasoline fraction and the high-boiling liquid fraction is a light cycle oil fraction.

3. The process of claim 2 wherein the cooled withdrawn stream is returned to the topmost tray at a temperature between about 100 and about 150° F. below the temperature of the vapor stream.

4. A process according to claim 2 wherein the light cycle oil fraction is withdrawn from a tray between about tray 8 and about tray 20 and wherein the liquid stream is withdrawn from a tray between tray 5 and about tray 14.

5. A process according to claim 4 wherein the liquid stream is withdrawn from between about tray 6 and about tray 9.

6. A process according to claim 4 wherein the liquid stream is withdrawn from between about tray 5 and about tray 14 at a temperature between about 325 and about 480° F.

7. In a method for separating a multicomponent mixture of hydrocarbons wherein fractionation of said mixture is maintained in a fractionation zone containing a given amount of fractionating trays which cooperate in the separation of components of said mixture according to their boiling characteristics and wherein a circulating reflux zone is maintained adjacent to and cooperating in the fractionation maintained in said fractionation zone, said circulating reflux zone comprising an intermediate boiling liquid drawoff located in one of the trays of the fractionation zone for removal of a liquid stream, a cooling zone wherein heat is extracted from said liquid stream and means for reintroducing the cooled liquid stream above the topmost tray of the fractionation zone, the products removed from said fractionation zone consisting of a vapor stream containing at least substantial quantities of a low-boiling hydrocarbon fraction having a desired low-boiling characteristic, said vapor stream leaving the topmost tray and being withdrawn overhead from an overhead drawoff and a high-boiling liquid fraction withdrawn below from a high-boiling liquid drawoff, the amount of heat extracted in said cooling zone being controlled to induce a predetermined amount of reflux in said fractionation zone which corresponds to the desired low-boiling characteristic of the low-boiling hydrocarbon fraction and the number of fractionating trays in the fractionation zone when said intermediate boiling liquid is conventionally withdrawn from the top tray or the tray adjacent thereto, the improvement which comprises: withdrawing to the circulating reflux zone a liquid stream having a relatively high-boiling characteristic from an intermediate tray at least 5 actual trays below said overhead drawoff and at least slightly above said high-boiling liquid drawoff, reducing the temperature of said withdrawn liquid stream in the cooling zone to a temperature between about 70 and about 180° F. below the temperature of the vapor stream being withdrawn overhead, returning the stream of reduced temperature to the topmost tray and maintaining said predetermined amount of induced reflux at a substantially constant level.

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