

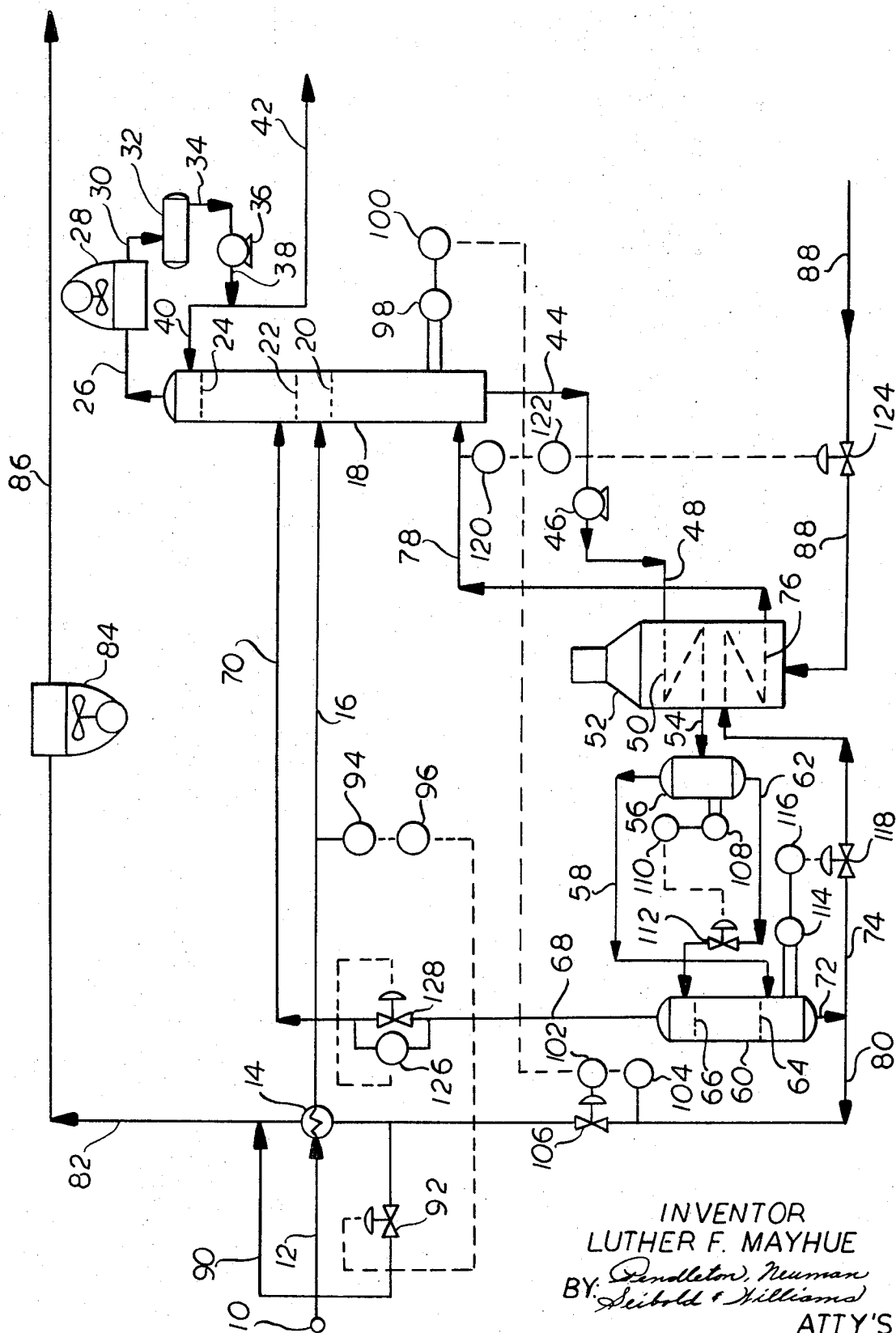
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FRACTIONATION PROCESS

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FRACTIONATION PROCESS

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ABSTRACT OF THE DISCLOSURE

This process separates a wide-boiling range hydrocarbon such as a gasoline-gas oil mixture into a light gasoline component and a heavier gas oil component having a relatively high flash point without resorting to conventional steam stripping or system depressurization. The mixture is first charged to a primary fractionation zone, and the resulting heavier hydrocarbon portion is then further heated and flashed. The flashed vapors are then charged to the lower portion of a light ends separation zone for countercurrent contact with the residue of the heavier hydrocarbon portion as reflux. The resulting light ends component is returned to the primary fractionation zone at a level above that at which the original gasoline-gas oil mixture was introduced. The products from the process comprise the finely-separated gasoline overhead from the primary fractionation zone and the heavy hydrocarbon component from the light ends separation zone, the latter having a relatively high flash point.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a process for the efficient and effective separation of a wide-boiling range hydrocarbon feedstock into a low-boiling component and a high-boiling component having a high flash point without resort to certain conventional separation techniques. More specifically, it relates to a process for carrying out such fine separation without the use of conventional steam stripping or system depressurization techniques whereby the light component has substantially no heavy hydrocarbons and the heavy component has substantially no light hydrocarbons which would adversely lower its flash point.

The method of the present invention is advantageously employed at locations without steam facilities and where associated processing or handling precludes system depressurization. For example, during the shipment of hydrocarbon streams by long distance pipeline, the products become intermixed to a limited extent, particularly at the "interface" between one product and the following product. At the pipeline destination, the intermixed products must be separated, but at such locations conventional utilities such as steam are often not available. Also, system depressurization cannot be used for separation purposes without substantial disadvantages because of associated pumping problems. The method of the present invention adequately copes with these problems.

Description of the prior art

Modern day petroleum product specifications require rigid quality control, and refining techniques have been highly developed to meet these quality requirements. While product quality specifications can be readily met at refinery locations where sophisticated processes, abundant utilities, and the like are available, such is not necessarily the case at other locations such as pipeline terminals. Thus, should off-specification product be inadvertently shipped or should different products become intermixed during shipment, these products must again be

carefully separated at product terminals where facilities for so doing are limited.

Prior art techniques for achieving such fineness of separation include steam stripping and system depressurization. Such techniques are not feasible at locations without available steam and where depressurization techniques are not acceptable because of attendant pumping problems.

It is therefore a general object of the present invention to economically cope with such separation problems. It is a more specific object of the present invention to separate a wide-boiling range hydrocarbon stream such as a gasoline-gas oil mixture into a light gasoline component and a heavier gas oil component, both meeting requisite product specifications. It is another object of the present invention to provide specification gas oil product meeting the requisite flash point requirement from a wide-boiling range hydrocarbon stream containing light gasoline components.

It is a more specific object of the present invention to separate a predetermined amount of light ends from fractionator bottoms or fractionator side draw product so as to raise the flash point thereof without resorting to steam stripping or depressurization. It is another specific object of the present invention to achieve a finer light ends cut from a mixed hydrocarbon stream than is feasible by steam stripping or system depressurization.

It is still another specific object of the present invention to achieve a light ends fractional separation without the use of steam or reduction of pressure in a manner which approximates a differential vaporization mechanism (fractional) as distinguished from equilibrium flash vaporization. It is still another specific object of the present invention to minimize the recycling of separated light ends even though they are returned to the primary fractionator after separation. These and other objects of the present invention will become apparent as a detailed description thereof proceeds.

SUMMARY OF THE INVENTION

The objects of the present invention are achieved by a multi-step fractionation or separation process wherein a wide boiling range feedstock is initially charged to a primary fractionation zone wherein the feedstock is fractionated into at least a lighter hydrocarbon stream and a heavier hydrocarbon stream. The latter stream is then further heated and introduced into a flash zone wherein lower boiling vapors are flashed therefrom. These lower boiling vapors and the residue of the heavier hydrocarbon stream are then charged to a light ends separator, the lower boiling vapors entering adjacent the bottom and the residue of the heavier hydrocarbon stream entering adjacent the top as a sort of reflux stream. The resulting light ends component from the light ends separator is returned to the primary fractionator where it is introduced above the level at which the wide boiling range feedstock entered. Thus, the light ends component is not entrained in the feedstock and returned to the flash and light ends separation zones.

The net overhead from the primary fractionation zone (total overhead less reflux) constitutes the light hydrocarbon product stream. The net bottoms from the light ends separation zone (total bottoms less the reboiler stream) constitutes the heavy hydrocarbon product from the process.

The separation of light ends from the heavier hydrocarbon stream by means of heating, flashing and countercurrently contacting the vapors and liquid stream from the flash zone closely resembles a differential vaporization mechanism (fractional) as distinguished from the less efficient equilibrium flash vaporization mechanism.

The separation of the light ends could also have been achieved by steam stripping or by reducing the pressure of the system, if such alternatives were otherwise feasible. Neither of these alternatives, however, would have given as fine a separation.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be more clearly understood by reference to the following detailed description read in conjunction with the accompanying drawing which is a schematic flow diagram of the fractionation process of the present invention as employed at a pumping station which receives transmix material from a pipeline manifold. While the transmix material in this preferred embodiment is a gasoline-gas oil mixture, it should be understood that the invention is not limited thereto. Other mixtures may be separated in accordance with the principles of the disclosed process, and any modifications necessary to adopt the process to such other streams will be obvious to those skilled in the art in the light of the present disclosure.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, a gasoline-gas oil mixture having the properties hereinafter set forth is charged from source 10 via line 12, feedstock-product heater exchanger 14 and line 16 to primary fractionator 18 at about 32 p.s.i.a. and 275° F. Source 10 may be a slop receiver for transmix material from the manifold of a pipeline. In this specific embodiment, primary fractionator 18 is a three-foot diameter fractionation tower having twenty sieve trays, dashed lines 20, 22 and 24 representing trays 19, 11 and 20, respectively.

A light hydrocarbon vaporous stream leaves fractionator 18 at about 324° F. via line 26 and enters condenser 28 where the vapors are condensed. The condensate leaves via line 30 and is collected in reflux accumulator 32. Effluent from accumulator 32 leaves via line 34, pump 36 and line 38, the reflux portion being returned to fractionator 18 via line 40 and the remainder constituting the light hydrocarbon product being removed from the fractionation system via line 42.

The light hydrocarbon product leaving line 42 may be further processed to meet various quality specifications. The further processing may include, for example, caustic washing, trickling through a sand tower, the addition of dye and tetraethyl lead and any other processing or blending which may be required to produce the desired end product, e.g., house brand motor fuel.

The heavier hydrocarbon stream leaves fractionator 18 at about 480° F. via line 44, reboiler pump 46 and line 48 and is heated to about 494° F. in upper coil 50 of reboiler furnace 52. The furnace tubes constituting coil 50 and the flow rates of the heavier hydrocarbon stream therethrough are selected so as to achieve substantially streamline flow and a minimum of turbulence, thereby enhancing the subsequent flashing operation.

The heated effluent from coil 50 is charged via line 5 to flash pot 56 wherein lower boiling vapors are flashed therefrom. In this specific embodiment flash pot 56 comprises a one-foot diameter drum having a length of approximately three feet.

The overhead vapors from flash pot 56 are charged via line 58 to the lower portion of light ends separator 60. The remaining heavy hydrocarbon liquid from flash pot 56 is charged via line 62 to the upper portion of light ends separator 60. In this specific embodiment light ends separator 60 may comprise a two-foot diameter column having six dual flow trays. Dashed lines 64 and 66 represent trays 1 and 6 of the six trays.

The light ends component leaves light ends separator 60 via line 68 and is returned to primary fractionator 18 via line 70 at a point above the feedstock inlet. In the

specific embodiment shown, the light ends component enters tray 22 whereas the feedstock enters between trays 20 and 22. This minimizes entrapment of the separated light ends component in the tray-to-tray downflow and the recycling of same to flash pot 56 and light ends separator 60.

The heavy hydrocarbon component leaves light ends separator 60 via line 72. The larger portion of it is employed as the reboiler stream which is returned to fractionator 18 via line 74, furnace coil 76 in reboiler furnace 52 (where it is heated to about 507° F.) and line 78. The remainder passes via line 80, feedstock-product heat exchanger 14, line 82, product after-cooler 84 and line 86 to gas oil product storage. A small portion of the gas oil product may be returned via line 88 as fuel oil for reboiler furnace 52.

Adequate controls are provided so that the proper flow rates and operating conditions are maintained throughout the system. Some of the controls are indicated in the drawing, and others will be apparent to those skilled in the art in the light of the present disclosure. For example, the flow of feedstock to fractionator 18 is controlled by means of a conventional flow transmitter and flow-controlled valve (not shown) in line 12. The temperature of the feedstock in line 16 is regulated by adjusting the flow rate of the heavy hydrocarbon product through feedstock-product heat exchanger 14. This is accomplished by varying the amount of hot product bypassed around the heat exchanger via line 90. This is controlled by valve 92. The position of valve 92 is responsive to a signal received via temperature transmitter 94 (line 16) and temperature controller 96.

The reboiler liquid level in fractionator 18 is controlled by liquid level transmitter 98 and liquid level controller 100 which transmits a signal to valve controller 102 which also receives a flow signal from flow transmitter 104. Valve controller 102 regulates the position of valve 106. The liquid level in flash pot 56 is controlled by level transmitter 108, level controller 110 and valve 112 in line 62. Similarly, the liquid level in light ends separator 60 is controlled by means of level transmitter 114, level controller 116 and valve 118 in line 74.

The temperature of the reboiler stream in line 78 is controlled by temperature transmitter 120 and temperature controller 122 which regulates the position of valve 124 in line 88 and thus the amount of fuel being supplied to reboiler furnace 52. The operations of condenser 28 and product after-cooler 84 are regulated by controllers responsive to the temperatures in lines 30 and 86, respectively, these controls not being shown in the interest of simplicity. The desired pressure differential between fractionator 18 and light ends separator 60 is maintained by means of differential pressure controller 126 which regulates the position of throttle valve 128.

As will become apparent from the following specific example, the separation of light ends from the heavy oil fraction from fractionator 18, which separation occurs in flash pot 56 and light ends separator 60, closely resemble that of a differential vaporization mechanism (fractional) as distinguished from equilibrium flash vaporization. The separation is even finer than that which might be expected by steam stripping or by reducing the pressure of the system. These latter alternatives are, of course, not available under certain circumstances, as hereinabove discussed.

The invention will be more clearly understood by reference to the following specific example, wherein 1,000 barrels per day of a gasoline-gas oil mixture are processed in accordance with the method of the present invention employing the system shown in the drawing.

EXAMPLE

The 1,000-barrels-per-day feedstock consists of approximately 32 volume percent of hydrocarbons boiling in the gasoline boiling range and 68 volume percent of hydro-

carbons boiling in the distillate or gas oil boiling range. The distillation and gravity are as follows:

Feedstock ASTM distillation:	° F.	
Initial boiling point -----	111	
10% -----	172	5
20% -----	251	
30% -----	337	
40% -----	385	
50% -----	410	
60% -----	428	10
70% -----	445	
80% -----	467	
90% -----	501	
End point -----	596	15
Gravity at 60° F., ° API -----	45.9	

Referring to the drawing, the feedstock is supplied from source 10 and charged to primary fractionator 18. The net fractionator overhead which leaves the system via line 42 comprises 320 barrels per day of gasoline having the following distillation and gravity:

Gasoline ASTM distillations:	° F.	
Initial boiling point -----	95	25
10% -----	125	
20% -----	140	
30% -----	156	
40% -----	174	
50% -----	194	30
60% -----	216	
70% -----	244	
80% -----	275	
90% -----	310	
End point -----	366	35
Gravity at 60° F., ° API -----	65.3	

The fractionator bottoms which leave fractionator 18 via line 44 comprises 51,984 pounds per hour of heavier hydrocarbons having the following distillation and gravity:

Fractionator bottoms ASTM-distillation:	° F.	
Initial boiling point -----	366	
10% -----	398	45
20% -----	411	
30% -----	422	
40% -----	433	
50% -----	442	
60% -----	454	50
70% -----	466	
80% -----	483	
90% -----	516	
End point -----	606	55
Gravity at 60° F., ° API -----	38.6	

After being heated in coil 50 of reboiler furnace 52, this heavier hydrocarbon stream is charged to flash pot 56. The overhead from the flash pot 56 which leaves via line 58 consists of 2,675 pounds of light hydrocarbons having API gravity at 60° F. of 45.2°. The bottoms from flash pot 56 which leave via line 62 consists of 49,309 pounds per hour of heavier hydrocarbons having an API gravity of 60° F. of 37.9°.

The overhead from light ends separator 60 which leaves via line 68 and re-enters fractionator 18 via line 70 consists of 2,599 pounds per hour of light hydrocarbon vapors having an API gravity at 60° F. of 45.4°. The bottoms from light ends separator 60 which leaves via line 72 consists of 49,385 pounds per hour of gas oil having an API gravity of 60° F. of 38.3°.

The distillate or gas oil product which leaves the system via line 86, after imparting some of heat to the feedstock in exchanger 14 and being further cooled in aftercooler

84, consists of 680 barrels per day of hydrocarbons having the following properties:

Distillate ASTM distillation:	° F.
Initial boiling point -----	370
10% -----	401
20% -----	412
30% -----	422
40% -----	433
50% -----	442
60% -----	454
70% -----	466
80% -----	483
90% -----	516
End point -----	600
Gravity at 60° F., ° API -----	38.3
Tag closed cup flash, ° F. -----	170

The gas oil net make from the system is reduced by the amount of gas oil which is returned as fuel via line 88 to reboiler furnace 52. In this specific embodiment approximately ten barrels per day are so employed, leaving a gas oil net make of 670 barrels per day. The use of a portion of the product as fuel for the process renders it independent of outside utilities.

A comparison of the properties of the feedstock and the gasoline and gas oil products set forth above evidence the fine separation characteristic of the fractionation process of the present invention. Those skilled in the art will also recognize that the flash point of the gas oil product, i.e., Tag closed up flash of 170° F., is sufficiently high to meet usual specifications for such a product.

From the above description, it is apparent that the objects of the present invention have been achieved. While only one preferred embodiment has been described in detail in connection with the accompanying drawing and specific example, many alternative modifications of the present invention will be apparent from the above description to those skilled in the art. These other alternatives are considered within the spirit and scope of the present invention and coverage thereof is intended by this application.

Having described the invention, what is claimed is:

1. A process for separating a wide-boiling-range hydrocarbon feedstock comprising:

- (a) charging said feedstock to a fractionating zone whereby said feedstock is fractionated into at least a lighter hydrocarbon stream and a heavier hydrocarbon stream;
- (b) heating said heavier hydrocarbon stream;
- (c) introducing the heated heavier hydrocarbon stream into a flash zone wherein lower-boiling vapors are flashed therefrom;
- (d) charging said lower-boiling vapors adjacent the lower portion of a light ends separation zone and the residue of the heavier hydrocarbon stream adjacent the upper portion thereof for countercurrent contacting thereof and removing from said light ends separation zone the resulting light ends vaporous component and heavy hydrocarbon liquid component; and
- (e) introducing said light ends vaporous component into said fractionating zone at a level above that at which said feedstock is charged thereto.

2. The process of claim 1 wherein a light hydrocarbon stream from said fractionation zone is cooled and withdrawn as a liquid product.

3. The process of claim 1 including the step of cooling at least a portion of said heavy hydrocarbon component and withdrawing the same as a product stream.

4. The process of claim 3 including the step of further heating at least a portion of said heavy hydrocarbon liquid component and circulating the same to said fractionating zone as the reboiler stream.

5. The process of claim 4 wherein a portion of said cooled heavy hydrocarbon component is employed as

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the fuel for said heating step and said step of further heating.

6. The process of claim 4 wherein said heating step and said step of further heating are carried out in the same furnace zone.

7. A process for separating a wide-boiling-range hydrocarbon feedstock comprising:

(a) charging said feedstock to a fractionating zone whereby said feedstock is fractionated into at least a lighter hydrocarbon stream and a heavier hydrocarbon stream;

(b) heating said heavier hydrocarbon stream;

(c) introducing the heated heavier hydrocarbon stream into a flash zone wherein lower boiling vapors are flashed therefrom;

(d) charging said lower-boiling vapors adjacent the lower portion of a light ends separation zone and the residue of the heavier hydrocarbon stream adjacent the upper portion thereof for countercurrent contacting thereof and removing from said light ends separation zone the resulting light ends vaporous component and heavy hydrocarbon liquid component;

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(e) introducing said light ends component into said fractionation zone above the level of said feedstock;

(f) further heating a portion of said heavy hydrocarbon component and recirculating the same to said fractionating zone as the reboiler stream;

(g) cooling another portion of said heavy hydrocarbon component and withdrawing the same as a gas oil product stream; and

(h) employing a portion of said gas oil product stream as fuel for said steps of heating and further heating.

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