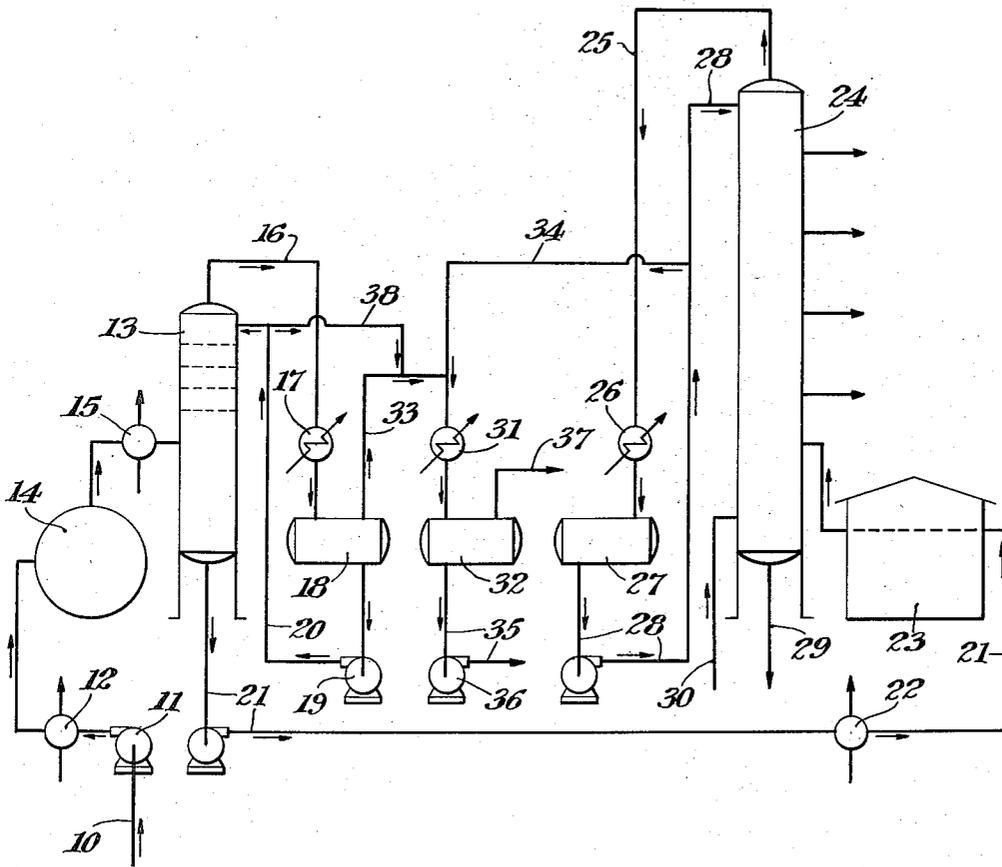


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W. W. KRAFT
DISTILLATION IN STAGES

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DISTILLATION IN STAGES

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3 Claims. (Cl. 208—354)

This invention relates to improvements in petroleum distillation and more specifically, to an improved method and apparatus for topping a crude oil containing a substantial proportion of light ends.

There are two generally used methods for treatment of such crude oil. In the first of these a single distillation column is used, but since temperature limitations in the flash zone preclude operation under pressure and inasmuch as it is necessary in order to condense the light ends with available water at normal temperature levels, the gaseous overhead is compressed. This requires a compressor and an extra amount of equipment to recover the desired gas.

An alternative method involves the use of two distillation columns, in the first of which the gasoline is produced as an overhead product at such pressure as to allow condensation of the gas with the gasoline. Such a tower requires a stripping section to recover all the gasoline and usually a heater is also required for reboiling. The residue is fractionated in the second tower but as it is usually difficult in such operations to produce a clean separation of cuts, the overhead must be returned to the first tower as slop.

The present invention is an improvement on the distillation system of co-pending application, Serial Number 243,623, filed August 25, 1951, by Pierre Lambert, now Patent No. 2,725,342, issued Nov. 29, 1955, which covers a variation of the so-called two tower system being primarily characterized in the operation of the first tower at a substantial pressure and with a relatively low temperature such that there is only a partial vaporization of the gas and gasoline. In such system the remaining gas and gasoline together with the side cuts and bottoms is then fractionated in a second column at a substantially lower pressure but at a substantially higher temperature than in the first tower. The overhead heavy ends of the gasoline are then added to the gas and gasoline from the first tower to reconstitute the gasoline yield.

The economies of such an operation are primarily in the elimination of heaters, the use of smaller tower equipment and the simplified control of the end products. There is no need of compressors or refrigerant cooling and the unit is flexible in operation with changes in feed stock.

I have found that in such an improved system the overhead heavy ends of the second column, which are added to the gas and gasoline from the first tower, may cause a high rate of recycle of heavy gasoline in the first or primary tower and thereby increase the heating and condensing load or may overload such tower during continuous operation.

The principal object of the present invention is to provide an improved method for topping a crude oil by a two tower system in which any tendency toward a high rate of recycle of heavy gasoline to the primary tower is avoided.

Further objects and advantages of my invention will appear from the attached drawing illustrative thereof,

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such drawing being a schematic flow diagram of a part of a topping unit for recovering gasoline from crude oil.

As more particularly shown in the drawing, an unreduced crude such as Kuwait containing approximately 2% gas, about 14.5% gasoline with side streams amounting to 43.5% and bottoms amounting to about 40% is charged at 10 through pump 11 and heat exchanger 12 to the topping unit 13. Usually the crude is passed through a desalting operation at 14 and it may also pass through another heat exchanger 15.

In accordance with my invention, topping unit 13 which is in the nature of a flash tower, has a lower flash zone with fractionating decks above the point of feed and is operated at a superatmospheric pressure in the order of 30–50 p.s.i.g. The bottom temperature of this particular tower is maintained in the range of 300°–400° F. to flash off an overhead amounting to about 7.5% of the crude. This includes approximately 1.8% of the total gas and about 5.7% of the gasoline or approximately half of the total gas and gasoline in the crude.

The overhead removed through line 16 is partially condensible with water in the heat exchanger 17 and the condensate is collected in drum 18. The condensate may be pumped through pump 19 and line 20 as reflux to the top of the tower 13.

The bottoms from tower 13 are removed through line 21 and pass through heat exchanger 22 and fired heater 23 where the temperature is brought up to approximately 700° F. to 750° F. which is substantially below cracking. The heated feed is then introduced into the second tower 24 which is operated at a substantially lower pressure in the order of 10–15 p.s.i.g.

In the second tower, the heavy ends of the gasoline driven overhead through line 25 are condensible in heat exchanger 26 with water. It will be appreciated that the heavy ends of the gasoline will condense at a higher temperature than the entire gasoline fraction because of the absence of lighter gasoline components. The condensate is collected at 27 and some of it is removed through line 28, and returned to column 24 as reflux. The side streams removed from this tower account for approximately 43.5% of the crude and the bottoms removed through the line 29 account for about 40% of the crude charged at 10. Stripping steam is introduced through the line 30 to this tower.

The condensate which leaves drum 27 through line 28, includes the heavy ends of the gasoline and in prior practice a portion of such condensate was returned to the primary tower to which it was introduced in part to the overhead vapors and in part as a reflux to the top deck. By returning such heavy ends to the already recovered light ends and condensing the combined stream, the condensed product stream included all of the gasoline and gas in the crude. I have found, however, that in such a system there may occur during long periods of operation a serious overloading of the primary tower because of an uncontrolled high recycle rate of heavy gasoline.

My topping system avoids the aforementioned overloading of heavy gasoline in the primary tower by an additional condensing and collecting step in which the light gasoline vapors of the primary tower and the heavy gasoline of the second tower are combined, but in which the heavy gasoline stream of the second tower is isolated from any return to the primary tower. To accomplish the aforementioned, I provide heat exchanger 31 and condensate collecting drum 32. Light gasoline vapors of the overhead removed from tower 13 are collected in drum 18 with overhead condensate. These light gasoline vapors are removed from drum 18 through line 33 and pass to heat exchanger 31 where they are condensed. A portion

of the heavy condensed gasoline overhead in line 28, not used as reflux for tower 24, is passed through line 34 and joins the flow of light gasoline vapors in line 33 for passage to exchanger 31 where it is cooled and then passed to drum 32.

Condensed light gasoline vapors and heavy gasoline collected in drum 32 are removed through line 35 and pump 36, to provide a product stream of full range gasoline. Any uncondensed vapors collected in drum 32 may be removed as gas product through line 37.

Any excess of condensed light gasoline vapors in reflux line 20 may be returned through line 38 to join the uncondensed light gasoline vapors in line 33 and form a part of the full range gasoline product. Normally such product is ultimately debutanized and may be depropanized with the butane returned back to the gasoline in a separate system to provide the specification vapor pressure gasoline.

It will be apparent that under the circumstances, recovery of the light ends of the gas and gasoline is accomplished in the first tower at temperatures lower than customary and with pressures which would otherwise cause cracking in a one tower system. In the second step the separation is carried out at the necessary high temperature to recover heavier ends of the gasoline and other distillate products but at pressures which can be substantially lower and in a tower which is substantially smaller than customary, due to the absence of the first 7.5% of the crude. As a result, both operations can be carried out with water cooled heat exchangers without the need of external compressors or other devices.

While I have shown and described a preferred form of embodiment of my invention, I am aware that modifications may be made thereto and I desire a broad interpretation of the invention within the scope and spirit of the description herein and of the claims appended hereinafter.

I claim:

1. The method of topping crude oil containing substantial portions of gas and gasoline to produce maximum gasoline boiling range products, which comprises preheating the crude oil and passing the heated oil to a first stage distillation carried out at a pressure above atmospheric pressure at which about one half of the total gas and gasoline content of said oil will be vaporized in flashing and rectification operations carried out in said first stage distillation, withdrawing as overhead the gas and light gasoline vapors from the first stage distillation and partially condensing said overhead in a first stage condensation to produce a first stage condensate, refluxing said first stage distillation with said condensate, withdrawing uncondensed gas and light gasoline vapors from said first stage condensation, withdrawing a bottoms product from said first stage distillation, heating said bottoms product to a temperature substantially above the temperature of said first stage distillation, passing said hot bottoms to a second stage distillation carried out at a pressure below the pressure of said first stage distillation, withdrawing a vapor overhead from said second stage distillation comprising the remainder of the gas and gasoline content of

said oil and condensing said second stage distillation overhead in a second stage condensation to produce a second stage condensate comprising the heavy ends of gasoline, refluxing said second stage distillation with a portion of said second stage condensate, combining the remaining portion of said second stage condensate with said uncondensed gas and light gasoline vapors from said first stage condensation to effect simultaneous preliminary condensation of said light gasoline vapors and absorption of said gas, and cooling said combined stream to provide a condensed total gasoline boiling range product.

2. The method of separating components of a hydrocarbon mixture which includes gas and gasoline to recover a maximum gasoline boiling range product, which comprises heating the hydrocarbon mixture and passing said heated mixture to a primary fractionating column to obtain an overhead and a residue, maintaining said primary column at a temperature and pressure which permit substantially complete removal of the gas components of said mixture in the overhead and partial removal of the gasoline components of said mixture in the overhead, withdrawing said overhead from said primary column and partially condensing said overhead in a first stage condensation to produce a first stage condensate, refluxing said primary column with said condensate, withdrawing uncondensed gas and light gasoline vapors from said first stage condensation, withdrawing the residue as a bottoms product from said primary column, heating said residue to a temperature higher than the bottoms temperature of said primary column and passing said heated residue to a secondary distillation column, operating said secondary column at a lower pressure than the pressure in said primary column, withdrawing a vapor overhead from said secondary column comprising the remainder of the gas and gasoline content of said hydrocarbon mixture and condensing said second stage distillation overhead in a second stage condensation to produce a second stage condensate comprising the heavy ends of gasoline, refluxing said secondary column with a portion of said second stage condensate, combining the remaining portion of said second stage condensate with said uncondensed gas and light gasoline vapors from said first stage condensation to effect simultaneous preliminary condensation of said light gasoline vapors and absorption of said gas, and cooling said combined stream to provide a condensed total gasoline boiling range product.

3. The method of claim 2 wherein the primary fractionating column is at a pressure in the range of 30 to 50 p.s.i.g. and between 300° F. and 400° F. bottom temperature and the secondary distillation column is at a pressure in the range of 10 to 15 p.s.i.g. and between 700° F. and 750° F. feed inlet temperature.

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