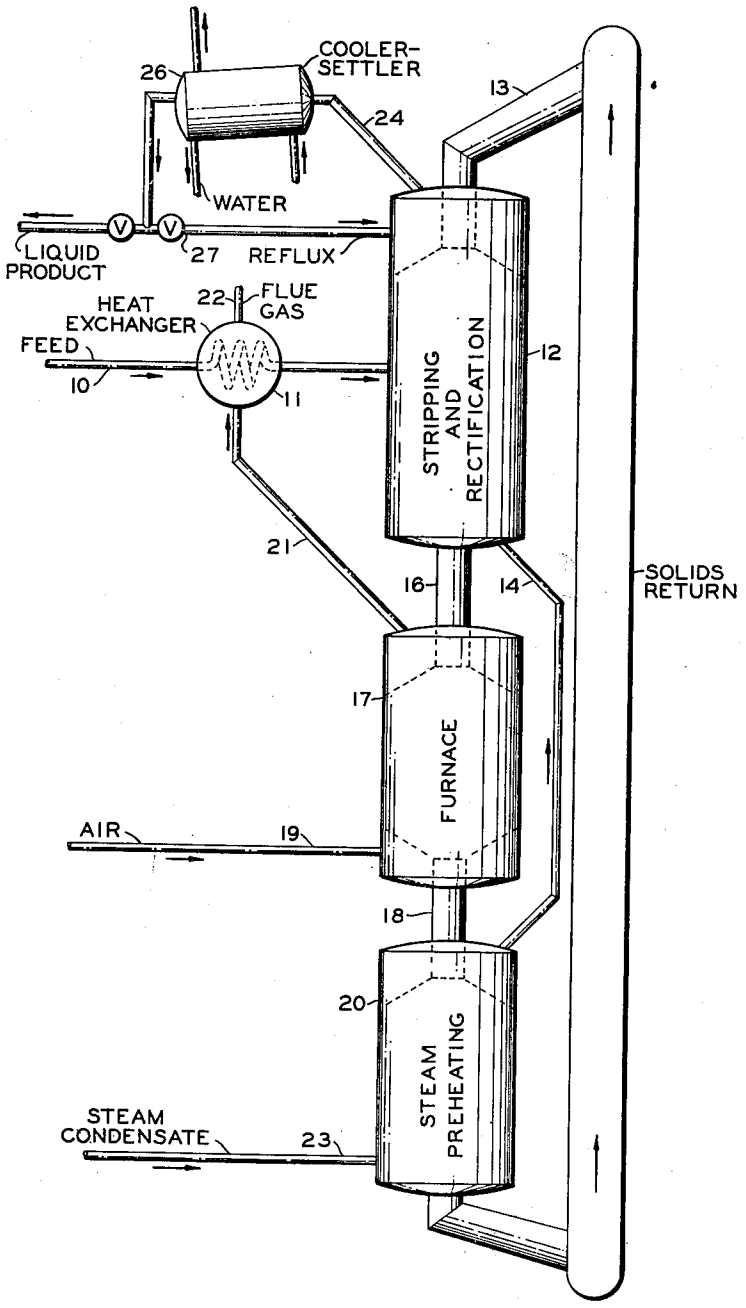
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AUTODISTILLATION

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AUTODISTILLATION

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This invention relates to an improved method for recovering valuable constituents from heavy hydrocarbonaceous materials. In one of its more specific aspects it relates to the recovery of clean heavy gas oil from heavy residuum stocks by an autodistillation process. One specific embodiment of my invention relates to the preparation of a good quality clean gas oil cracking feed from heavy residual hydrocarbonaceous materials with a minimum of cracking of the feed.

In present day processing of petroleum, maximum use is made of the oil to obtain the utmost economic remuneration possible. In spite of the highly developed treating, separating, and recovering steps used, there are still considerable quantities of residual oils and asphaltic containing materials suitable only as fuel oils, paving materials, roofing compounds, and so forth, which bring very little return on investment, since the quantity of these oils and residues generally exceeds the demand.

Present day apparatus for treating the heavy residuum stocks resulting from topping of petroleums are those requiring the use of either high vacuum distillation or moderate vacuum and high temperature distillation. In the former procedure, bubble cap trays, packing, and the like are unsatisfactory because of high pressure drop. In the latter case, considerable cracking takes place, causing carbonaceous deposits on the trays and packing, thereby clogging the equipment. Thus it is seen that further treatment of these heavy residues to recover the maximum quantities of gas oil contained therein is a difficult and often unsolved problem.

An object of this invention is to provide a method for recovering clean heavy gas oil from heavy hydrocarbonaceous materials with a minimum of cracking of the feed.

Another object of this invention is to provide a method for recovering clean gas oil from heavy petroleum residuum by distillation utilizing a continuously moving column packing.

Still another object of this invention is to provide a method for recovering a maximum of gas oil from a heavy residuum stock by a process wherein some cracking of the feed may take place, said cracking not being disadvantageous.

Other objects and advantages will be apparent

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to those skilled in the art from the accompanying discussion and disclosure.

I have discovered an improved process for the treatment of heavy hydrocarbonaceous materials such as residues to produce clean gas oil products. Broadly, my process is a method for distilling heavy residuum stocks in the presence of a moving bed of packing using a vacuum and moderate temperatures.

Refer now to the attached drawing for a complete discussion of a preferred embodiment of my process. Various additional valves, pumps, and other conventional equipment, necessary for the practice of this invention, will be familiar to one skilled in the art and have been omitted for the sake of clarity.

A heavy residuum of about 10 to 20° API gravity is passed, at a suitable feed rate selected with regard to the size of the apparatus, quantity of steam to be used, and flooding rate of the apparatus, through line 10 and heat exchanger 11 where it is heated to a temperature in the range of 600 to 700° F. and thence to stripping and rectification zone 12. The selection of a temperature much below this range increases the steam requirement excessively in supplying additional heat, while use of a temperature above this range will result in undesired cracking in the stripping and rectification zone. Solid packing for this zone is introduced near the top thereof by means of any suitable conveying apparatus indicated by conduit 13 and is flowed therethrough at a linear velocity of 0.1 to 0.5 foot per minute. As the packing moves downwardly through the stripping and rectification section, it is continuously contacted with feed and steam, the latter being introduced through line 14. The steam thus introduced to maintain a bottom temperature in the range of 700 to 750° F. provides distillation heat which causes the lighter components of the residuum feed to be vaporized and passed upwardly through the column. The quantity of steam used for stripping ranges from 3.5 pounds per gallon of overhead product to 15 pounds per gallon. The smaller figure applies when a pressure of about 40 mm. of mercury is utilized. It is not economically feasible to operate at atmospheric pressure, since it is estimated that approximately 300 pounds of steam per gallon of overhead would be required. The

upper portion of this column acts as a rectification zone, thus making it possible to withdraw a plurality of products of varying boiling point. The non-vaporized material clings to the packing as it passes downwardly, and as it moves through the lower portion of zone 12, which is a stripping zone, the maximum quantity of gas oil is removed therefrom by steam stripping. In this zone there may also be some advantageous cracking of the non-volatilized materials which are on the packing. From zone 12 the packing having deposited thereon residual hydrocarbonaceous and asphaltic materials, passes downwardly through conduit 16 into furnace 17. Air is introduced to this zone near the bottom thereof through line 19 in sufficient quantity to cause controlled combustion of the materials deposited on the moving packing. Additional inert gas such as refinery flue gas containing non-combustible material may be used to aid in reducing the temperature of the packing prior to contacting with H_2O as hereinafter discussed. By the time the packing reaches the bottom of this zone the carbonaceous or other deposits have been removed therefrom in what might be called a cleaning process. Thus, the packing, as it passes through conduit 18, is in a relatively clean but rather hot state. Steam condensate or water from another source is introduced near the bottom of preheating zone 20 through line 23, contacting the hot column packing, thereby providing steam which is removed from the top of this zone through line 14 and is passed as previously discussed to the stripping and rectification column where heat obtained by combustion of the heavy portions of the feed in zone 17 is given up by the steam to effect fractional distillation of the feed. The combustion gases from zone 17 are removed from the gas space in the top of this zone through line 21 and are passed to heat exchange with the feed for zone 12 in heat exchanger 11. An alternative of this is to place coils in the top of zone 17, above the packing therein, and to circulate the feed to zone 12 therethrough. Cooled combustion gases are removed from this heat exchanger through line 22. The clean cool packing is withdrawn from the bottom of zone 20 and passed through previously mentioned conveyor means 13 back to the top of the stripping and rectification column. Effluent from the stripping and rectification section generally boiling in the range of 850 to 1150° F. is withdrawn overhead through line 24 and is passed through cooler-settler 25 to cause condensation and phase separation of the distilled hydrocarbon materials and water and the removal of the latter therefrom. The hydrocarbon materials pass to line 27 where the product stream is divided, a portion comprising 10 to 35 volume per cent of the total being recycled to the stripping and rectification zone to act as reflux, while the remaining portion is recovered as product. Suitable means for applying a vacuum on the apparatus is not shown, but is attached to line 24 in any suitable manner.

The solid material used as the moving packing can comprise Berl saddles, Raschig rings, spherical, rod shaped, rectangular or irregularly shaped pebbles, or other conventionally shaped solid particulate packing adaptable to a moving bed and made of refractory material such as the heat resistant clay compounds, metals, or metal alloys. It is preferred that the packing comprise shaped material. The furnace and steam preheating zones discussed are preferably insulated in a suitable manner, such as an internal lining of fire brick or by jacketing and the circulation of suitable coolants through said jacket. The remaining portions of apparatus, such as the heat exchanger 11, cooler 26, the stripping and rectifying column, oil, air and steam condensate injection nozzles, the solid return, and so forth are conventional and may be readily selected by one skilled in the art, depending on the quantity of materials to be handled, the specific packing to be used, the proportion of oil to be recovered, temperatures to be used, and the like.

The advantages of the present invention are illustrated by the following example. The reactants and their proportions and other specific ingredients are presented as being typical and should not be construed to limit the invention unduly.

Example

A vacuum reduced crude having an API gravity of 19.1 and comprising 9.7 volume per cent of a total crude is heat exchanged with the combustion gases of a furnace used to remove carbonaceous asphaltic deposits from the moving packing of a column of the type described in the attached figure. The temperature of the reduced crude is raised to 650° F. and it is then introduced to the stripping and rectification section of my apparatus. Steam preheated in the steam preheater of my invention is introduced in the vicinity of the bottom of the stripping and rectification section of my column at a temperature in the range of 1000 to 1100° F. and in a quantity of about 3 and one-half pounds per gallon of reduced crude feed. The steam passing upward through the column strips the heavy gas oil upwardly while it continuously contacts a downwardly flowing packing. The stripped oil, which is of a boiling range of 850 to 1150° F. and which is of a clean character, that is, having less than a 0.5 carbon residue, is recovered overhead and is then separated by condensation of the stripping steam therefrom. The condensate is recycled to the steam preheater. A portion of this recovered clean oil is reintroduced near the top of the column so as to provide rectification therein. The recovered oil, suitable for a feed to a cracking unit because of its clean character, has an API gravity of about 21 and comprises 8.9 volume per cent of the total crude. This, combined with the gasoline, kerosene, light gases, gas oil, etc., removed by conventional means, amounts to over 99 volume per cent of the total crude. The packing leaving the bottom of the stripping and rectification portion of my column enters the furnace where air is admitted in a manner such that the carbonaceous deposits on the packing are burned off in a controlled manner. As previously discussed, the combustion gases from this burning are heat exchanged with the feed oil. From the furnace zone the now clean but hot packing is passed downwardly to a steam preheating zone where either steam condensate or water from another source is contacted with the packing, thereby producing sufficient steam for the stripping of the clean gas oil from the vacuum reduced crude. The packing leaving the steam preheating zone is at a temperature of about 400° F. and is recycled back to the top of the stripping and rectification portion of the column by means of a vacuum lift or other suitable means. The resulting product is a clean distillate. This tar separated from the oil is not completely lost, since it is burned in the furnace zone to provide

sufficient heat for generating steam for the stripping step. The maximum bottom temperature of the stripping and rectification section is maintained at 750° F. to avoid cracking, and the use of steam in the quantity previously discussed further inhibits such cracking. Higher pressures and more steam may be used in my process. However, this example is treating a specific feed, and the conditions given are generally those selected as optimum. If the crude oil, i. e., the vacuum reduced crude, has more asphalt content than the above discussed oil, additional heat would be available in the furnace zone for preheating the crude oil and/or for making steam. Obviously, if an excess of heat is available it may be readily utilized for other plant processes as desired. In any event, the result is the same, production of maximum yields of clean distillate with elimination of the production of fuel oils and the like of little value.

Although this process has been described and exemplified in terms of its preferred modifications, it is understood that various changes may be made without departing from the spirit and scope of the disclosure and of the claims.

I claim:

1. A method for recovery of high yields of clean gas-oil from heavy residual hydrocarbon oil which comprises gravitating a bed of packing downwardly into and through a stripping and rectification zone; introducing said heavy residual hydrocarbon oil into said gravitating bed of packing intermediate its ends; distributing said heavy residual hydrocarbon oil through said gravitating bed of packing; introducing steam into the lower end of said gravitating bed of packing at a temperature sufficiently high to vaporize at least a portion of said heavy residual hydrocarbon oil from the surface of said packing; passing said steam and vaporized hydrocarbon upwardly through and in direct heat exchange with said bed of packing; removing overhead a mixture of steam and clean gas-oil vapors; condensing said steam and said gas-oil vapors; separating said gas-oil and water resulting from the condensation; recycling a portion of the recovered gas-oil to the top of said gravitating bed of packing as reflux; continuously gravitating said packing from said stripping and rectifying zone at a rate of 0.1 to 0.5 linear foot per minute; burning carbonaceous deposits from the surface of said packing gravitated from said stripping and rectifying zone by contacting same with air in a combustion zone; passing resulting combustion products and said heavy residual hydrocarbon oil feed in an indirect heat exchange prior to the introduction of the residual oil into the stripping and rectifying zone; gravitating the resulting hot clean packing from said combustion zone through a steam producing zone; contacting water with said hot clean packings in a direct heat exchange so as to convert said water to steam; removing said steam from said steam producing zone and introducing said steam into the lower end portion of said stripping and rectifying zone at a temperature in the range of 700 to 750° F.; gravitating resulting cooled packing from the lower end of said steam producing zone; and elevating said cooled packing to top of said stripping and rectifying zone.

2. A method for the recovery of high yields of clean gas-oil from heavy residual hydrocarbon oil which comprises gravitating a bed of packing material downwardly into and through a stripping and rectification zone; introducing said

preheated heavy residual hydrocarbon oil at a temperature in the range of 600 to 700° F. into said gravitating bed of packing intermediate its ends; distributing said preheated hydrocarbon oil through said gravitating bed of packing; introducing steam at the lower end portion of said gravitating bed of packing at a temperature sufficiently high to vaporize at least a portion of said hydrocarbon oil from the surface of said packing; passing said steam and vaporized hydrocarbon upwardly through and in direct heat exchange with said bed of packing; removing said steam and hydrocarbon oil vapors from the upper end portion of said stripping and rectification zone; condensing said steam and hydrocarbon oil vapors; separating resulting liquid gas-oil from resulting water; recycling a portion of said recovered gas-oil to the upper end of said gravitating bed of packing as reflux; gravitating said packing from the lower end of said stripping and rectification zone to a combustion zone therebelow at a rate of 0.1 to 0.5 linear foot per minute; burning carbonaceous materials from said packing gravitated from said stripping and rectification zone by contacting same with air; passing said heavy residual oil feed for said stripping and rectification zone in indirect heat exchange with resulting combustion products from said combustion zone; gravitating hot clean packing from said combustion zone into and through a steam producing zone; contacting water with said hot clean packing in a direct heat exchange so as to convert said water to steam; removing said steam from said steam producing zone and introducing it into the lower end portion of said stripping and rectifying zone at a temperature in the range of 700 to 750° F.; gravitating said packing from the lower end of said steam producing zone; and elevating said packing to the top of said stripping and rectification zone.

3. A method for the recovery of high yields of clean gas oils from heavy residual hydrocarbon oil which comprises gravitating a bed of packing downwardly through a stripping and rectification zone; introducing said heavy residual hydrocarbon oil into said gravitating bed of packing intermediate its ends; distributing said heavy residual hydrocarbon oil through said gravitating bed of packing; introducing steam into the lower end portion of said stripping and rectification zone in an amount equal to 3.5 to 15 pounds per gallon of overhead hydrocarbon products at a temperature sufficiently high to vaporize at least a portion of said hydrocarbon oil from the surface of said packing; passing said steam and vaporized hydrocarbon oil upwardly through and in direct heat exchange with said bed of packing; removing said steam and hydrocarbon oil vapors from the upper end portion of said stripping and rectification zone, said oil boiling in the range of 350 to 1150° F.; condensing said steam and oil vapors; recovering resulting liquid gas-oil from resulting water; recycling between 10 and 35 volume per cent of the recovered gas-oil to the upper end of said gravitating packing bed as reflux; continuously gravitating packing from the lower end of said stripping and rectification zone to a combustion zone therebelow at a rate of 0.1 to 0.5 linear foot per minute; burning carbonaceous deposits from said packing in said combustion zone by contacting said packing with air; passing resulting hot combustion products in indirect heat exchange with said heavy residual oil prior to the introduction of said oil into said stripping and rectification zone, thereby

heating said feed to a temperature in the range of 600 to 700° F.; gravitating the hot clean packing from said combustion zone to a steam producing zone therebelow, wherein said hot packing is contacted with water so as to convert said water to steam; removing said steam from said steam producing zone and passing said steam to the lower end portion of said stripping and rectification zone at a temperature in the range of 700 to 750° F.; gravitating said packing material from the lower end of said steam producing zone; and elevating said packing material to the upper end portion of said stripping rectification zone.

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