

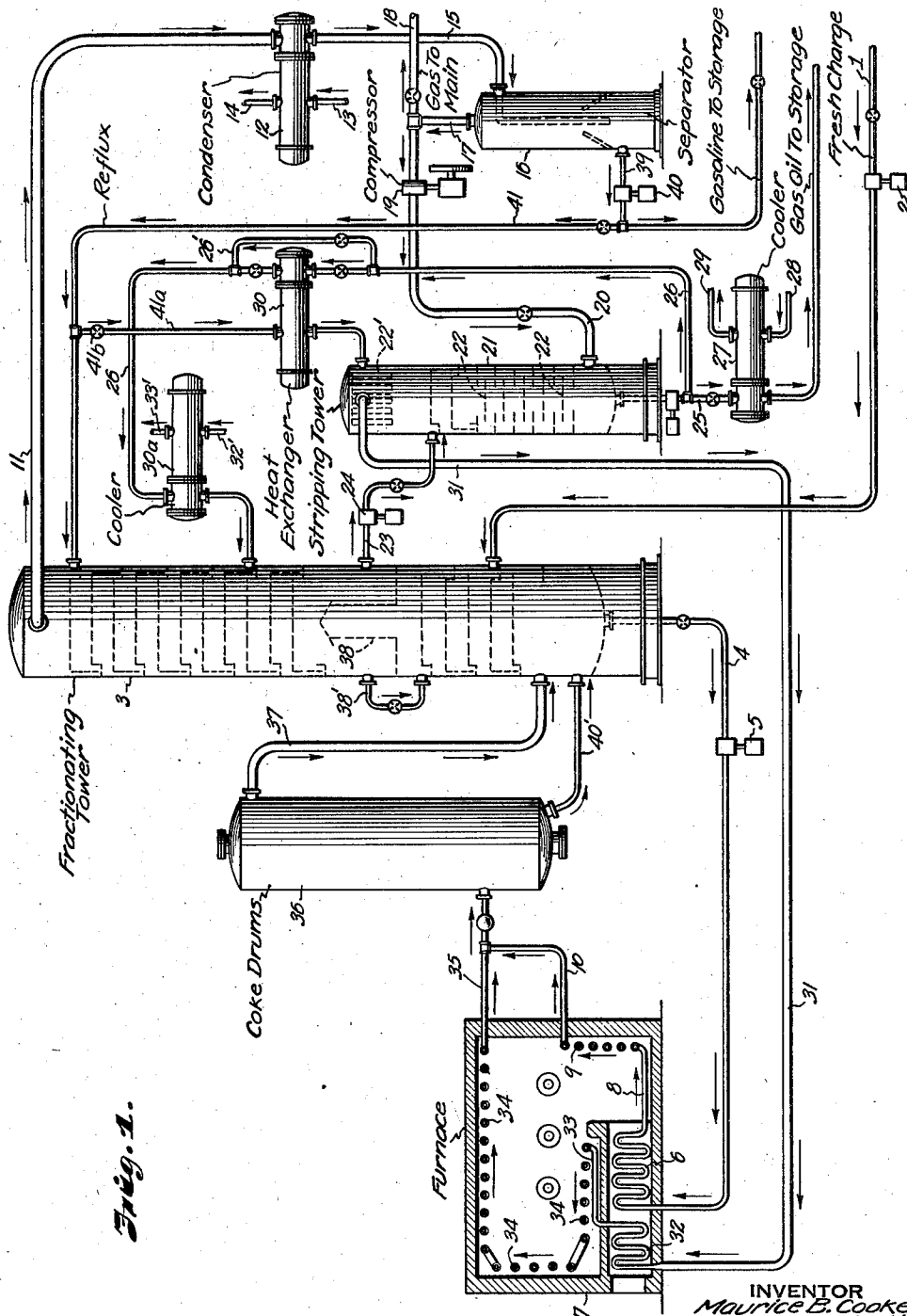
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METHOD OF PRODUCING COKE

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METHOD OF PRODUCING COKE

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Our invention relates to the art of distillation and more particularly to the distillation of asphaltums, asphaltic residuums and heavy petroleum residues for the production of solid, dry coke.

5 The production of coke from the standpoint of petroleum refining may be generally classified under two main headings; first, coke produced from shell still distillation of reduced crude and, second, coke produced as a by-product of a crack-

10 ing operation. Each of these processes embraces a particular field. The production of coke from shell still distillation of heavy residuums is a secondary feature arising from the primary purpose which is to recover the gasoline and heavier products from the residue. The formation of coke in large quantities is objectionable from the standpoint of efficient operation of a shell still. For example, a heavy oil residuum of 5 A. P. I. gravity must be distilled at temperatures ranging between 920° F. to 940° F. to recover the lighter fractions contained therein. A residuum of this gravity will coke at temperatures ranging between 800° F. to 875° F. if distilled as a substantially stagnant pool. The inefficiency of the process because of carbon deposition renders this method of distillation quite uneconomical.

25 The non-residue cracking of gas oil and heavier distillates for the production of gasoline is accompanied by the production of coke. Such coke is generally of low market value and unsatisfactory because of wetness from retained volatiles which, when the coke is burned, produce soot and foul the furnace. The coke crumbles readily, frequently explodes because of occluded oil, and is not readily salable for domestic and industrial consumption. Very seldom is this coke directly suitable for metallurgical purposes.

30 It is an object of our invention, therefore, to provide a process for producing a solid dry coke from asphalt or a heavy petroleum residuum, recovered from any previous distillation or cracking operation, which will be suitable for domestic or industrial consumption.

45 It is a further object of our invention to provide a process in which a heat carrying medium is utilized to produce a solid dry coke from asphalt or a heavy petroleum residuum recovered from any previous distillation or cracking operation.

50 It is a still further object of our invention to provide a combined coking and distillation process which will produce a solid dry coke and fixed gas and secure a substantial recovery of hydrocarbon distillate of substantially a gas oil boiling

range, from asphalt or a heavy petroleum residuum recovered from any previous distillation or cracking operation.

5 It is another object of our invention to provide a coking process utilizing a heat carrying medium in which the volatile content of the coke produced is controlled by the time temperature relationship of heat carrying medium to liquid established in the coking chamber.

10 Another object of our invention is to provide a coking process in which those heavy fractions not initially coked are continuously recycled to secure complete reduction to and a maximum yield of coke from the initial charge.

15 Another object of our invention is to provide a coking process in which the composition of the heat carrying medium recovered in the process may be controlled to obtain the most suitable reactant for the coking operation.

20 Other and further objects of our invention will appear from the following specification and claims.

25 The accompanying drawing, which forms part of the instant specification and is to be read in conjunction therewith, is a schematic showing in elevation with parts in section of one form of apparatus capable of carrying out the process of our invention.

30 In general, we subject asphaltic residuum or heavy petroleum oil to fractionation as a result of which a bottom fraction, of constant quality with respect to gravity, distillation and boiling range, and lighter distillates are formed. The bottom fraction is heated under conditions which will prevent the formation and deposition of carbon in the heating element and will substantially avoid cracking. A heat carrying medium which may be a gas or light distillate, recovered, for example, from the overhead products of the fractionating tower or from any other suitable source, is heated 40 to a temperature above that of the heated fraction to be coked and physically mingled with the heated liquid fraction in a coking chamber. As a result of the heat interchange between the heated liquid fraction and the heat carrying medium, a carbonizing of the petroleum compounds is effected with a resultant production of coke, gas, and volatiles which latter are mainly of gas-oil boiling range. The volatiles and gas are removed from the coking drum and returned to 50 the fractionating tower where by fractionation the heaviest ends are removed and recycled for complete coking, and the lighter ends recovered for use as a heat carrying medium in the system. As a result of the operation of our process we are 55

enabled to produce not only a maximum yield of solid dry coke from an initial charge, but also to recover a considerable amount of distillates of gas oil character.

Referring now more particularly to the drawing, the petroleum to be processed is led from a source (not shown) through a line 1 having a pump 2 to the lower section of a two section fractionating tower indicated generally as 3. The heaviest fraction which accumulates in the bottom of this tower is pumped through the line 4 having a pump 5 to a convection section 6 of the furnace setting 7. This convection section 6 is connected by means of a line 8 to the tubes of a radiant heating section 9 of the furnace from which a line 10 leads to the feed line 35 of a heat carrying medium. From the top of the fractionating tower 3 a line 11 leads to a vapor condenser 12 which is provided with cooling liquid inlet means 13 and outlet means 14. This condenser 12 is connected by means of a line 15 with a separator 16 from the top of which a line 17, provided with a bleed-off line 18, is connected to the intake side of a compressor 19. The outlet side of this compressor is connected by means of a line 20 to the bottom of a combined stripping and gas enriching tower 21 provided with baffle means 22' and trays indicated generally as 22. The gas reduces the partial pressure and acts as a stripping medium. From a suitable section of the fractionating tower 3 a line 23 provided with a pump 24 leads to the upper tray of the stripping section in the tower 21. A withdrawal line 25 from the bottom of the tower 21, passes through a cooler 27 provided with liquid inlet and outlet means 28 and 29, respectively, to a storage tank (not shown). A branch line 26 having suitable valves passes through the heat exchanger 30, and cooler 30a provided with cooling liquid inlet and outlet means 32' and 33', respectively, to a suitable tray of the fractionating tower 3. The heat exchanger 30 may be bypassed by means of a line 26' having a valve. The separator 16 is provided with a withdrawal line 39 having a pump 40 for the removal of light distillate collected in the separator 16 and for delivering it to storage or for further processing. A line 41 connects the withdrawal line 39 with the top of the fractionating tower 3 for the return of reflux thereto. From any suitable point on the line 41, a line 41a having a valve 41b leads through the heat exchanger 30 to the trays in the upper part of the gas enriching section of the tower 21. Connected to the top of the tower 21 is the heat carrying medium feed line 31 which leads to the tubes of the economizer convection section 32 of the furnace setting 7. This convection section is connected by means of the line 33 to the tubes 34 of a radiant heating section of the furnace. The outlet from these tubes is connected by means of a line 35 with a coking chamber 36. This line 35 may be manifolded and connected to a plurality of coking chambers although we have shown but one for the sake of simplicity. In the event that a plurality of these chambers is used, it becomes possible to utilize any one for coking while another is being cleaned of the coke which may already have accumulated therein from a previous coking operation. The upper part of the coking drum 36 is connected to the bottom section of the fractionating tower 3 by means of a line 37. The upper and lower sections of the fractionating tower are connected by means of a large vapor passage 38 and liquid return line 38' which serves to return part of the

condensate from the upper portion of the tower to the lower portion to knock back heavy ends carried over by the vapors from the lower to the upper portion of the tower. A line 40' returns uncoked residuum for recycling.

An example of the operation of our invention is as follows: Asphalt, asphaltic residuums or heavy petroleum residue is charged by means of the pump 2 through the line 1 to the fractionating tower 3 wherein the liquid is partially vaporized, the vapors rising upward through the tower in which fractional condensates collect on the various trays. The heavy liquid fraction which collects in the bottom of the tower, and which may be, for example, at a temperature ranging between 600° F. to 750° F., and which, under the pressure and temperature conditions maintained in this portion of the tower will be kept free from light ends, is pumped through the line 4 by means of the pump 5 through the convection section 6, connecting line 8 and radiantly heated section 9 of the furnace setting 7. The velocity of the liquid through the tubes of these heating sections is such as to prevent the formation and deposition of carbon and substantially avoid cracking. The heated liquid oil which has been raised to a temperature between 800° F.-875° F. or a temperature as high as possible without deposition of coke in the tubes, is charged through the line 10 to the line 35 in which it is contacted by a heat carrying medium which has been recovered from the fractionating system or other suitable source and enriched or treated to secure the desired constituency in a manner which will be more fully described hereinafter. As a result of the physical mingling of the heat carrying medium and liquid oil in the coking drum wherein the mixture will be, for example, at a temperature ranging between 900-1000° F. depending on the character of the oil to be converted to coke and the constituency of the heat carrying medium, a carbonizing or coking of the heavy liquid petroleum will be effected with the simultaneous evolution of lighter hydrocarbons, a minor portion of gas and gasoline and a major portion of gas oil boiling range fraction. It is also to be observed that as the result of the physical mingling of the liquid and heat carrying medium at the selected temperature, a dry solid coke is produced which will have a minimum amount of occluded oil. When a suitable amount of coke has accumulated within the vessel 36 another vessel of the battery may be selected to continue the coking and the solid coke in the first vessel may be removed by any of the means well known in the art. Satisfactory operation of a coking vessel of this type is secured by means of the temperature level and the temperature difference in inlet and outlet held in this chamber. A further means of securing efficient functioning of this drum, that is, the attaining of a maximum production of coke per pass while leaving a minimum amount of heavy fractions to be recycled as liquid, is by the regulation of the composition. For example, at a given composition of the liquid charge and the heat carrying medium, syphoning or other irregularities in the drum will occur under given temperature conditions. Elimination of this improper functioning of this drum may be obtained by fixing the inlet temperature and varying the outlet temperature of the drum, to establish a fixed temperature difference between inlet and outlet, or by maintaining the same outlet temperature and varying the inlet temperature to secure a fixed temperature difference be-

tween inlet and outlet. The oil vapor and gas leaving the coking drum 36 which are, for example, at a temperature ranging from 875° to 950° F. are delivered through the line 37 to the bottom of the fractionating tower 3 for separation or fractionation. The vapor inlet to the bottom section of the fractionating tower is submerged below the liquid level maintained in this section for the purpose of immediate temperature reduction of the hot vapors and for securing stripping action upon the liquid contained in the bottom of the tower. The ascending vapors are further cooled and fractionated when passing through the trays above, counter-current to the incoming fresh feed from the line 1 and the supplementary reflux withdrawn from the bottom of the upper section of the tower through the line 38'. After this process the vapors rise upward through the large vapor passage 38 into the upper section of the fractionating tower 3. Here a separation is made between the light and heavy ends, which latter are mainly gas oil boiling range constituents which are withdrawn through line 23 at a temperature ranging from approximately 500 to 550° F. The lighter ends consisting of a light distillate and gas are withdrawn from the top of the tower through line 11 to be recovered and mostly recycled in the system as the heat carrying medium.

Returning now to the fractionating tower, the light distillate and gas which under the temperature and pressure conditions existing in the fractionating tower have not been condensed on the various trays are removed through the line 11 and are passed through the vapor condenser 12 wherein the light distillate is liquefied and the degree of condensation is controlled by the condenser outlet temperature to secure a gas of such leanness as will function most effectively as a gas oil stripping agent later in the process. The cooling of this vapor condenser is effected by water which enters through the line 13 and after circulation is removed through the line 14. The distillate and gases are removed from the vapor condenser through the line 15 and passed into the separator 16 from which the light distillate is removed through the line 39 by means of the pump 40 and a portion delivered to storage. The other portion of light distillate is returned in part as reflux to the top of the fractionating tower 3 through the line 41 and in part used for controlling the constituency of the heat carrying medium in the stripping tower 21. The gas or uncondensed fraction is taken off overhead through the line 17 to the intake side of the compressor 19. The amount in excess of the fraction desired as a heat carrying medium is continuously removed from the line 17 through the line 18. The compressor 19 will deliver the gas at a pressure for example of 50#-100# per square inch to the bottom of the tower 21. Gas oil at a temperature of around 500-550° F. removed from the fractionating tower 3 by means of pump 24 and the line 23 is charged to a section below the uppermost or enrichment trays of the tower 21. The gas delivered to the bottom of the tower rises upward and comes into intimate contact with the liquid gas oil descending over the baffle section of the tower. The gas serves to strip from the gas oil the necessary fractions so that the gas oil will meet the necessary specifications with respect to flash point. The gas oil is removed from the bottom of the tower 21 through the line 25 and is cooled in the cooler 27 to which cooling liquid is fed through the line 28 and removed

through the line 29. The gas oil after cooling may then be delivered to storage. The portion of the gas oil in excess of the net gas oil produced which may be at a temperature ranging from 400 to 450° F. is diverted through the line 26, heat exchanger 30, and cooler 30a and delivered to a suitable tray in the fractionating tower 3 to serve as intermediate reflux. The cooler 30a is provided with suitable cooling liquid inlet and outlet means 32' and 33' respectively. A certain portion of the light distillate flowing through the line 41 from the separator 16 is diverted through the line 41a having a valve 41b and passed in heat interchange relationship in the exchanger 30 with the gas oil delivered thereto by means of the line 26. The heated light distillate is delivered from the exchanger 30 to the tower 21 at a point above the top tray of the gas enriching section of this tower. By this means we are enabled to provide for an enrichment of the heat carrying medium in the upper part of the tower 21 before delivery to the furnace 7. The temperature of the light distillate delivered to the upper part of the tower 21 may be controlled by suitable manipulation of the valves in lines 26 and 26', whose adjustment will permit any desired amount of gas oil to flow through the heat exchanger 30. It will be observed that by means of the vapor condenser 12 we have been able to control the leanness of the gas delivered to the stripping section of the tower 21 to secure the most effective stripping of the descending gas oil and by the temperature control of the light distillate feed passing through the heat exchanger 30 we are enabled to control the richness of the gas after its stripping function has ended. The enriched gases from the tower 21 which may now be at a temperature between 450-500° F. is delivered under pressure through the line 31 to the economizer convection section 34 of the furnace 7. These gases are raised in the furnace to a temperature between 1100 and 1200° F., are removed through the line 35, and contacted with the heated liquid oil from the line 10 to the coking drum 36.

It is to be understood that the recital of temperatures and pressures in connection with the various steps of the process is by way of example only since the exact figures must be selected in accordance with the character of the petroleum being processed and the constituency of the heat carrying medium.

It is to be observed that we have accomplished the objects of our invention and have provided a process which will produce a dry coke for any grade of charging stock and secure recovery of a maximum amount of distillate of substantially a gas oil boiling range gas and a minor amount of light distillate from asphalt or a heavy petroleum residuum.

It will be understood that certain features, sub-combinations and operations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of our claims. It is further obvious that various changes may be made in details within the scope of our claims without departing from the spirit of our invention. It is, therefore, to be understood that our invention is not to be limited to the specific details shown and described.

Having thus described our invention, what we claim is:

1. A process for producing solid coke from asphaltums, asphaltic residuums or heavy petro-

leum oils, comprising the steps of passing the oil to a fractionating zone, withdrawing the residue therefrom, passing the residue to a heating zone and there heating the residue, passing the heated residue to a carbonizing zone, removing the uncondensed mixture of hydrocarbon vapors and gases from the fractionating zone, cooling the mixture sufficiently to condense the distillate therefrom and leave a substantially gasoline free lean gas, passing a stream of the lean gas to a stripping zone, withdrawing a side stream from the fractionating zone and passing it to the stripping zone, intimately contacting the lean gas in the stripping zone with the side stream and withdrawing the stripped side stream from the stripping zone, withdrawing from the stripping zone the mixture of lean gas and products stripped from the side stream, heating the gaseous mixture, physically mingling the heated gas with the heated residue passing to the carbonizing zone, effecting carbonizing of the condensate by the heated gas under time temperature conditions productive mainly of hydrocarbon vapors and a solid dry coke, and returning the vapors to the fractionating zone.

2. A process for coking asphaltums, asphaltic

residuums or heavy hydrocarbon oils comprising the steps of separating the uncondensed gas vapor mixture withdrawn from a fractionating zone into a distillate and a substantially gasoline free cool lean gas, passing the cool lean gas into a stripping zone, intimately contacting the gas therein with a downflowing stream of relatively hot liquid withdrawn from the fractionating zone whereby the gas is heated and enriched with light hydrocarbons undesirable in the stripped product, withdrawing the stripped liquid from the stripping zone, heating a relatively heavy hydrocarbon oil, separately heating a stream of enriched gas withdrawn from the stripping zone to a temperature sufficient to ensure coking of the heated oil, intimately physically commingling the heated oil and gas, causing carbonizing of the oil and decomposition of the heated gas to take place under time temperature conditions productive mainly of hydrocarbon vapors and a solid dry coke, and returning the vapors to the fractionating zone.

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