

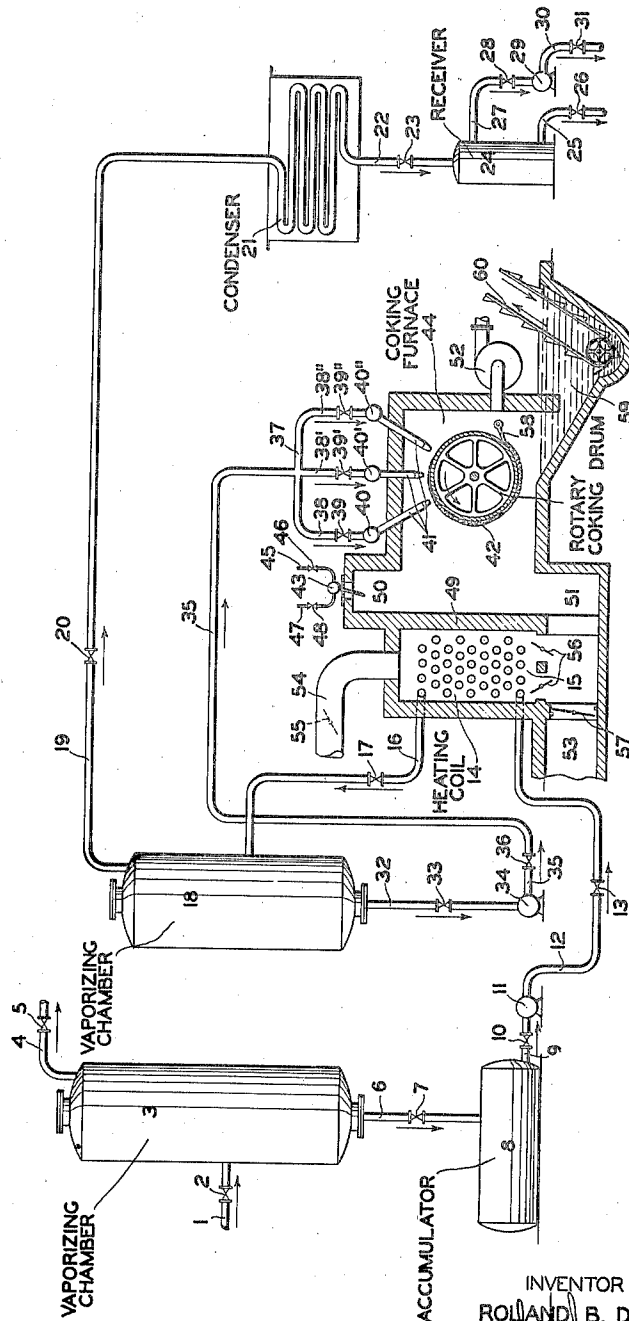
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PROCESS AND APPARATUS FOR COKING HYDROCARBON OILS

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PROCESS AND APPARATUS FOR COKING
HYDROCARBON OILS

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This invention refers to an improved process and apparatus for the coking of heavy petroleum oils and is more particularly directed to the process and apparatus for the coking of residue resulting from the conversion and flash distillation (vaporization under reduced pressure) of hydrocarbon oil or hydrocarbons generally.

In one embodiment, the invention comprises subjecting liquid products resulting from the pyrolytic conversion of petroleum or other hydrocarbons, at substantial superatmospheric pressure, to further vaporization in a vaporizing zone operated at substantially reduced pressure, withdrawing non-vaporous residual liquid from the vaporizing zone, heating the same in a heating coil, introducing the heated residual oil into another vaporizing chamber preferably maintained at subatmospheric pressure, whereby to effect its further vaporization, subjecting the evolved vapors to condensation, recovering the resulting distillate, withdrawing the residue remaining unvaporized from said separate vaporizing chamber and discharging the same at progressive intervals onto the external surface of a rotating drum within a furnace, upon which surface a layer of coke is allowed to accumulate, supplying heat to the residual material upon the surface of said drum by direct radiation from fuel undergoing combustion and from hot refractory walls of the furnace, continuously removing accumulated coke from said rotating drum, discharging the same from the furnace and utilizing hot combustion gases from the coking zone to heat the oil passing through said heating coil.

It will be understood, of course, that the invention is not limited to the coking of residual oils resulting from cracking nor to all of the steps outlined in the above specific embodiment. The features of the invention and the apparatus disclosed have wide applicability and it is not intended to limit the invention except as defined in the appended claims.

The accompanying diagrammatic drawing is an elevation with parts in section of one specific form of apparatus in which the process may be practiced.

Liquid products resulting from the conversion of hydrocarbon oil or other hydrocarbons at substantial superatmospheric pressure are supplied from any suitable cracking equipment, not illustrated, either alone or together with vaporous conversion products of the process, while still in heated state, through line 1 and valve 2 to vaporizing chamber 3.

Chamber 3 is preferably maintained at a sub-

stantially reduced pressure relative to that at which the liquid conversion products are produced, by means of which appreciable vaporization thereof is accomplished in this zone. The evolved vapors as well as any vaporous conversion products supplied to chamber 3 with the liquid conversion products are withdrawn therefrom through line 4 and valve 5 to subsequent treatment such as fractionation, etc., not pertinent to the present invention and therefore not illustrated. The residual liquid remaining unvaporized in chamber 3 is withdrawn from the lower portion of this zone through line 6 and valve 7 and may be directed to a suitable accumulator 8 from which it is withdrawn through line 9 and valve 10 to pump 11 and continuously discharged through line 12 and valve 13 to heating coil 14. Accumulator 8 serves as a reservoir to insure the continuous supply of residual liquid to the heating coil without the necessity of maintaining any appreciable body of liquid in chamber 3 so that the products discharged into chamber 3 will not be excessively cooled by the presence of a large body of previously accumulated residue. Accumulator 8 is, however, not essential to the operation of the process and may be eliminated, when desired. When accumulator 8 is employed it is preferably insulated to conserve heat.

The non-vaporous residual liquid supplied to heating coil 14 is heated therein by indirect heat exchange with hot combustion gases from a coking furnace which are supplied as will be later more fully described, to heating zone 15, within which coil 14 is located. The temperature and pressure conditions to which the oil is subjected in this zone and the velocity of the oil flowing through the heating coil are regulated to prevent any appreciable coke formation in this zone and to insure further vaporization of the residual liquid to the desired degree under the pressure conditions maintained in vaporizing chamber 18, to which the heated oil from heating coil 14 is supplied through line 16 and valve 17.

The further vaporization of the liquid conversion products in chamber 18 is preferably carried to a point where the remaining non-vaporous residue is reduced to a relatively viscous liquid, such as pitch or the like, and preferably sub-atmospheric pressure is employed in chamber 18 in order to assist such vaporization. The vapors evolved in chamber 18 are withdrawn therefrom through line 19 and valve 20 and are subjected to condensation in condenser 21 from which the resulting distillate and gas passes through line 22 and valve 23 to collection and separation in

receiver 24. The distillate may be withdrawn from receiver 24 through line 25 and valve 26 to storage or to any desired further treatment and may, when desired, be returned for further conversion to the same cracking system wherein the liquid conversion products supplied to chamber 3 are produced. Uncondensable gas produced by the operation may be withdrawn from receiver 24 through line 27 and valve 28 and when sub-atmospheric pressure is employed in chamber 18 a suitable vacuum pump 29 may be employed in line 27 wherefrom the gases are discharged through line 30 and valve 31 to scrubbing and storage or elsewhere, as desired.

The viscous residual liquid remaining unvaporized in chamber 18 is withdrawn from the lower portion of this zone through line 32 and valve 33 to pump 34 by means of which it is fed through line 35 and valve 36 to header 37 wherefrom it passes through branch lines 38, 38' and 38'' controlled by the respective valves 39, 39' and 39'' to manifolds 40, 40' and 40'', respectively, from each of which the oil may be fed by means of a plurality of suitable nozzles 41 onto the outer surface of a drum 42 which is rotated, in the particular case illustrated, in a counter-clockwise direction.

By introducing the oil onto drum 42 at progressive points around its path of rotation, as illustrated in the drawing, a film or layer of fresh oil may be sprayed over the coked or partially coked layer of previously applied oil whereby a coke layer of several inches thickness, for example, may be built up upon the rotating drum. Also by applying fresh increments of oil over the surface of the previously coked or partially coked residue the pores of the latter may be filled with oil and the porosity of the final coked product considerably reduced. Another factor affecting the porosity of the coke is the velocity with which the oil is discharged onto the drum and the size of nozzle 41 may be regulated to suit requirements in this respect. By reducing the residue to a heavy relatively viscous nature before it is directed onto the surface of the coking drum its tendency to adhere to the surface of the drum during the process of coking is materially improved and the coking operation generally facilitated, due to the fact that there are less volatiles to be evolved from the residue in the coking furnace. This method of operation also obviously increases the recovery of liquid products from the process as compared with an operation wherein the residue is not subjected to extensive vaporization prior to being discharged onto the coking drum and furthermore, by the method of operation of the present process, a much smaller amount of volatile material is contaminated with combustion gases by being commingled therewith in the coking furnace.

Heat for coking of the heavy residue discharged onto the coking drum is derived from the combustion of fuel of any suitable form supplied through burners such as indicated at 43 into the coking furnace 44. Preferably the proportion of air in the combustible fuel air mixture thus supplied to the furnace is maintained sufficiently low to obviate combustion of the residue undergoing treatment and/or the coke produced. Fuel such as oil, gas or pulverized solid fuel, for example, may be supplied to burner 43 by means of line 45 and valve 46 and air may be supplied thereto through line 47 controlled by valve 48. Preferably, the burners are tilted, as indicated in the drawing, so as to direct the com-

bustible materials against a suitable refractory wall 49 of the furnace so disposed that the surface of the material undergoing coking on drum 42 is subjected to radiation therefrom. Direct radiant heat from the materials undergoing combustion is also imparted to the surface of the material undergoing coking and in the case here illustrated a direct unrestricted path through furnace 44 is provided for the combustion products from firing compartment 50 to flue 51 along wall 49 of the furnace so as to minimize commingling of the combustion gases with hydrocarbon gases and vapors evolved from the residual material during the coking operation. The latter are withdrawn, preferably, at a point in the furnace remote from the direct path of flow of the combustion gases which pass, in the case here illustrated, through a suitable fan or blower 52 to suitable scrubbing or absorption equipment, not illustrated, or elsewhere, as desired. The combustion gases from flue 51 may pass through tunnel 53 to a suitable stack, not shown, but preferably are directed, all or in part, into heating zone 15 of the furnace, containing heating coil 14, about which the hot combustion gases pass, imparting heat to the oil flowing therethrough and being directed therefrom through a suitable flue 54 regulated by damper 55 to a stack, not shown. Dampers 56 and 57 serve to regulate the proportion of the total combustion products from furnace 44 which are allowed to pass through heating zone 15.

The accumulated layer of coke may be removed from the rotating coking drum 42 by means of a suitable scraper 58, or in any other suitable manner, not illustrated; the coke passing, in the case here illustrated, through a suitable quenching medium 59 such as water, for example, to conveyor 60 by means of which it is removed from the system to storage or elsewhere, as desired.

The preferred range of operating conditions in a process such as illustrated and above described may be approximately as follows: The temperature to which the residual liquid from the vaporizing chamber of the cracking system is subjected in the heating coil may range, depending upon the characteristics of the residue, from 700 to 800° F., or thereabouts, and preferably, as already indicated, the conditions of treatment in this zone are such as to prevent any appreciable coke formation therein. The pressure employed in the heating coil may range, for example, from substantially atmospheric to 100 pounds, or more, per square inch. The vaporizing chamber following the heating coil, as already mentioned, is preferably operated at subatmospheric pressure, although substantially atmospheric or low super-atmospheric pressure may be employed in this zone, when desired. The temperature to which the nonvaporous residue is subjected in the coking zone may range, for example, from 1000 to 1500° F., or more, and substantially atmospheric pressure is preferably employed in the coking zone. The pressures employed in the condensing and collecting portions of the system are preferably substantially equalized with the pressure employed in the vaporizing chamber to which the heated residual liquid from the heating coil is supplied.

As a specific example of one operation of the process of the present invention as it may be practiced in conjunction with a cracking operation producing, as the residual product, a "Bunker C" fuel oil: this material is withdrawn from the va-

porizing chamber of the cracking system, which is operated at a superatmospheric pressure of approximately 50 pounds per square inch, at a temperature of about 680° F., and is passed at high velocity through a heating coil supplied with combustion gases from the coking furnace and is discharged therefrom at a temperature of approximately 775° F. into a vaporizing chamber operated at a pressure about 5 pounds per square inch below atmospheric. Vaporous products from the subatmospheric vaporizing chamber are subjected to condensation and the resulting distillate and gas collected and separated. The non-vaporous residue from the subatmospheric vaporizing chamber is sprayed at high velocity onto an externally heated rotating coking drum supplied with predominantly radiant heat from materials undergoing combustion and the hot refractory walls of the coking furnace. The coking temperature employed in this zone is approximately 1400° F., measured at a point adjacent the surface of the material undergoing coking on the drum. The coke deposited on the rotary drum is continuously removed therefrom by means of a scraper and quenched. This operation will yield, per barrel of cracked fuel oil, approximately 20% by weight of petroleum coke having a volatile content of less than 5% by volume and an apparent density of approximately 60 pounds per cubic foot. The coke although of a porous nature has good structural strength and is recovered largely in the form of lumps. The additional products of the process comprise approximately 70%, based on the fuel oil residue, of an 18–20° A. P. I. gravity fuel oil, recovered as the distillate product of the process. This material has an initial boiling point of approximately 475° F., and about 5% boiling at 572° F., has a color of about 3 N. P. A., a low carbon content by the Conradson method and no appreciable quantity of B. S. & W. (bottom settlings and water), the remaining 10%, or thereabouts, based on the fuel oil residue treated is chargeable to gas.

I claim as my invention:

1. A coking apparatus comprising a furnace having a heat radiant wall dividing the furnace into a heating section and a coking section, a heating coil in the first-named section on one side of said wall, means for generating flame in the coking section and for impinging the same against the opposite side of said wall, a rotary cylinder in the coking section in unobstructed relation to said opposite side of the wall, means for passing

oil through said coil and for discharging residual portions thereof onto said cylinder, and means for passing combustion gases from the coking section through said heating section.

2. A process for coking residual hydrocarbon oils which comprises heating the residual oil to a temperature of at least 700° F. while flowing in a restricted stream through a heating zone, introducing the heated oil to a vaporizing zone and therein vaporizing a substantial portion thereof whereby to reduce the oil to a heavy viscous residue, discharging the latter onto the exterior surface of a cylinder rotating within a coking zone, applying a coking heat to the residue on the rotating cylinder, and removing the resultant coke from the cylinder, said coking heat being transmitted, at least in part, to the residue on said cylinder by direct radiation from flame generated within the coking zone.

3. A process for coking hydrocarbon oil in a furnace having a heat radiant wall dividing the furnace into an oil heating zone and a coking zone, said process comprising passing a stream of residual oil through the heating zone on one side of said wall and heating the same therein to distillation temperature, vaporizing a substantial portion of the heated oil to form a heavy viscous residue, discharging said residue onto the exterior surface of a rotating cylinder disposed in said coking zone, burning fuel adjacent the opposite side of said wall to generate radiant heat in the coking zone, coking said residue on the cylinder by direct radiant heat from the burning fuel and by radiant heat from said wall, and passing combustion gases from the coking zone through the oil heating zone.

4. A coking apparatus comprising a furnace having a heat radiant wall dividing the furnace into a heating section and a coking section, a heating coil in the first-named section and a rotary cylinder in the coking section, a vaporizing chamber outside the furnace and communicating with said coil, means for discharging residue from said chamber onto the exterior surface of said cylinder, means for burning fuel in said coking section adjacent said heat radiant wall whereby to heat the residue on the cylinder by radiation from the burning fuel and said wall, and means for passing combustion gases from the coking section through said heating section of the furnace to heat said coil.

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