

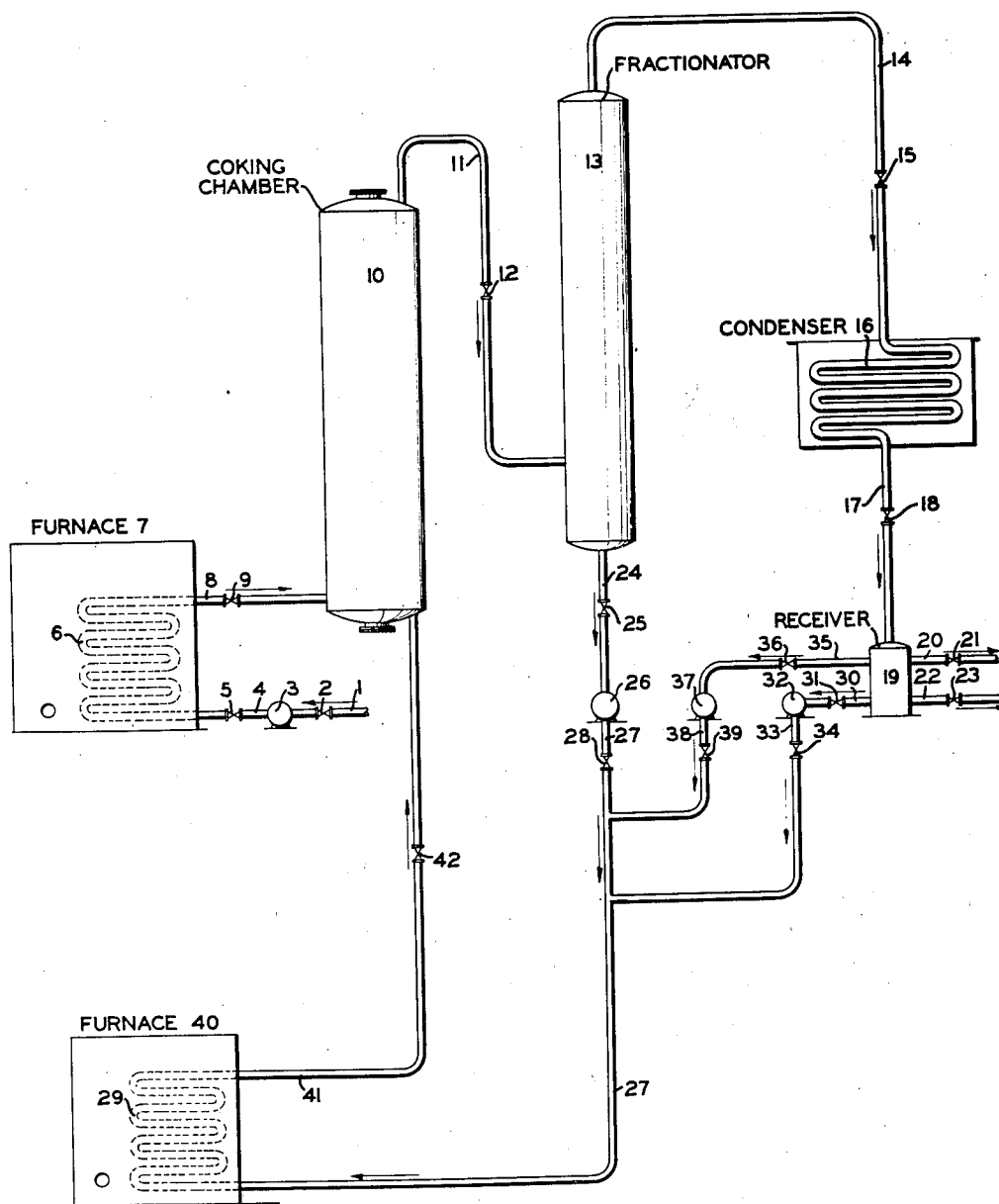
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CONVERSION OF HYDROCARBON OIL

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CONVERSION OF HYDROCARBON OIL

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This invention relates to the treatment of hydrocarbon oils and coal and more particularly refers to the pyrolytic conversion of hydrocarbon oil and the simultaneous devolatilization of coal to produce motor fuels of high antiknock quality and a coke or carbonaceous residue of relatively low volatile matter content.

The present invention makes use of relatively clean distillate which is heated to a relatively high temperature in a heating element, to substantially devolatilize coal or other solid hydrocarbonaceous material by introducing the highly heated oil into a body of said solid hydrocarbonaceous material in a coking zone. Means are also provided for furnishing additional heat to the material undergoing coking by supplying thereto heated intermediate products of the system, together with portions of the distillate and gas produced, all of which are subjected to independently controlled conversion conditions in a separate heating element, products from which are likewise introduced into the coking zone. The latter feature not only serves to increase conversion in the coking zone and to decrease the volatility of the carbonaceous residue produced but also serves as a means of both increasing the yield of light products, such as distillate and/or gas, and regulating the quality of the distillate and gas produced.

Aside from the production of a carbonaceous residue of low volatile content, by varying the operating conditions employed the process may be operated for the production of substantial yields of light distillate, such as motor fuel of high antiknock value, or for the production of increased yields of gas and decreased yields of liquid products even, if desired, to the exclusion of any substantial quantity of distillate.

While the foregoing has specifically referred to coal as the solid component of the charging stock, the features of the invention are well adapted to the treatment of other materials, such as natural or synthetic asphalts, heavy tars or pitches, shales, lignite, and in fact are limited only insofar as charging stock is concerned, to the treatment of materials coming within the general classification of solid or semi-solid hydrocarbonaceous substances, simultaneous with the conversion of hydrocarbon oil.

We have found that the volatility of the carbonaceous product of the system is a function of the characteristics of the heat-carrying medium, with which it is contacted in the coking zone, and in a preferred embodiment of the present invention a relatively light hydrocarbon oil distillate,

such as kerosene, kerosene distillate, naphtha, or the like, resulting from either cracking or synthesis or a natural product, comprises the liquid portion of the charging stock supplied to the system. It is our belief that such oils have a solvent action upon the material undergoing coking and materially assist substantial devolatilization of said material and that, by proper regulation of the operating conditions, oils of this character greatly enhance both the yields and quality of the desired light products.

A specific embodiment of the present invention may comprise subjecting a relatively light hydrocarbon oil distillate, such as kerosene, to conversion conditions in a heating element, introducing the heated materials into a bed of solid hydrocarbonaceous material, such as coal, disposed within an enlarged zone maintained at substantially atmospheric pressure, subjecting vapors from the coking zone to fractionation, subjecting vapors from the fractionator to condensation, and collecting the resulting distillate and gas, subjecting reflux condensate, produced by fractionation of the vapors, alone or together with a portion or all of the distillate produced by the system and when desired, a portion of the gas, to independently controlled conversion conditions in a separate heating element, materials from which are introduced into direct contact with the materials in the coking zone.

The attached diagrammatic drawing illustrates one specific form of apparatus embodying the features of the present invention and wherein the process of the invention may be practiced. The liquid portion of the charging stock, preferably comprising a relatively light hydrocarbon oil distillate, may be supplied through line 1 and valve 2 to pump 3, from which it is fed through line 4 and valve 5 to heating element 6. Heating element 6 is disposed in a furnace 7 of any suitable form and the oil supplied thereto is heated to the desired conversion temperature under any desired pressure conditions and passes therefrom through line 8 and valve 9 into coking chamber 10.

Coking chamber 10 is preferably operated at substantially atmospheric or relatively low superatmospheric pressure and contains a substantial bed or may be substantially filled with a solid or semi-solid hydrocarbonaceous material such as coal. This material is preferably placed within the chamber prior to the operation of the process or may be continuously or intermittently charged to the coking zone during the operation. When desired, in order to prolong the

operating cycle, a plurality of coking chambers similar to chamber 10 may be employed, although not illustrated in the drawing, in which case they may be operated either simultaneously or alternately. The heated hydrocarbon oil from heating element 6 preferably enters the lower portion of the coking chamber, passing upward through the bed of hydrocarbonaceous material in this zone.

Vapors from the coking chamber pass through line 11 and valve 12 to be subjected to fractionation in fractionator 13, which may be any suitable and well known form of fractionating device capable of separating the relatively light desirable components of the vapors from their heavier components.

Vapors and gases from fractionator 13 pass through line 14 and valve 15, are subjected to condensation and cooling in condenser 16, distillate and uncondensable gas from which passes through line 17 and valve 18, to be collected in receiver 19. Gas may be released from the receiver through line 20 and valve 21, while distillate may be withdrawn through line 22 and valve 23.

Relatively heavy components of the vapors from chamber 10 which are condensed in fractionator 13 may collect as reflux condensate in the lower portion of this zone to be withdrawn therefrom through line 24 and valve 25 to pump 26, from which they are fed through line 27 and valve 28 to heating element 29 for further conversion.

A portion or all of the distillate from receiver 19 may be withdrawn through line 30 and valve 31 to pump 32, to be fed therefrom through line 33 and valve 34 into line 27, commingling therein with the reflux condensate from the fractionator and passing therewith to heating element 29. Similarly, a portion of the gas from receiver 19 may be withdrawn through line 35 and valve 36 to pump or compressor 37, from which it is fed through line 38 and valve 39 into line 27 and thence to heating element 29, together with reflux condensate from the fractionator and distillate from the receiver.

Heating element 29 is located in a furnace 40 of any suitable form and the materials supplied thereto are subjected preferably to relatively severe conversion conditions under any desired pressure. The heated materials from heating element 29 pass through line 41 and valve 42 into coking chamber 10, preferably entering the lower portion of this zone and coming into direct contact therein with the material undergoing coking, serving to effect or assist its substantial devolatilization and assisting conversion in the coking chamber.

Pressures employed within the system may range from substantially atmospheric to super-atmospheric pressures as high as 2000 lbs. or more per square inch. Conversion temperatures employed may range from 900 to 1800° F., more or less. Temperatures employed in the heating element to which the liquid portion of the charging stock is supplied preferably range from 900 to 1200° F., or thereabouts, and the pressures employed in this zone may range from substantially atmospheric to super-atmospheric pressures of the order of 500 lbs. or more per square inch. The coking zone is preferably operated at a pressure ranging from substantially atmospheric to relatively low superatmospheric pressures of about 100 lbs. per square inch. The pressure employed in the coking zone may be substantially equalized

or somewhat reduced in the succeeding fractionating, condensing and collecting portions of the system. Temperatures ranging from 900 to 1800° F. more or less, may be employed in the heating element to which intermediate and final light products of the system are supplied and the pressure employed in this zone may range from substantially atmospheric to superatmospheric pressures as high as 500 lbs. or more per square inch.

As a specific example of the operation of the process of this invention, coal breeze amounting to approximately 50% by weight of the total charging stock is disposed in alternately operated coking chambers maintained at a pressure of approximately 50 lbs. per square inch. Kerosene distillate, which comprises the remaining 50% or thereabouts of the charging stock is subjected to a temperature of approximately 900° F., under a superatmospheric pressure of approximately 350 lbs. per square inch in the heating element and is introduced into the lower portion of the coking zone. Reflux condensate from the fractionator of the system, together with a small portion of the distillate and gas produced by the system, is subjected in a separate heating element to a temperature of approximately 1050° F. under a pressure of approximately 100 lbs. per square inch, and is thence introduced into the lower portion of the coking zone. This operation may yield, per ton of charging stock, about 1000 lbs. of coke having a volatile content of about 8% and of firm structure, about 4000 cu. ft. of gas of high calorific value, and about 125 gallons of motor fuel having an octane number of approximately 78.

As a further illustration of the advantages of the present invention, it may be possible to treat 60% or more coal, based on the weight of the total charging stock, due to the possibility of employing large quantities of heat-carrying media at relatively high temperatures as compared with the processes wherein a mixture of hydrocarbon oil and coal derives its sole source of heat by passage through a heating element; which latter process is limited to the use of about 25-30% of coal based on the weight of the total charging stock.

It will be understood that the foregoing example illustrates only one of the many types of operation to which the process of the present invention is adapted and should therefore not be construed as a limitation. For example, by employing higher temperatures in either or both heating elements and by recirculating more of the distillate, it may be possible to substantially increase the yield of gas and decrease the volatility of the carbonaceous product; also by recirculating more gas and subjecting it to relatively high temperatures the quantity of the gas produced and its hydrogen content may be increased.

We claim as our invention:

1. A process for producing high antiknock motor fuel, gas and devolatilized coke from hydrocarbon liquids and carbonaceous solids comprising charging an enlarged reaction zone with carbonaceous solids, heating a hydrocarbon oil to a relatively high cracking temperature and introducing the same to said reaction zone to pass through the bed of carbonaceous material therein, taking off vapors from said reaction zone, subjecting the same to reflux condensation to separate intermediate fractions, subjecting the vapors escaping reflux condensation to final condensation, collecting the resulting gasoline dis-

tillate and uncondensed gases, separately heating a portion of the gasoline distillate to conversion temperature and thence introducing the same into contact with the material in the reaction zone simultaneously with the introduction of said oil to the reaction zone to facilitate the devolatilization of the solid carbonaceous material therein.

2. A process which comprises distilling hydrocarbon oil and solid bituminous material in an enlarged zone, removing vapors from said zone

and fractionating the same to condense heavier fractions thereof and to form a gasoline distillate, heating a portion of the gasoline to conversion temperature while flowing through a heating zone and thence discharging the same at such temperature into contact with the material in said enlarged zone during the distillation of the oil and solid material therein to supply heat for the distillation thereof.

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