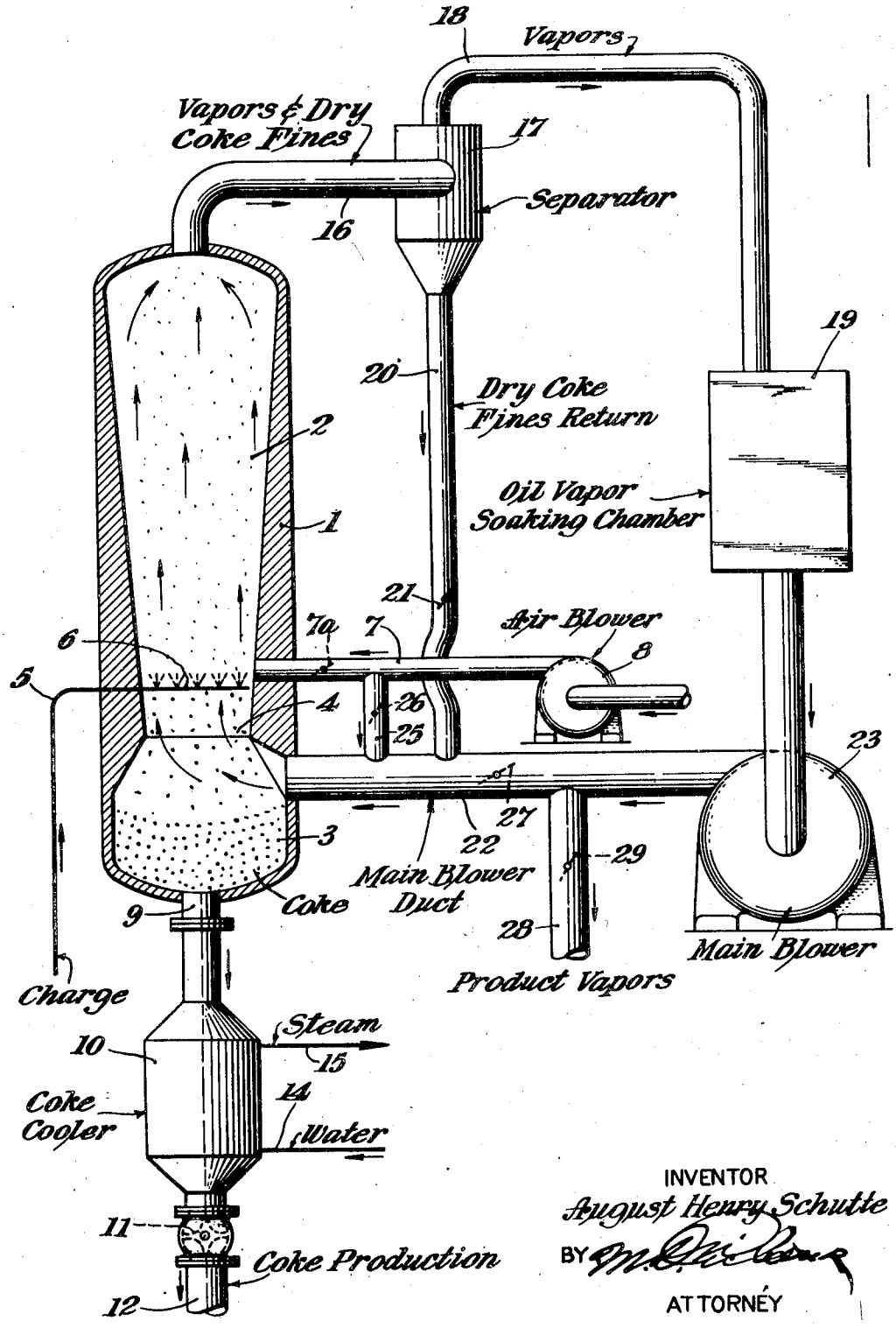
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HYDROCARBON COKING

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HYDROCARBON COKING

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This invention relates to treating hydrocarbons and, in particular to the treatment of heavy oils.

It is the particular object of this invention to provide a new and improved method, and apparatus, for treating such oils, and particularly residues and/or by-products of petroleum refining, cracking, etc., whereby they are readily and conveniently converted to coke.

It is a further object of this invention to provide such a new and improved method which is continuous, and wherein heavy oil is converted into coke and vaporous products by introduction, in droplets, into a burning column of combustion air and other vapors and gases having coke particles suspended therein in disperse phase, the particles being retained and recirculated in the suspension until they grow beyond a predetermined size, and the supply of combustion air to the burning column being so controlled as to maintain the combustion partial (i. e., insufficient air for complete combustion).

It is a further object of this invention to provide such a method wherein the vaporous products of the aforesaid coking reaction are withdrawn from the aforesaid burning column, separated from coke fines, and subjected to a soaking operation, without addition of heat, for sufficient time to allow completion of reactions (i. e., cracking, etc.) therein, a part being withdrawn as production, and a part being returned to, or recycled through, the burning column.

It is a further object of this invention to provide apparatus particularly adapted to the accomplishment of the aforesaid method and above enumerated objects.

It is a further object of this invention to provide such improved method and apparatus wherein the ultimate recovery of values is achieved in the form of coke as a commercial product, thermal energy in the form of heated gases, and thermal energy in the form of steam produced in the process and in the apparatus as an incident to the cooling of production coke, in addition to the products derived from the soaked vaporous by-products of the coking operation.

These and other objects and advantages of the invention will clearly appear from the following description taken with the drawing and the appended claims.

In the drawing, showing diagrammatically one illustrative form of apparatus for achieving the principles of this invention, a reactor, generally designated 1, is provided which forms a chamber providing superposed communicating elutriator or reaction section 2 and coke collection section 3.

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The elutriator or reaction section 2 comprises an elongated upwardly flared, upwardly divergent, or downwardly convergent chamber portion communicating with the coke collection chamber 3 through the throat portion 4.

Supply means 5 communicating with a supply of heavy oils, bottoms, tars or residues at suitable temperature, preferably from 875° F. to 900° F., terminates in a suitable distributor 6 disposed in the lower portion of the reaction or elutriator section 2 adjacent the throat 4 and distributes the charge in the form of droplets in the upwardly moving column of gases, coke particles, etc., as hereinafter described.

Adjacent the charge distributor 6, an air inlet 7 for fresh or make-up air communicates with the elutriator or reaction section 2 and supplies air thereto from the air blower 8 under control of the valve 7a.

A coke outlet 9 leads from the lower end of the coke collection section 3 to a coke cooler 10 which receives the production coke and cools it to suitable temperatures before it is discharged through feeder 11 and outlet 12 to a suitable collection station as, for instance, a briquetting device, a chain grate, or a storage chamber or station.

Water is supplied through inlet 14 to coke cooler 10 and converted to steam in the cooler 10, being withdrawn as steam through the outlet 15 and conveyed to any desired point of use.

Leading from the upper end of the elutriator section 2 is the vapor outlet 16 which conveys overhead vapors and coke fines to a separator 17, preferably of the "Cyclone" type, which separates the solids comprising the coke fines from the vapors. The vapors are passed through the vapor outlet 18 of the separator 17 to the oil vapor soaking chamber 19 where they are retained for sufficient time, without addition of heat, for occurrence of, or completion of, reactions such as cracking therein. The solids (coke fines) are sent through the solids outlet 20 of the separator 17, under control of the valve or damper 21, to the main blower duct 22.

The main blower duct 22 communicates with the coke collection chamber 3 below the throat 4 of the chamber 1 and also with the delivery of the main blower 23 having its inlet 24 connected with the above described oil vapor soaking chamber 19 to which vapors are supplied through the vapor outlet 18 of the separator 17, as described above.

A connection 25 controlled by valve 26 is provided between the air inlet 7 and the main blower duct 22 whereby air from the air blower 8 may be

supplied either directly to the reaction section or elutriator section 2 under control of the valve 7a, as described above, or supplied in admixture with the vapors and dry coke fines in the main blower duct 22 under control of the valve 26.

A valve 27 is provided for controlling the delivery from the main blower duct 22 to the coke collection section 3, and a gas outlet 28, controlled by valve or damper 29, is also provided for controlled extraction of product gases which may be sent to waste heat, to a boiler, condenser or other point of use such as an oil cracking system or a catalytic cracking reactor.

The (oil) charge upon admission approximates from 20% to 30% vapor and from 70% to 80% liquid. About 60% of the charge being vaporized in the elutriation section 2, the remainder in the form of heavy tar must be coked by the application of sufficient thermal energy to convert it into solid coke; this is accomplished through the combustion maintained throughout the chamber 2, 3.

Since the elutriator section 2 provides a diverging passage for the vapors and coke fines passing upwardly through the throat 4, the velocity of the vapors and fines decreases during their upward travel. By controlling the size of the droplets or particles in which the charge is supplied to and above $\frac{1}{32}$ inch diameter, for instance, while controlling the supply of air through inlet 7 and of vapors and fines through the main blower duct 22 (from soaking chamber 19 and separator 17), the velocity and combustion in the elutriator section can be so controlled as to produce in the elutriator section a temperature between 900° F. and 1500° F. and a column of gases and fines in motion, the fines being of such size as readily to accommodate coking by acting as neuclei for further coke deposit resulting in their growth to "production coke" size. The deposit of coke will increase their weight and size and cause them, upon growth to "product size," to fall out of suspension into the coke collection section for removal as described above. Those fines which are sufficiently buoyant to be carried over to the separator are returned or recycled and subjected to further growth upon their return, i. e., by collision with oil and coke particles under combustion in the column which causes further coke deposit and growth.

These fines (coke particles) of lesser size and weight which remain in suspension in the overhead vapors are removed through outlet 16 to the separator 17 whence they are returned or recycled through solids outlet 20 and main blower duct 22 to the uprising column of fines suspended in vapors, where, upon sufficient increase in size and/or weight, they fall into the coke collection chamber 3 to become production coke.

Consider from another aspect, the variation and control of velocity in the burning column achieved through the upwardly divergent elutriator section, forms of the reaction or elutriator section, a separator which retains in this reaction chamber for further coking treatment, drying, or growth, those particles which are insufficiently buoyant to pass over to the separator 17 and yet below production coke size. At the same time, by operation of this separator, those coke particles which are of "production coke" size and quality are separated out of the suspension and delivered by gravity to the coke collection chamber 3. The fines which are sufficiently buoyant to pass over to the separator (and which are naturally below "production coke" size) are recycled through the burning column for further coking, treatment and growth.

The term "heavy oils" as used herein is to be broadly interpreted as covering hydrocarbons and oils of various specifications which may be converted into coke; the term embraces residues and residuals from topping processes and distillation processes and tars and other by-products of hydrocarbon cracking processes, etc.

In coking a 12.5° A. P. I. oil charge, supplied at the rate of 4,000 bbl./day or 57,400 lb./hr., the coke production equals approximately 12.2% (approx.) of the charge weight or

$$12.2\times{}^{1}/_{100}\times 57{,}400 \text{ lb.}=7{,}000 \text{ lb./hr.}$$

(approx.) where the above described apparatus and method are used.

In coking such a charge the conditions are as follows:

Reaction temperature (in 2)	1,400° F.
Vapor outlet temperature (in 16)	1,400° F.
Recirculation temperature (in 22)	1,200° F.
Requisite minimum velocity (at throat 4) for operation (i. e., elutriation in 2)	6½ feet per second at 1,400° F.
Minimum time of residence (in 2) for heat transmission (i. e., conversion of oil particles to coke particles)	22 sec.
Oil charge (in 5) at 900° F., 35% vapor	57,400 lb./hr.
Size of oil particle on admission to chamber (2)	$\frac{1}{32}$ in. diameter
Air (in 7)=248,000 cu. ft./hr	19,500 lb./hr.
Oil vapors produced (in 18)	50,400 lb./hr.
Flue gas, produced (in 18)	20,900 lb./hr.
Coke (in 3)	7,000 lb./hr.
Minimum size of collected coke particles (in 3)	$^{1}/_{64}$ in. diameter

Where—

Height of reaction section (2)=105 ft.
Area of reaction section (at 4)=51 sq. ft.

From the above description, it will clearly appear that I have provided a new and improved coking method and apparatus for achieving the above stated objects and advantages as well as other advantages apparent to those skilled in the art.

It is, of course, to be understood that the above description is merely illustrative and in nowise limiting and that I desire to comprehend within my invention such modifications as are included within the scope of the following claims.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of coking heavy oil comprising, injecting particles of said oil into a generally upwardly moving current of heated gases and vapors in a confined space while supplying sufficient combustion air for partial combustion, burning part of the contents of said space for converting said oil particles into coke particles, and controlling the velocity of said contents of said space in such manner that coke particles above a predetermined size drop out of the contents of said space for collection as production coke while

drawing off coke particles below a predetermined size from the upper portion of said space.

2. The method of continuously coking heavy oil comprising forming a suspension by continuously injecting particles of said oil into an upwardly moving current of gases undergoing combustion in a confined space while supplying sufficient combustion air only to render said suspension capable of partial combustion to convert said oil particles into coke, and controlling the velocity of said suspension in such manner that coke particles above a predetermined size drop out of said suspension for collection as production coke while drawing off part of said coke particles below a predetermined size from the upper part of said suspension, a pair of the coke particles being continuously moved in said suspension.

3. The method of continuously treating heavy oils comprising injecting particles of said oil into an upwardly moving current of gases undergoing combustion in an upwardly expanding space while supplying sufficient air to form a suspension capable of partial combustion to convert said oil particles into coke, and controlling the velocity of said suspension in such manner that coke particles above a predetermined size drop out of said suspension for collection as production coke while particles below said predetermined size are continuously subjected to the effect of combustion gases and the oil whereby these below sized particles can increase to the predetermined size.

4. The method defined in claim 2 wherein a portion of fine coke particles below said predetermined size are continuously removed from said suspension and recycled therethrough for further growth to production coke size.

5. The method defined in claim 2 wherein the velocity of said upwardly moving current decreases progressively with the height of said confined space to provide separation of fine buoyant coke particles from the larger coke particles in said space.

6. The method defined in claim 3 wherein the coke particles below said predetermined size are continuously removed from said burning suspension with vaporous products of the coking reaction, then separated from said vaporous products and recycled to said burning suspension for growth to production coke size.

7. The method of continuously coking heavy oil comprising continuously injecting upwardly, particles of said oil at approximately 900° F. into an upwardly moving current of burning gases and air at from 900° F. to 1500° F. in a confined elutriator chamber to form a suspension, maintaining said particles in said chamber for a sufficient time to convert said particles into coke, and controlling the velocity of said suspension in such manner that coke particles above a predetermined size drop out of said suspension for collection as production coke and so that a part of the coke particles below such size are carried out of the chamber.

8. The method defined in claim 7 wherein said oil particles comprise droplets of approximately $\frac{3}{32}$ inch diameter, and wherein the minimum time of retention in said chamber is 22 seconds.

9. The method defined in claim 7 wherein said oil particles comprise droplets of approximately $\frac{3}{32}$ inch diameter and from 20% to 35% vapor content upon admission to said chamber, wherein the time of retention in said chamber is at least 22 seconds, and wherein the minimum production coke particle size is $\frac{1}{64}$ inch diameter.

10. The method of continuously coking heavy oil, comprising forming a suspension by continuously injecting particles of said oil into an upwardly moving current of gases undergoing combustion in a confined space while supplying sufficient combustion air only to render said suspension capable of partial combustion to convert said oil particles into coke, controlling the velocity of said suspension in such manner that coke particles above a predetermined size drop out of said suspension for collection as production coke, continuously removing a part of the dry coke particles below said predetermined size from said burning suspension with vaporous products of the coking reaction, separating said below-size coke particles from said vaporous product and returning said below-size coke particles to said burning suspension for growth to production coke size, soaking said vaporous products of the coking reaction for conversion and withdrawing a part of said soaked vaporous products while returning the remainder of said soaked vaporous products to said upwardly moving current.

11. In apparatus for coking heavy oils, a reactor having therein a chamber forming a coke collection section and an elutriator section thereabove, means for supplying heavy oil particles to said chamber, and means for controllably supplying combustion air and hot vapors to said chamber for forming a partially burning upwardly moving suspension with said oil, means for controlling the velocity of said suspension in said elutriator section for retention therein of coke particles above a predetermined size whereby finer coke particles only may pass over with the product vapors from said elutriator section, means for separating said fine coke particles from said product vapors, a vapor soaking chamber receiving and retaining the separated vapors for completion of reactions therein without addition of heat, and means for recirculating said fine coke particles through said burning suspension with a portion, at least, of the output of said soaking chamber.

12. In apparatus for coking heavy oils, a reactor having therein a chamber forming a coke collection section and an elutriator section thereabove, said sections being joined by a throat, means for supplying heavy oil particles to said elutriator section above the throat, means for supplying combustion air and hot vapors to said elutriator section for forming a burning, upwardly moving, partially combustible suspension with said oil, valve means for controlling the velocity of said suspension in said elutriator section for retention therein of coke particles above a predetermined size, whereby finer coke particles only may pass over with the product vapors from said elutriator section, the size of the throat and the velocity of combustion air being insufficient to carry larger coke particles, whereby said larger coke particles drop through the throat into the coke collection section, separating means for separating said fine coke particles and said product vapors, soaking means for receiving and retaining said separated product vapors for completion of reactions therein, means for withdrawing a portion of the output of said soaking means as production, and means for supplying the remainder of said output to the burning suspension in said elutriator.

13. In apparatus for coking heavy oils, a reactor having therein a chamber forming a coke collection section and an elutriator section thereabove, means for supplying heavy oil particles to said chamber, and means for controllably sup-

plying combustion air and hot vapors to said chamber for forming a partially burning, upwardly moving suspension with said oil, means for controlling the velocity of said suspension in said elutriator section for retention therein of coke particles above a predetermined size whereby finer coke particles only may pass over with the product vapors from said elutriator section, means for separating said fine coke particles from said product vapors, and means for recirculating said fine coke particles through said burning suspension with a portion, at least, of the product vapors.

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