

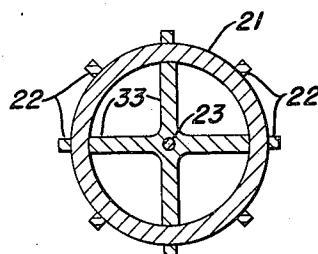
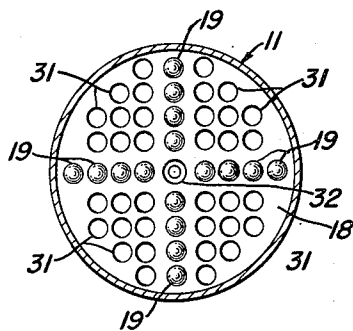
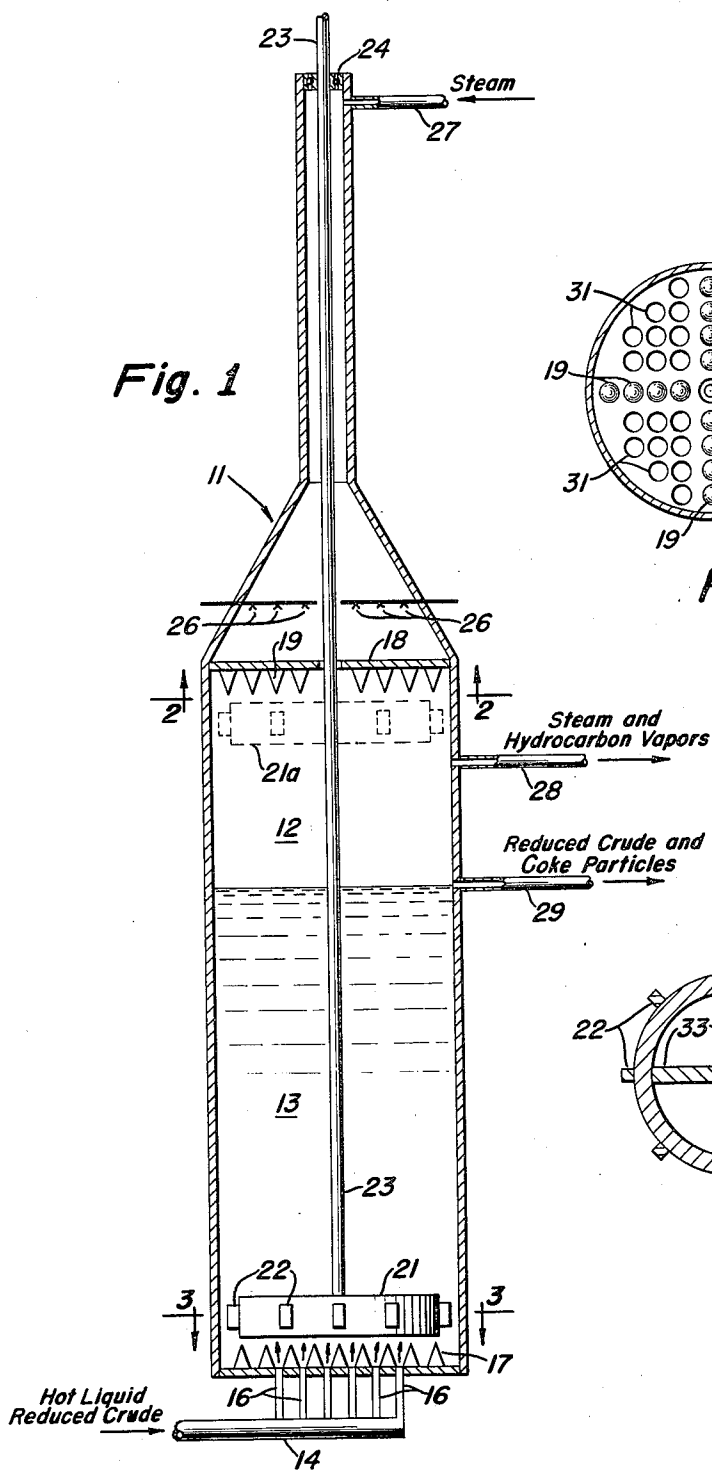
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COKING APPARATUS FOR HYDROCARBON OILS

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1 Claim. (Cl. 202—221)

This invention relates to a liquid phase coking process and an apparatus particularly useful for carrying out the process.

In most prior art coking processes, the heated heavy hydrocarbon oil is introduced into a coking vessel wherein it is completely converted to coke and vapors of the cracked oil. It has recently been found that contrary to this type of operation, it is often desirable to minimize the amount of coking and cracking of the hydrocarbon oil. The prior art techniques and apparatus are not particularly suited to this type of operation. It has been found that the liquid phase coking of hydrocarbon oils provides an easily controlled method for adjusting and minimizing the amount of coke and cracked hydrocarbon vapors formed.

An object of the present invention is to provide a process for the liquid phase coking of heavy hydrocarbon oils, and an apparatus useful in such a process. Another object is to provide a liquid phase coking process in which coke deposited within the coking vessel is continuously removed therefrom during the coking operation, thereby enabling lengthy operation of the process without shutting down in order to remove coke from the coking vessel. A further object is to provide a mild coking process and apparatus therefor which is particularly useful for demetallating reduced crudes by mild coking thereof in a continuous manner and thereby preparing high yields of greatly improved charge stocks for catalytic cracking. An additional object is to provide an apparatus for the liquid phase coking of heavy hydrocarbon oils which has cutting means that prevents any substantial accumulation of coke within the coking vessel during its use in the coking process.

In accordance with the invention a heavy hydrocarbon oil, such as a reduced crude, is introduced as a hot liquid into a coking vessel. Hot oil is maintained as a liquid pool at coking temperatures whereupon a portion of the liquid oil is converted to vapors and coke. The hydrocarbon vapors are withdrawn from the upper vapor zone of the coking vessel, and the product liquid hydrocarbon oil is withdrawn from the coke liquid zone of the coking vessel at a point remote from the introduction of the hot oil charge. The inner walls of the coking vessel, particularly those in the liquid zone which are in contact with the liquid hydrocarbon oil and upon which the larger amounts of coke are deposited, have coke cut continuously therefrom. The coke is cut from the walls in the form of small coke particles which are suspendable within the liquid hydrocarbon oil. The liquid hydrocarbon oil which is continuously withdrawn from the coking vessel carries and removes the coke particles from the coking vessel. In a preferred form of the invention, a liquid reduced crude is substantially demetallated by converting a portion thereof to coke in an amount approximately equivalent to the Ramsbottom carbon content of the reduced crude charge.

A suitable apparatus for carrying out the process comprises an upright coking vessel having a lower liquid zone

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and an upper vapor zone with means for introducing liquid oil into the liquid zone and withdrawing partially coked oil from the liquid zone at a point remote from the liquid inlet. Decoking means are located in the coking vessel. These means comprise stationary cutter teeth located about the bottom of the liquid zone and also located in the vapor zone, and a circular cutter mechanism having cutter blades disposed about its circumference. A rotatable shaft is attached to the center of the cutter mechanism and extends upwardly therefrom through a bushing at the top of the coking vessel. Suitable means are provided for rotating the cutter shaft and cutter mechanism and vertically actuating them so as to cut coke from the interior side walls of the coking vessel. As the cutter mechanism descends to its lower-most position, the cutter teeth in the bottom of the liquid zone cut any coke which adheres to the bottom of the cutter mechanism. Similarly, when the cutter mechanism ascends to its upper-most position, rotation of the cutter mechanism permits the fixed cutter teeth in the vapor zone to cut coke which adheres to the top of the cutter mechanism. Steam is introduced through an inlet located near the top of the zone in an amount to prevent any substantial deposition of coke upon the rotating shaft. The steam sweeps out the hydrocarbon vapors from the vapor zone through a vapor outlet located below the steam inlet. The vertical distance from the top of the vapor zone to the vapor outlet is greater than the vertical distance from the vapor outlet to the bottom of the liquid zone. By this proper adjustment of vertical distances, the rotating shaft which passes through the bushing means does not have any substantial amount of coke accumulated thereon, and thereby enables trouble-free operation of the decoking means. A more thorough understanding of the liquid phase coking process and an apparatus suitable for carrying out the process will be apparent from the attached drawings and the detailed description thereof which follows.

Figure 1 represents a side view in cross-section of the coking vessel. Figure 2 is a plan view taken along lines 2—2 of Figure 1 and shows the stationary cutters located in the vapor zone. Figure 3 is a plan view taken along lines 3—3 of Figure 1 and depicts a cross-section of the circular cutter mechanism.

Referring now to Figure 1, coking vessel 11 is an upright enclosed cylindrical vessel which has an upper vapor zone 12 and a lower liquid zone 13. The upper section of vapor zone 12 is of reduced cross-sectional area. The bottom of coking vessel 11 is provided with liquid inlet manifolding line 14. Individual liquid inlet lines 16 connect the bottom of the liquid zone 13 with manifolding line 14. Conically shaped stationary cutters 17 are fixedly attached to the bottom of liquid zone 13, with their conical cutting points extending upwardly. The conical points terminate in the same horizontal plane. In vapor zone 12, cutter support means 18 which consists of a circular plate member having a number of perforations therein and also having a circular opening in its center, is fixedly attached to the inside wall of coking vessel 11. The circular opening is provided with cutter edges which function to remove coke from rotating shaft 23 which rides therethrough. Stationary conical cutters 19 are fixedly attached to cutter support means 18 and have their conical point and cutting edges extending downwardly. The cutting point of cutters 19 are substantially all in the same horizontal plane.

Cutter mechanism 21 is of circular cross-section and has outwardly extending cutter blades 22 positioned about its circumference. Attached to the center of cutter mechanism 21, in a manner which will be described in more detail in connection with Figure 3, is rotatable shaft 23. This shaft is rigidly attached to the center of

cutter mechanism 21 and extends upwardly therefrom through bushing means 24 located in the top of coking vessel 11. External means, not shown herein, are employed to rotate and vertically actuate shaft 23 and thereby simultaneously rotate cutter mechanism 21 and vertically actuate it between its lower-most position as shown herein and its upper-most position which is represented herein by 21a in dashed lines. A number of steam jets 26 may be positioned just above cutter support means 18 to direct the high velocity steam through the perforations in cutter support means 18 and assist in removing coke from the center portion of cutter mechanism 21. These steam jets are operated only when cutter mechanism 21 is in its raised position as shown by dashed lines 21a.

Steam inlet line 27 is provided at the top of coking vessel 11 near bushing means 24. Vapor outlet line 28 is provided in vapor zone 12 at a position substantially below steam inlet line 27. Liquid outlet line 29 is provided in liquid zone 13.

Referring now to Figure 2, the conical cutters 19 are shown to form a cross-like array. Perforations in cutter support means 18 are represented herein by numerals 31. Rotating shaft 23 rides within circular opening 32, the edges of which circular opening function to cut any deposited coke from shaft 23 as it is vertically actuated.

In the cross-sectional plan view of cutter mechanism 21 which is shown in Figure 3, cutter blades 22 are positioned around the circumference of cutter mechanism 21. The cutter mechanism 21 is formed of a wheel-like member having four radial spokes 33 extending from its center to the wheel portion. Rotating shaft 23 is shown attached to the radial spokes 33.

In an embodiment of this invention, hot liquid reduced crude (heated to coking temperatures which are herein-after discussed) is introduced into coking vessel 11 by way of manifolding line 14, then through inlet line 16 into the bottom of the liquid zone 13 of the coking vessel. Steam may also be introduced if desired together with the charge reduced crude. A liquid pool of reduced crude is maintained within liquid zone 13 under coking conditions. Temperatures of from 750° to 925° F., preferably 775° to 825° F. are satisfactory for mild coking conditions, but higher temperatures can be employed for more severe coking operations. From 5 to 80 percent of the reduced crude charge is immediately flashed off as a vapor, the amount flashed being dependent upon the extent of reduction of the reduced crude and the amount of heavy materials in the reduced crude. Residence time of the reduced crude in the liquid zone may be from 0.1 to 15 minutes based on charge introduced, or longer if extensive coking is desired. In the embodiment described herein, a 50 percent reduced crude is charged while operating at a coking temperature between about 775° to 825° F. for a residence time of 1 to 3 minutes based upon the amount of reduced crude charged to the coking vessel. The amount of charge reduced crude converted to coke is approximately equivalent to the Ramsbottom carbon content of the reduced crude charge, which is usually from 1 to 5 percent by weight. Approximately 2 to 6 percent of the reduced crude is cracked to lower boiling hydrocarbon vapors such as naphtha, etc.

Shaft 23 is rotated and vertically actuated by means not shown herein so as to move the cutter mechanism between its lower-most point shown by solid lines 21 and its upper-most point shown by dashed lines 21a. The rotating action of the cutter mechanism causes cutter blades 22 to cut coke from the interior side walls of coking vessel 11, the greater amount of coke being formed on the side walls in liquid zone 13. When the cutter mechanism 21 reaches its lower-most position, its rotating action causes cutter teeth 17 to cut coke adhering to the bottom of cutter mechanism 21. The force of

the flow of hot liquid prevents any substantial coke deposition between the radial spokes 33 and the wheel-like structure of cutter mechanism 21. When cutter mechanism 21 is raised to its upper-most position as represented by dashed lines 21a, rotation of the cutter mechanism similarly enables stationary cutter teeth 19 to cut adherent coke from the top of cutter mechanism 21. Steam which is introduced through steam jets 26 passes down through perforations 31 and also assists in removing coke formed in cutter mechanism 21 between its wheel-like member and its radial spokes 33. Steam is introduced through steam inlet 27 and passes downwardly along rotating shaft 23 through the vapor zone so as to provide a linear velocity therein of about 1 to 3 feet per second. The steam sweeps away hydrocarbons and substantially prevents coke deposition on rotating shaft 23. The cutter edges of central opening 32 in cutter support means 18 remove any coke which may be formed along rotating shaft 23.

The steam vapors passing downwardly through the vapor zone 12 sweep hydrocarbon vapors and a mixture of vapors passes out from coking vessel 11 by way of vapor outlet 28. Since the vapor section 12 which is above vapor outlet 28 has a substantial amount of steam therein, coke is not readily formed in this section and upon the rotating shaft during its presence in this section. Because the vertical distance between the top of coking vessel 11 and the vapor outlet 28 is greater than the vertical distance between vapor outlet 28 and the bottom of liquid zone 13, the entire length of rotating shaft 23 which passes through bushing 24 is continuously maintained within this minimized coke forming section of vapor zone 12. This enables trouble-free operation of rotating shaft 23 through the bushing means 24.

The coke particles which are formed by cutting coke from the inner surfaces of the coking vessel are produced in a particle size such that they can be suspended in the liquid reduced crude. The vaporization of reduced crude as it enters the bottom of liquid zone 13 and the vertical and rotating action of cutter mechanism 21 assist in suspending the coke particles in the pool of liquid reduced crude in liquid zone 13. After the proper residence time within liquid zone 13, the product liquid reduced crude containing suspended coke particles is removed from liquid zone 13 by way of liquid outlet line 29. The product reduced crude is substantially demetallated. It is then quenched to prevent further cracking and then filtered to remove the metals-containing coke particles. Thereafter it may be charged to a catalytic cracking operation for the production of gasoline. The vapor mixture removed by way of vapor outlet 28 can be condensed, the water removed therefrom, and the liquid hydrocarbons passed together with the quenched product liquid reduced crude to the catalytic cracking operation. Because only a very small amount of the reduced crude is converted to coke and low boiling hydrocarbons such as cracked naphtha, fixed gases, etc., very high yields of excellent catalytic cracking charge stock are produced by the embodiment described herein.

While the embodiment illustrated herein employs a particular charging stock, a specific apparatus design, etc., the scope of the invention is not limited thereto but includes other charging stocks, coking conditions of temperature, residence time, etc. as well as other types of apparatus such as would be apparent to those skilled in the art.

We claim:

1. An apparatus for the liquid phase coking of reduced crude which comprises an upright coking vessel of circular cross-section having an upper vapor zone which is of reduced cross-section near its top and a lower liquid zone, a steam inlet located near the top of the vapor zone, a vapor outlet located in the vapor zone below

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the steam inlet, a liquid inlet located near the bottom of the liquid zone, a liquid outlet located in the liquid zone above the liquid inlet, the vertical distance from the top of the vapor zone to the vapor outlet being greater than the vertical distance from the vapor outlet to the bottom of the liquid zone, upwardly extending stationary cutter teeth fixedly disposed about the bottom of the liquid zone, downwardly extending stationary cutter teeth fixedly disposed in the vapor zone, a rotatable and vertically actuatable circular cutter mechanism having cutter blades disposed about its circumference, a rotatable shaft attached to the center of the circular cutter mechanism and extending upwardly through bushing means associated with the top of the coking vessel, and means for simultaneously rotating and vertically actuating said shaft whereby said cutter blades on the circular cutter mechanism cut adherent coke from the inner side walls of said coking vessel, the maximum downward

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movement of the circular cutter mechanism being so limited that the bottom-most portion of the circular cutter mechanism is immediately above the top of the fixed cutter teeth located in the bottom of the liquid zone and the maximum upward movement of the cutter mechanism being so limited that the top-most portion of the cutter mechanism is immediately below the bottom of the fixed cutter teeth located in the vapor zone.

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