July 26, 1960 W. M. MILLER 2,946,741

FLUID COKING

Filed June 21, 1956 2 Sheets-Sheet 1

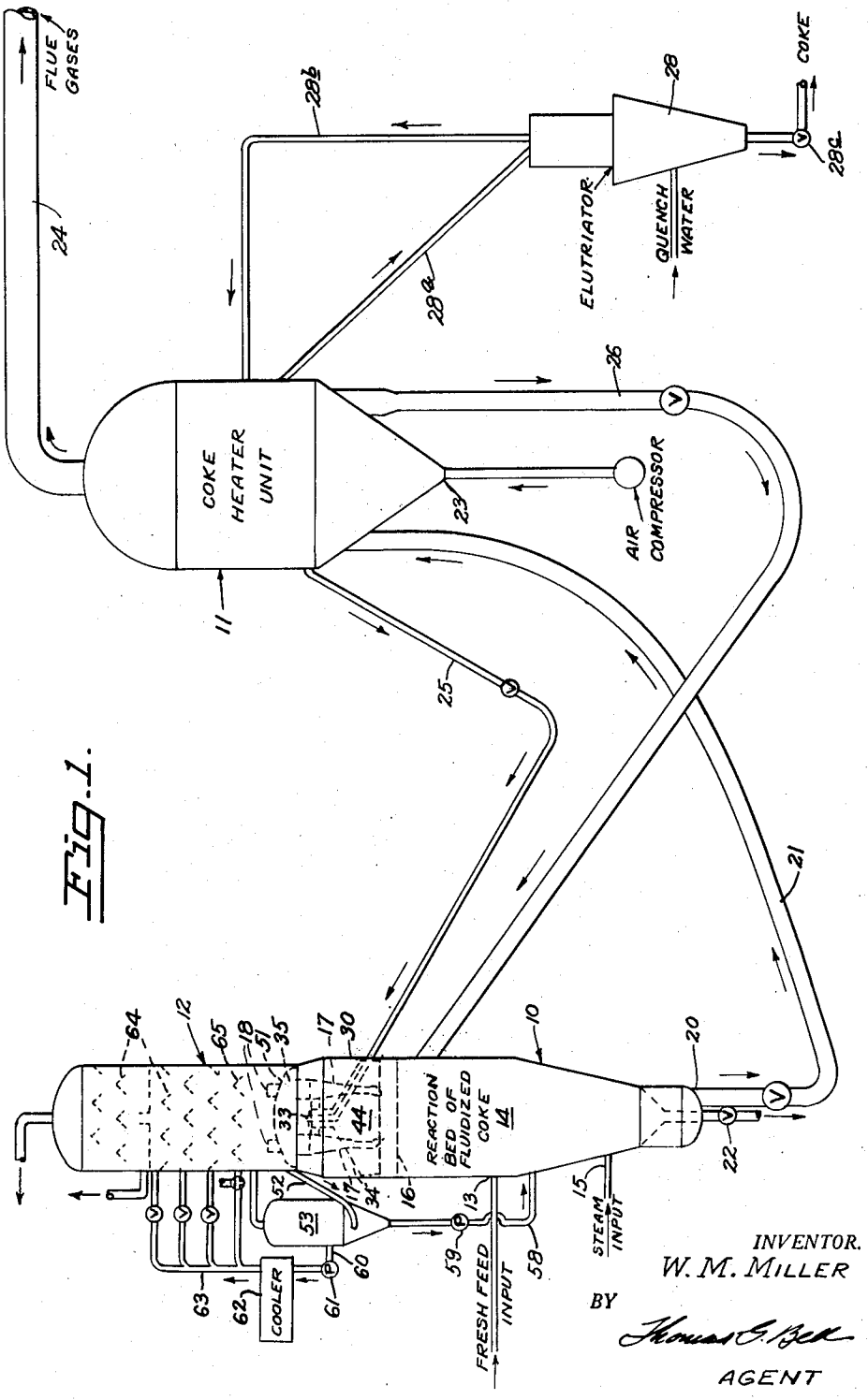


Fig. 1.

INVENTOR.
W. M. MILLER
BY
Thomas G. Beck
AGENT

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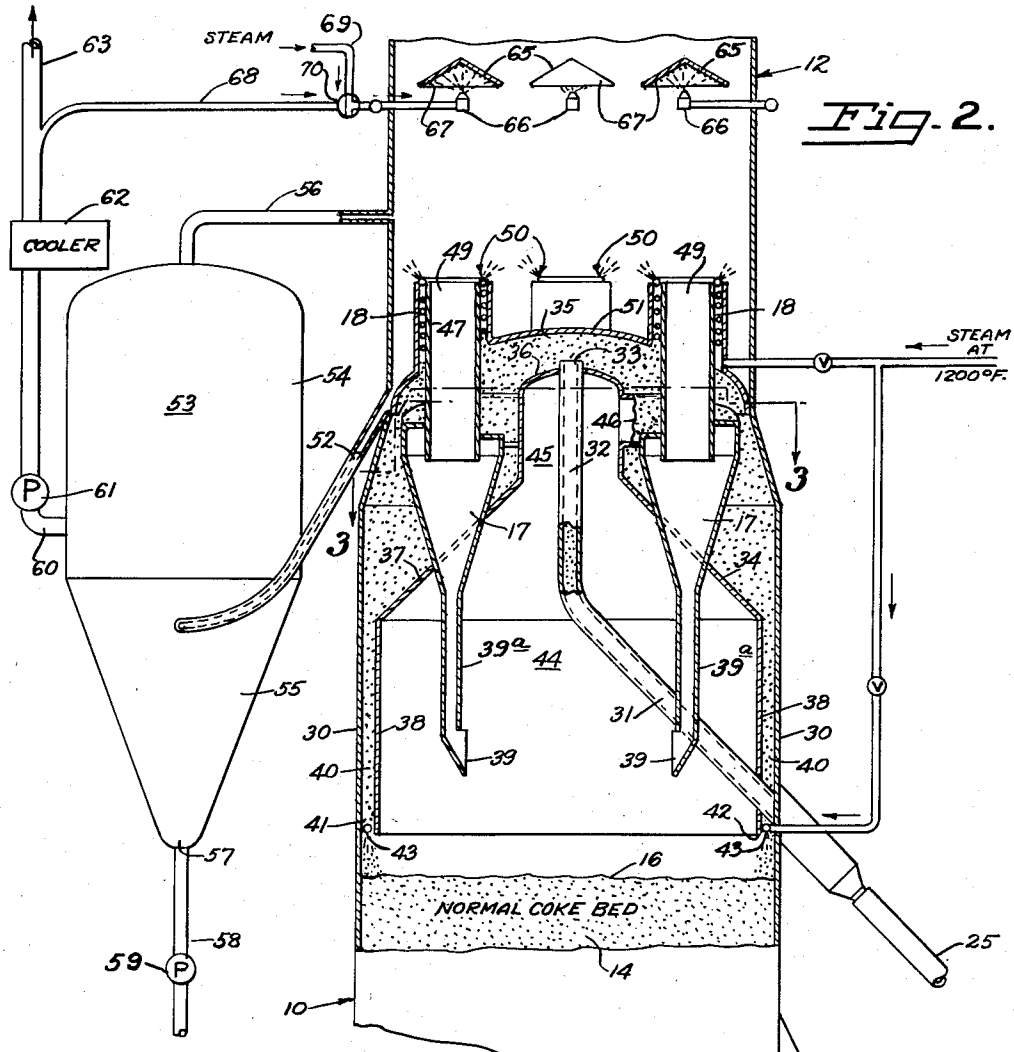


Fig. 2.

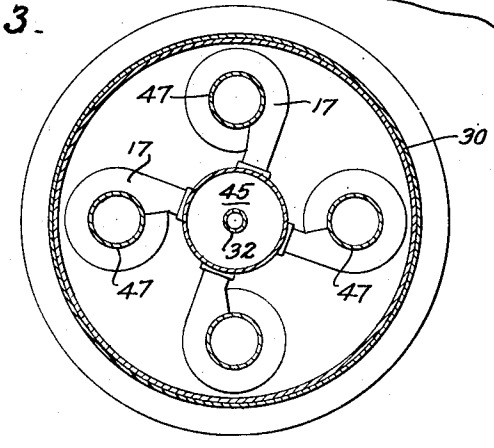


Fig. 3.

INVENTOR.
W. M. MILLER
BY Thomas G. Bell
AGENT

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2,946,741

FLUID COKING

Walter M. Miller, Walnut Creek, Calif., assignor to Tidewater Oil Company, a corporation of Delaware

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4 Claims. (Cl. 208—127)

This invention relates to improvements in method and apparatus for effecting the conversion of heavy petroleum stocks to more desirable lower-boiling products by a fluidized coking process.

Pilot and commercial plant experiences have demonstrated that the fluidizing and circulation of coke in an operation utilized in petroleum refineries to upgrade heavy residual oils to lighter products useful in the manufacture of gasoline, etc., presents no problem when the proper ratios of feed, coke, temperature, and steam are used. In the operation, solid coke particles, fluidized by steam and other vapors, are cycled between a burner (heater) unit and a coking (reactor) unit. In the burner unit, some coke is burned in order to heat the rest of the coke, and the hot coke is conveyed as small solid particles in a fluidized stream back to the reactor unit. In the reactor, the heavy oil is sprayed on the hot coke, and the heat cracks the oil into an effluent mist with concomitant formation of additional coke, which is deposited on the coke particles, enlarging them. The coke particles that become cooled by giving up heat in the operation, are recycled to the burner in a fluidized stream, the process being a continuous one. The effluent is withdrawn from the reactor and scrubbed, to cool it, and may then be given further treatment as desired; excess coke is also withdrawn from the system as a by-product.

A serious problem that has not heretofore been solved is how to transfer the reactor effluent (the cracked vapors and high-boiling uncracked asphaltic compounds produced in the coking reactor and carried off in the form of an entrained mist) from the reactor to the scrubber (where the effluent is cooled by quenching) without depositing coke in the transfer lines. There, coke has built up in the cyclones and their exhaust risers to such an extent that it greatly shortened the runs that could be made before having to stop the apparatus and clean out the coke deposits.

Coke has also been deposited on the walls of the dilute-phase section of the reactor and on the bottom side of the lower baffles in the scrubber. Furthermore, the coke carried over in the effluent has accumulated in the bottom of the scrubber and has plugged the suction lines to the quench-oil and recycle pumps.

Moreover, evidence indicates that, in addition to the coke carried into the transfer lines from the reactor, considerable coke has been produced right in the transfer lines, due to reactions inside the cyclones and their risers. This coke has begun to deposit on the walls very early and, once some deposits were formed, the accumulation was accelerated, because the coke then had a surface it could stick to. The deposits then built up rapidly until they closed off one or more of the cyclones; finally the entire apparatus had to be closed down, cooled, and the coke laboriously chipped away. This evidence as to the formation of coke elsewhere than in the reactor contradicts what was believed before and therefore nullifies some of the assumptions on which the apparatus had been constructed; so the solution of the problem has become more difficult and more necessary than before.

One object of the invention, therefore, is to confine the production of coke to the coke bed in the coking reactor and to inhibit subsequent reactions from producing coke in the effluent from the reactor.

Another object of the invention is to provide a method and apparatus for inhibiting the deposition of coke, however formed, in the effluent transfer lines, including the cyclones, between the coking reactor and the scrubber.

Another object of the invention is to inhibit the deposition of coke on the walls of the dilute-phase section of the reactor and on the bottom side of the lower baffles in the scrubber.

Another object of the invention is to reduce the amount of coke carried over into the scrubber.

Another object of the invention is to reduce the coke content of the scrubber quench-oil.

Another object of the invention is to provide an apparatus for returning to the coking reactor such coke as is carried over into the scrubber, after separating it from the other products carried over, so that the quench-oil can be substantially coke-free, so that this coke cannot plug the suction lines to the pumps for the quench-oil, and so that the coke itself can be returned to the coke bed in the coke reactor.

Another object of the invention, the achievement of which is necessary to achieve the foregoing objects, is to provide a system by which the effluent from the coking reactor is transmitted into the scrubber without having its temperature lowered and without having its temperature greatly raised or subjected to any sudden change before quenching.

It has been found that the effluent will inevitably produce coke if there is any drop in the temperature of the effluent prior to its quenching. Experience indicates that the effluent should not drop even one degree in temperature until it is instantaneously quenched in the scrubber. The reason for this unusual and unappreciated phenomenon lies partly in the fact that the reactor effluent is not a true vapor but is rather a mixture of cracked vapors and entrained, high-boiling, uncracked, asphaltic compounds in the form of a mist. It has been found that this asphaltic mist will condense and form coke on any metal surface cooler than the effluent mixture. In order to avoid a reduction in temperature, the temperature of the effluent should be kept rising gradually until it is quickly cooled by quenching. Yet the mist will also crack and deposit coke if it is subjected to excessively high temperatures. For example, the cracking of this mist proceeds at an extremely fast rate when 1125° F.-coke actually contacts the reactor effluent at the mouth of the cyclone in a system that has heretofore been generally used. In brief, hot vapors should not contact cold metal, and cold vapors should not contact hot metal.

Another object of the invention, therefore, is to gradually raise the temperature of the effluent as it rises in the dilute or vapor phase of the reactor without contacting it directly with freshly heated coke.

The method of this invention includes continuously raising the temperature of the effluent as it rises in the reactor's dilute phase, passes through the cyclones, and is conducted into the scrubber. Preferably, the heat necessary to produce this increase in temperature is obtained from freshly heated coke, direct from the heater, which is kept separate from the rising effluent by baffling it therefrom. The method also calls for conducting that effluent which condenses away from the lower part of the scrubber and settling entrained coke out therefrom, cooling the coke-freed oil and returning

it as quench-oil to the scrubber, and returning the coke to the reactor.

The apparatus by which the foregoing objects may be achieved and by which the method of the invention may be practiced involves several important changes in the structure of a fluidized coking unit, namely, (1) the provision around at least the upper part of the cyclones of a baffle with sloping sides and a depending cylindrical skirt spaced relatively closely from the reactor's inner walls and extending down to a short distance only above the normal coke bed; (2) means for conducting some of the hot fluidized coke particles from the burner into the coking reactor above the baffle and above the cyclone inlets, so that the coke passes down around portions of the cyclones and then down between the inner lined wall of the reactor and the skirt of the baffle into the coke bed, thereby heating the cyclones, the risers, and the baffle; (3) the provision of downwardly directed jets of steam at approximately 1200° F. at the bottom of the skirts to bar the entry of cracked effluent up into the downflowing heated coke; (4) the use of a novel outlet structure for the risers that lead from the cyclones and terminate in the scrubber, each riser being provided with jets projecting steam outwardly and upwardly around its exhaust opening; (5) the provision of a settler tank outside the scrubber, into which is conducted that effluent which is fully condensed by the initial quenching, and wherein the quenched oil is cleaned for return to the scrubber while the settled coke slurry is recycled to the coking reactor; (6) a novel arrangement of baffles in the lower part of the scrubber and the use therewith of additional quench-oil or low temperature steam.

Other objects and advantages of the invention and its details of construction will be better understood from the following detailed description of a preferred embodiment thereof presented in accordance with the statute.

In the drawings:

Fig. 1 is a view somewhat diagrammatic in form of a fluid coking apparatus of the type to which this invention applies, including a coking reactor, a coke burner, and a scrubber, and including apparatus embodying the principles of this invention.

Fig. 2 is an enlarged view in elevation and in section of a portion of the upper end of the coking reactor of Fig. 1 and a portion of the lower end of the scrubber, including apparatus embodying the principles of this invention.

Fig. 3 is a view in section taken along the line 3—3 in Fig. 2.

The purpose of a fluidized coking installation like that shown in Fig. 1 is to treat the residual oils from petroleum refining processes to obtain upgraded, lighter products that can be introduced into thermal or catalytic cracking units. Some naphtha and gas fractions are also produced. As a by-product, coke is obtained in fine particles like sand. This process contrasts with those processes which terminate with an asphalt residue and is distinctive in giving both a greater total yield from the crude oil and more salable and more valuable by-products. It is distinguished from "delayed coking" processes by being a continuous process.

As shown in Fig. 1, the coking installation normally comprises a reactor **10**, a heater **11**, and a scrubber **12**. The system is generally similar to a fluidized catalytic cracking unit but operates with coarser solids. In the reactor **10**, hot oil feed at about 400°–600° F. from the refinery is sprayed at **13** through nozzles into a bed **14** of finely divided fluidized coke at a temperature of about 900° to 1050° F. and at a pressure somewhat above atmospheric. Throughout, the solid particles are fluidized by steam, which is added at **15** near the lower end of the reactor **10** and elsewhere through the reactor, as well as by the cracked products which are generated in the bed of fluidized coke. The coke in the reactor **10**, therefore, acts substantially as a fluid, tending to boil and having what may be called a normal bed level **16** which varies up and down and bubbles considerably. The spray of liquid feed at **13** is distributed over the surface of coke particles in the bed **14**. The small, hot coke particles act as heat sources to effect cracking of the feed, forming coke and a vaporized effluent which leaves the reactor **10**. The effluent exits through a bank of cyclones **17** which separate entrained coke particles and return them to the bed **14**, while the effluent flows up through risers **18** into the scrubber **12**. In the scrubber **12** the effluent is cooled suddenly, by quenching, and is then passed to a fractionator (not shown) and a condenser (not shown), from which it is introduced into various phases of the refining process.

In the reactor **10** the decarbonization reaction simultaneously deposits a layer of coke on the particles in the bed **14**. This deposit includes those components of the feed having a high tendency to form coke, and the coking serves to remove them from the distillate products. Also, all but a minor part of the metallic contaminants and ash in the feed are retained in the coke, so that the effluent is thereby cleaned from the very high ash content of the pitch.

To obtain the hot coke needed in the reactor **10**, part of the product coke formed therein is withdrawn from the lower end **20** and transferred as a steam-borne fluid, via a pipe **21** into the heater **11**, which is also operated as a fluidized bed. Chunks of coke unsuitable for fluidization and circulation may be removed from the reactor **10** through the valve **22**.

Air is added to the heater bed through the opening **23**, some of the coke is burned, forming carbon dioxide and carbon monoxide and heating the bed to a temperature of approximately 1100° to 1200° F. The combustion products escape through the flue **24**. An amount of coke weighing about 5 to 7 percent of the fresh feed oil from **13** is burned as coke in the heater **11** in this reaction, and most of the remaining hot coke is recirculated to the reactor **10** through the conduits **25** and **26** to maintain the proper reaction temperature, steam being added where needed to maintain fluidization. As the reaction in the reactor **10** cools the coke, the cooler coke is continuously being returned to the heater **11** through the pipe **21**, a stripper being provided above the reactor bottom wherein the hydrocarbon vapors are displaced by steam to prevent their being carried over to the heater **11**.

In the reactor **10**, the particle size of the coke perpetually tends to grow as a result of the coke deposition described above. Since, as is well known, there is a desired maximum particle size, the larger particles are replaced by small seeds. This may be done by grinding or by other suitable means. Also, product coke is withdrawn from the burner **11** and sent to an elutriator **28** via a pipe **28***a*. In the elutriator **28** the product is cooled and washed by water. The elutriator **28** also serves to return finer particles to the burner-reactor system via the pipe **28***b* and provides for regulation of the size of the coke, the larger particles of which are withdrawn from the elutriator **28** through a conduit **28***c* at a safe temperature for handling.

So far, the description has related to the environment of the invention, in which are incorporated the novel features that will now be described. It will be noted that the heated coke particles from the burner **11** are returned to the reactor **10** through a major conduit **26** and a smaller conduit **25**. Heretofore, when two conduits have been used, the smaller conduit conducted the coke up to the mouths of the cyclones **17** where it contacted the effluent. The purpose was to inhibit coke deposition on the interior surfaces of the coking vessel, including the cyclones, above the fluid bed by maintaining, in the effluent withdrawn overhead, entrained solids from the fluidized coking bed in certain quantities (e.g., see Patent 2,735,806). These solids were intended to uphold the

temperature of the vapors, to scour attendant surfaces thereby removing carbon deposits, and to provide surfaces upon which the condensing vapors were absorbed. However, for reasons explained above, this prior-art expedient failed to solve the problem because its beneficial effects were, to a great extent, countervailed by the formation of additional coke, due to the reaction produced by the sudden temperature change undergone by the effluent when it met the much hotter coke from the burner. Also the introduction of freshly heated coke into the cyclone openings placed additional load on the cyclones and aggravated the carryover of entrained coke into the scrubber. In addition, the prior art placed a structure called an "anti-coking baffle" around the cyclones 17 and spaced from the upper wall of the reactor 10, with the purpose of keeping coke from encrusting the top wall of the reactor 10. The "anti-coking baffle" defined an upper chamber from the remainder of the reactor, and hot steam was sent into this chamber with the idea of keeping the baffle wall hot enough so that a minimum of coke would be deposited thereon. No coke was allowed to pass into the chamber above this "anti-coking baffle." The foregoing explanation will help in appreciating my invention, wherein a somewhat similar-appearing baffle is provided but in which an entirely different type of operation is achieved by important structural changes.

In the present invention (see Fig. 2), hot coke is carried in the pipe 25 from the burner 11 to the reactor 10 through the reactor wall 30 into an inlet pipe 31, the upper portion 32 of which is substantially vertical, and is conducted therein up along the central vertical axis of the reactor 10 to a point near the very top of the reactor 10 where an inlet opening 33 is provided above a baffle 34, which has a different structure from an "anti-coking baffle." The hot coke from the inlet pipe 31 is deposited above the baffle 34, filling the space 35 with coke. The baffle 34 has an upper portion 36 provided with the inlet opening 33 for the hot coke, a conical wall 37 extending down and out toward the reactor's walls 30, and a skirt 38 which depends from the low end of the conical portion 37 down to or below the level of the dip-leg outlets 39 of the cyclones 17, whence the coke particles separated out from the effluent in the cyclones 17 are returned to the coke bed 14.

The coke that enters the space 35 thus surrounds at least the upper portion of the cyclones 17 and the lower portion of the cyclone risers 18 and acts to gradually increase the temperature of the effluent as it rises. If desired, the lower portions of the cyclones 17 down to the dip-leg 39*a* may also be enclosed by the baffle 34. There will be some cooling of the coke as it falls from the top 36 of the baffle 34 to the coke bed level 16; therefore, since the coke is warmest at the top and cools as it flows down, it maintains the temperature of the rising effluent at a gradually increasing value. Since its temperature is increasing, the effluent cannot condense on the walls of the coke-heated transfer lines where it would coke and encrust the walls. Thus, the invention achieves the important object of inhibiting the formation and deposition of coke in the effluent during its passage from the entrance 46 to the cyclones 17 up to the bottom of the scrubber 12. This solves the problem of preventing coke deposition in the transfer lines, since the dry entrained coke particles from the coke bed 14 are hard and do not stick to the metal walls.

Simultaneously, the hot coke in the space 35 heats the baffle 34 thereby performing several other important functions: the heat keeps the baffle 34 warm so that coke does not tend to deposit on its lower surface; the baffle 34 transmits heat to the dilute phase portions 44 and 45 of the reactor 10, preventing the vaporous effluent from cooling and depositing coke; and the baffle separates the hot coke from the effluent, preventing the formation of coke which happens in prior art devices where they do come into contact.

After the fluidized coke flows down the conical baffle portion 37, it passes between the skirt portion 38 and the reactor inner wall 30. The annular space 40 here is relatively narrow to prevent escape of effluent up therethrough, and the continuous downward flow of coke also prevents effluent from entering through the space 40. However, in addition, for use at the beginning of operations, at times when the coke flow may be intermittent, and as a precautionary measure, an annular tubing 41 is provided in the space 40 around the bottom 42 of the skirt 38, and downwardly directed jets 43 of superheated steam to prevent any effluent from passing up through the stream of downflowing coke into the space 40 where it would tend to form coke and to cause plugging. It should be noted that the heated coke from the burner 11 is in the form of very hard particles which do not stick to the walls of the reactor 10 or of the baffle 34. Only the newly formed coke that would be produced from the effluent could stick to the walls and cause plugging, and that is what the jets 43 prevent.

Thus, the effluent rises, as it should, into the space 44 in the center of the reactor 10 constituting the reactor's dilute phase, and flows from the upper end 45 thereof into the entrance openings 46 of the cyclones 17. In the coke-heated cyclones 17 the effluent is separated from entrained coke particles, which fall toward the bottom and out the cyclone exit 39, while the effluent rises upwardly into the risers 18.

The bottom portion of each riser 18 is heated by the hot incoming coke. The upper portion is heated, as is normal, by steam at about 1200° F. conducted through an upwardly spiralling tubing 47. The steam in this tubing 47 maintains the temperature at the desired level. The steam in the tubings 47 may be provided from the same source as that for the tubing 41.

Heretofore, the upper end of the riser 18 has consisted of an elbow, but this has been found detrimental because it causes deposition of coke from the effluent at the funnel, due to cooling thereof. Various improvements have been suggested, but the present invention provides a simpler and more useful structure in which the riser can extend vertically upwardly all the way to its exhaust opening 49, which is the same diameter as the remainder of the riser 18. The effluent is therefore conducted without meeting obstructions or restrictions in the risers 18, and a steadily rising temperature is maintained, thereby eliminating substantially all the coke formation in the riser. To prevent the stream of exhausted effluent from sucking in material in the scrubber 12, jets 50 spray steam, at approximately 1200° F., upwardly at about 45° outwardly from the top of the risers 18. Preferably, the jets 50 are disposed in a ring around the outlet 49, as by providing them at the upper end of the coiled tubing 47, the last turn of which is horizontal and is at the tip of the outlet 49.

When the effluent enters the scrubber 12, it is instantaneously quenched. While this instantaneous action does not produce any coke, the condensed liquid that formerly collected on the bottom wall 51 of the scrubber 12 did have an adverse effect, since this cooler liquid necessarily cooled the risers 18. Since even a slight cooling action leads to the formation of coke, it is desirable to eliminate it completely. Also, coke which accumulated therein tended to plug the pipes leading to the pump for the quench-oil, the quench-oil being obtained from the condensed effluent. Both these adverse effects are avoided by draining the floor 51 and conducting all the condensed liquid from the outwardly sloping floor 51 of the scrubber 12 through a conduit 52 into a settler tank 53, preferably shaped generally as shown with an upper cylindrical portion 54 and a lower conical portion 55.

The condensed effluent enters the settler 53 at about the upper end of the lower, conical portion 55. The capacity of the settler 53 is large enough to give several minutes of settling, and the pressure is kept at the same

value as that of the scrubber 12 by a pressure-equalizing conduit 56 at its upper end. The coke slurry settles to the bottom and is recycled by a pump 59 to the reactor 10 through the bottom outlet 57 and conduit 58. The clean quenched oil is withdrawn through a conduit 60 from the upper cylindrical portion 54 of the settler 53, is forced by a pump 61 to a cooler 62 and, cooled, is returned to the scrubber 12 through a conduit 63 for use as quench-oil.

That effluent which did not condense has in the meantime been passing upwardly in the scrubber 12. As it does so, it is continually quenched and cooled by sprays of oil from the conduit 63. Sheds 64 send the effluent on a labyrinthine path that assures adequate contact with the quench-oil. The present invention provides, in addition, a group of bottom sheds or trays 65 and spray nozzles 66 below each lower tray 65 to wet the lower surface 67 of the bottom trays 65 and thereby prevent coking at that point by protecting them with a film of cool oil. These nozzles 66 may be supplied with quench-oil from the conduit 63 through a branch conduit 68 (in which event they are turned on only after the unit is sending up enough effluent to keep oil from dripping back into the risers 18). Or they may be supplied from the beginning with low pressure, relatively cool (e.g. 300° F.) steam from the conduit 69. The steam may be used instead of oil, or a switchover to oil may be made after the unit is in full operation by turning the three-way valve 70. The pipes to the nozzles 66 preferably enter radially through the scrubber walls, so that they are as short as possible. These bottom trays 65 are preferably placed vertically above the risers 18 and serve to prevent quench liquid from above from falling into the exhaust openings 49. While most of the trays 64 in the scrubber are normally inverted V-troughs, the bottom trays 65 may be, and preferably are, cone-shaped so that they better overlie the exhaust openings 49.

In operation, the fresh-feed material is sprayed at 13 into the bed of fluidized coke 14, while steam is put in at 15 and elsewhere. Coke is constantly being drained from the reactor 10 and conducted through the conduit 21 to the heater 11 where some of the coke is burned to heat the remainder, and hot coke is returned from the heater 11 via conduits 25 and 26. The coke returning through the conduit 25 flows into the space 35 above the baffle 34 and serves to heat the baffle 34 and the effluent flowing up through dilute phase sections 44 and 45 of the reactor, the risers 18, and at least the upper part of the cyclones 17. The flow of coke downwardly means that the portion at the top is hottest and therefore the effluent is hottest at the top. However, the temperature increase is a gradual one.

The hot coke flows on down through the space 40 between the reactor wall 30 and the baffle skirt 38, whence it falls onto the normal coke bed 16. The steam sprays 43 prevent any partially cracked effluent which rises from the normal coke bed level 16 from flowing up through the space 40 and depositing coke therein. The effluent flows up through the space 44, 45 in the center of the upper end of the reactor 10 and enters the several openings 46 into the cyclones 17. Coke particles are removed in the normal manner and are returned to the coke bed through the cyclone's lower end 39. The effluent, freed from these coke particles, flows up through the risers 18 while its temperature is very gradually increased and then it is expelled through the outlet 49 into the lower end of the scrubber 12. At the outlet 49 steam sprays 50 protect the risers 18 and the effluent therein from sucking in drops of condensate, and the overlying sheds 65 prevent oil from falling in. The sprays 66 of steam or quench-oil prevent the formation of coke on the bottom surface 67 of the sheds 65 which themselves, together with the other sheds 64 thereabove, serve to assure contact between the quench-oil and the effluent.

Effluent which condenses and settles on the floor 51 is piped out therefrom by the conduit 52 into the settler tank 53. From there clean quench-oil is withdrawn and cooled for return into the scrubber 12. From the bottom of the settler tank 53 a slurry containing most of the coke in the condensed effluent is returned to about the middle of the coke bed 14 for further processing.

The foregoing description of the apparatus and its operation has also included numerous indications of my novel method. For one thing, the method includes subjecting the rising effluent to continually gradually rising temperatures while passing it through the reactor's dilute phase, separating it from entrained coke particles, and conveying it into the scrubbing zone. It obtains the desired temperature conditions by flowing a stream of heated coke downwardly around the transfer lines, cyclones and dilute phase, while baffling it therefrom. It passes this hot coke onto the coke bed through a restricted area, while simultaneously deflecting effluent away therefrom by downwardly directed jets of steam. Similarly, the entry of effluent into the scrubber is surrounded and prevented from exerting unwanted suction by spraying steam upwardly and outwardly around the entering effluent. Further, the method of this invention involves conveying condensed effluent away from the scrubber and settling it, separating the coke slurry from substantially coke-free oil to use as quenching oil, and returning the coke slurry to the coke reacting zone.

Practice of the method of this invention, particularly when used in conjunction with the apparatus heretofore described, results in a substantial reduction of coke formation and coke carry-over between the reactor and the scrubber. Moreover, this invention makes it possible to operate the coking apparatus substantially continuously without having to make frequent stops for slowly cleaning out coke deposits after having allowed the apparatus to cool for many hours.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. In a coking process for upgrading heavy petroleum fractions, in which a fluidized bed of heated coke is continuously sprayed with a fresh feed of said fractions to produce thermal cracking thereof into a vaporous effluent and additional coke, said vaporous effluent being separated from coke particles and transferred upwardly to a quenching zone while the coke is cycled through a heating zone for reuse; the novel steps of conveying freshly heated coke in a downwardly and outwardly flowing stream around and separated from the upwardly flowing effluent so as to heat it without direct contract therebetween and so that the temperature imparted to said effluent is highest at the top and rises gradually and consistently during the upward passage of said effluent; maintaining said separation to a point just above the bed level; and there adding said downwardly flowing stream of coke to said coke bed, while spraying jets of steam downwardly at the point where the separation of said effluent from said downwardly flowing stream of coke terminates, to direct said effluent away from said stream.

2. In an apparatus for upgrading high-boiling petroleum fractions by a fluidized coking process and including a coking reactor with a generally cylindrical wall enclosing a coke bed portion and a dilute phase portion above the coke bed portion, with a cyclone means therein for separating coke particles from the effluent and returning the coke particles to said coke bed, a scrubber above said reactor where said effluent is quenched, and vertical riser means conducting said effluent directly from said cyclone means to said scrubber, the combination

therewith of a series of upwardly and outwardly directed steam jets around the outlet of the riser means in the scrubber for preventing the sucking of drops of quenched effluent into the rim of said outlet, shed means in said scrubber spaced a short distance vertically above the outlet of said riser, and means to spray fluid cooler than said effluent on the lower surface of said shed means, said shed means protecting said riser outlet from falling drops of condensed effluent and said spray means protecting said lower surface of said shed means against the formation of coke thereon.

3. In an apparatus for upgrading high-boiling petroleum fractions by a fluidized coking process and including a coking reactor with a generally cylindrical wall enclosing a coke bed portion and a dilute phase portion above the coke bed portion with a cyclone means therein for separating coke particles from the effluent and returning the coke particles to said coke bed, and a scrubber above said reactor where said effluent is quenched, the combination of a straight vertical riser conducting said effluent along a straight vertical path from each said cyclone means into said scrubber, said riser having an open upper end for vertical discharge of said effluent, and a series of upwardly and outwardly directed steam jets around and on said riser outlet for preventing quenched effluent from being sucked into said outlet.

4. In a hydrocarbon oil fluid coking vessel which comprises means for establishing and maintaining a fluid bed of particulate solids at a coking temperature in the lower portion with a disperse zone thereabove, cyclone separating means in the upper portion of said vessel with a dependent dip-leg and means for injecting liquid hydrocarbon oil into an intermediate portion of said fluid bed, the improvement which comprises a substantially conical partition separating said cyclone means from said disperse zone and continuous with a substantially cylindrical partition separating said disperse phase from the inner wall of said vessel providing an annular space therebetween terminating immediately above said bed at a level no higher than the lower end of said dip-leg, cyclone entrance means extending through said baffle and connecting said cyclone means with said disperse zone, and inlet conduit means for admitting a stream composed mainly of heated particulate solids into the space between said conical baffle and the upper end of said vessel at a point adjacent the apex of said conical baffle whereby the cyclones and the walls of the disperse zone are heated by external contact with the hot solids descending from said apex to said bed.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 16,252	Catlin	Dec. 12, 1926
1,790,824	Loebell	Feb. 3, 1931
2,661,324	Leffer	Dec. 1, 1953
2,734,852	Moser	Feb. 14, 1956
2,763,601	Martin	Sept. 18, 1956
2,789,082	Barr	Apr. 16, 1957
2,791,549	Jahnig	May 7, 1957
2,793,173	Fritz	May 21, 1957
2,810,679	Haig	Oct. 22, 1957
2,859,168	Downing et al.	Nov. 4, 1958
2,881,130	Pfeiffer et al.	Apr. 7, 1959
2,890,999	Polack	June 16, 1959