

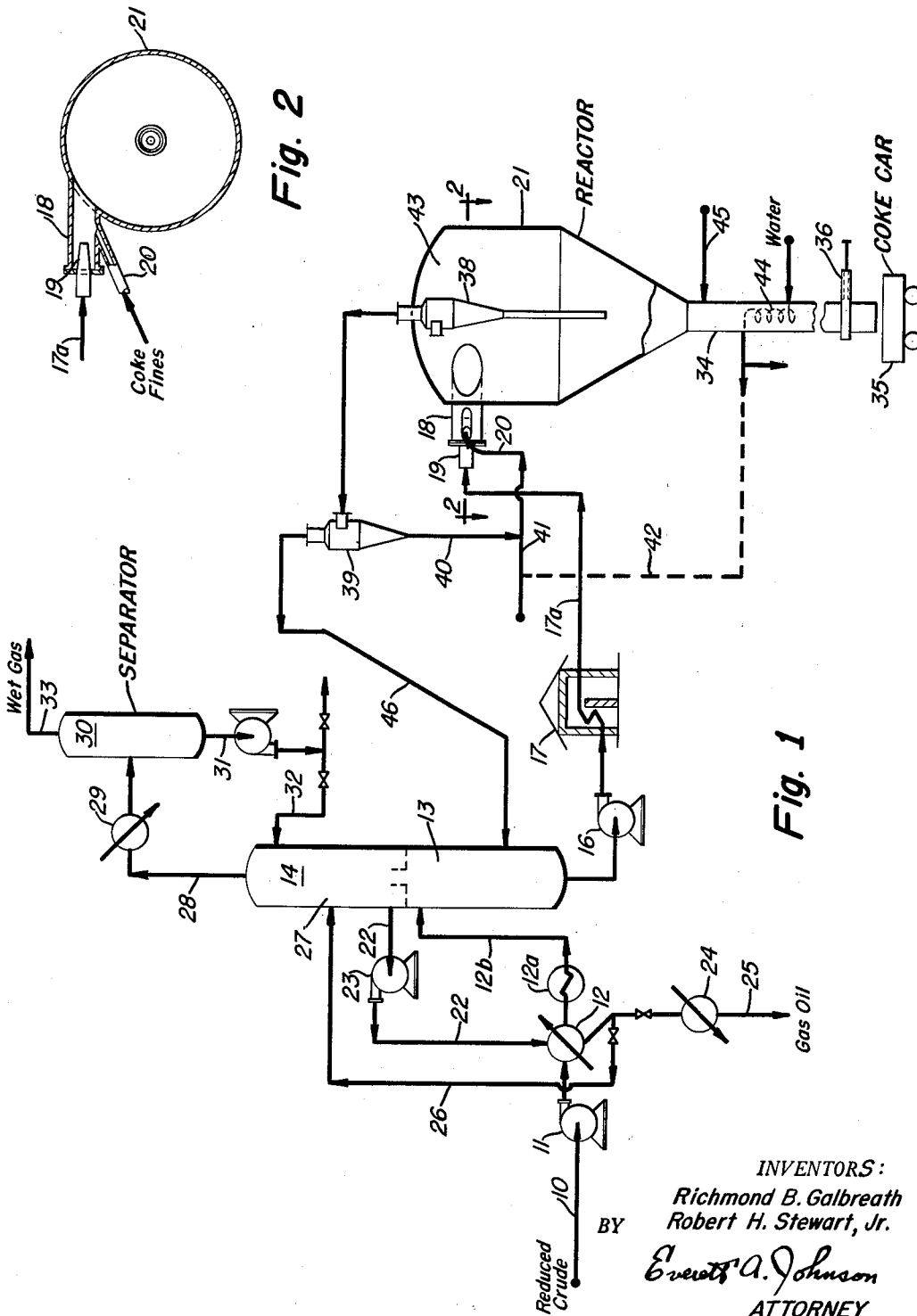
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PROCESS FOR CONTINUOUS FLUID COKING

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PROCESS FOR CONTINUOUS FLUID COKING

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This invention relates to a method and means for coking of heavy petroleum oil fractions and is more specifically concerned with a coking process wherein reduced crude is introduced into the coking chamber in the form of a spray.

One difficulty with spray coking processes heretofore proposed is the tendency of coke to build up on the inner walls of the coking chamber. Such build up or deposit of coke quickly fills the coking chamber resulting in uneconomical operation of the coking process because of the recurrent shut downs and coke cleaning required.

These and other difficulties are apparently due to the fact that at some point in its reduction from hot liquid oil to solid coke, the coke passes through a plastic and highly adhesive phase. For this reason, it heretofore has been proposed to effect the coking in the presence of a stream of highly heated gasiform fluids such as steam or hydrocarbon gases. Although such a system is an improvement over the simple spraying of hot oil into a coking drum, the very large volume of gasiform fluids required makes it difficult to separate the suspended coke particles in an efficient and economical manner. Large coking drums and collection chambers are necessary and, in general, the operation is not commercially attractive.

It is, therefore, a primary object of this invention to provide a system for continuous fluid coking wherein finely divided, free-flowing particles of coke is the product. A further object of this invention is to provide a system whereby reduced crude can be coked without excessive build up of coke within the coking chamber. An additional object is to provide a method for coking petroleum oils which requires less expensive structures and equipment than heretofore necessary. It is also an object of our invention to provide a system for vapor phase coking wherein coke fines are employed as coke-forming nuclei. Still another object of our invention is to provide a system wherein the process is continuous and the intermittent cleaning of coking drums is eliminated while producing a finely divided coke of uniform size which is easy to handle and marketable. These and other objects of the invention will become apparent to those skilled in the art as the description of our invention proceeds.

Briefly, according to our invention, reduced crude is coked continuously by spraying the heated charge tangentially into a cyclone reactor after admixing hot recycled coke particles with the spray of atomized charge to serve as coke-forming nuclei. Product coke is withdrawn from the base of the reactor and overhead vapors are fractionated in the crude-reducing tower.

The system includes a cyclone reactor with tangential hot feed injection through spray nozzles with a stream of hot coke fines contacting the spray to form large coke particles. The cyclonic action within the reactor enhances high heat transfer rates and rapid coking. Within the cyclone reactor we maintain a dense phase fluidized bed of coke which is continually withdrawn from a bottom portion of the vessel. We provide a cyclone separator means (which may be in an upper part of the coking chamber or reactor) which separates vapors from fine coke particles. These fine coke particles are transferred

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from the cyclone dipleg and returned to the tangential feed zone to contact incoming atomized feed.

Our fluid coking process uses only one coking vessel, a cyclonic type reactor, and the feed to this vessel is injected tangentially through a high velocity nozzle. Coke fines are injected into the atomized feed from the high velocity nozzles immediately after the feed leaves the nozzle but before the feed vapors change direction in the cyclone. In this way contact area is increased and rapid coking is obtained, thereby avoiding coke build up on the reactor walls.

Further objects and advantages of our invention will be described in conjunction with the accompanying drawing wherein:

Figure 1 is a diagrammatic view including a vertical section of the coking apparatus; and

Figure 2 is a plan view taken along the line 2—2 in Figure 1.

Referring to the drawing, reduced crude of about 15° API is introduced via line 10 and pump 11 through heat exchanger 12, furnace 12a, and line 12b into section 13 of the crude-reducing tower 14. The heavy crude fraction withdrawn from the crude-reducing tower 14 via line 15 and pump 16 is heated in furnace 17 to a temperature of above about 975° F., for example 1000° F.

The hot charge in line 17a is passed into the contacting device 18 through high velocity nozzle 19. A second stream comprising coke fines is obliquely introduced into the contacting device 18 by line 20 and commingled with the feed spray emerging from the nozzle 19. The flow rate through the atomizing nozzle 19 can be varied but should, in any event, be high enough to avoid streamline flow therethrough to produce the desired spray or fog of feed. The spray from the nozzle 19 and the coke fines from line 20 commingled therewith are introduced tangentially from the contacting device 18 into cyclonic reactor 21.

Although we have described and shown in the drawing only one assembly 18—19—20, several such assemblies may be provided at vertically and/or circumferentially spaced points on the chamber 21. If desired, the ratio of coke fines to hot feed spray may be controlled in the individual assemblies as coking conditions may warrant.

Coking and plugging of the tubes in heater 17 and in the nozzles 19 can be minimized by maintaining adequate velocities therethrough. The desired velocities, of for example approximately five feet per second, may be obtained by introducing high pressure steam (400 p. s. i. g.). Plugging by coke formed in other parts of the system than the heater 17 and the nozzles 19 can be eliminated by suitable screens upstream of the nozzles 19 and preferably in parallel to facilitate servicing.

A gas oil is withdrawn via line 22 and pump 23 and used to preheat the crude passing through heat exchanger 12 after which it is further cooled in cooler 24 and withdrawn from the system via valved line 25. Alternatively, a portion of the gas oil can be recycled by valved line 26 to an upper part 27 of the tower 14. Overhead from the crude tower 14 is passed via transfer line 28 and cooler 29 to separator 30. Unstable gasoline may be withdrawn from the system via line 31 or returned via line 32 to the crude tower 14 as reflux. Wet gas is vented from the separator 30 via valved line 33.

Within the coking reactor 21, the lighter portions of the reduced crude are vaporized and the heavier, unvaporized portion forms a transient liquid film on the coke fines. These fines remain suspended within the cyclone reactor 21 for a time sufficient to allow the rapid contacting of the growing coke particles with additional quantities of atomized feed. There is rapid heat transfer from the liquid to the coke nuclei, which avoids adhesion to the walls of coker 21.

This build up of coke on the coke nuclei continues until

the coke particle collects in the fluidized dense phase in the lower portion of the cyclonic reactor 21. Fluent dry coke is removed continuously from the cyclonic reactor 21 and fed through a standpipe 34 into the coke car 35 by slide valve 36.

Coking vapors and the coke fines which remain suspended therein after cyclone 33 within the cyclonic reactor 21 are separated in cyclone separator 39, the coke fines passing downwardly through the cyclone dipleg 40. From the base of the dipleg 40 the hot coke fines are suspended in a heated gasiform fluid such as steam or nitrogen supplied by line 41 and transferred via line 20 to the nozzle 19 to be commingled with additional quantities of atomized feed as described above.

The feasibility of the process depends upon rapid coking of the atomized feed as it leaves the contacting chamber 18 and enters the cyclonic coking zone 21. The ratio of coke nuclei to oil in the contacting zone 18 is controlled so that the desired rapid coking is obtained. High heat transfer rates within the contacting chamber 18 and the presence of coke nuclei bring about almost instantaneous coking thereby avoiding plastering of the walls of the coking chamber 21 which would otherwise result in the necessity of shutting down.

The size of the recycle coke nuclei may be in the range of from about 5 to 100 microns, but preferably averaging less than about 80 microns. The product coke withdrawn by standpipe 34 from the reactor 21 may average about $\frac{1}{16}$ inch in diameter, but is preferably greater than about 150 microns.

Although the final cyclone 39 is shown as being exterior of the cyclonic reactor 21, it should be understood that one or more stages of cyclone separators 38 may be provided within the coke-disengaging zone 43 within the upper part of reactor 21 and that coke fines from the diplegs of these cyclone separators 38 may also be utilized as are the coke fines separated in cyclone separator 39. Particle size may be controlled by additions or withdrawals from the recycle coke fines stream.

Fluid heating means such as coils 44 may be disposed in heat exchange with the hot product coke in standpipe 34. When water is the cooling fluid, the produced steam may be used for transferring the fines from dipleg 40 to the nozzles 19. In a similar way, nitrogen or other fixed gas may be heated and used to transfer the coke fines and add heat to the coking chamber 21.

It is also contemplated that a highly heated fluidizing gasiform fluid may be introduced at one or more points 45 in the lower portion of the cyclonic reactor 21 so as to maintain the product coke in a mobile dense phase and so as to elutriate the coke fines from the bulk of the product thereby providing a source of nuclei for the continued coking of the reduced crude.

The coke-free vapors containing gas, steam, gasoline, and gas oils are withdrawn from the cyclone separator 39 and passed by transfer line 46 to the main crude fractionator 14. If desired, a portion of the gas oils from tower 14 may be recycled through the furnace 17 to the nozzles 19 and the reactor 21.

Although we have described our invention with reference to a particular embodiment thereof, it should be understood that this is by way of illustration only and that the scope of the invention is not necessarily limited thereby. However, from the above description, it will be apparent that we have attained the objects of our invention and have provided an integrated system for continuous coking of reduced crude in the vapor phase by employing recycled coke fines as coke-forming nuclei.

What we claim is:

1. A process for coking reduced crude continuously which comprises the steps of heating a stream of reduced crude to a temperature above about 975° F., spraying the hot reduced crude tangentially into an upper part of a cyclonic coking zone, admixing with the spray a quantity of coke particles as coke-forming nuclei, accumulat-

ing a mass of fluent coke particles in a lower part of said coking zone, withdrawing fluent product coke from the base of the coking zone as a fluent finely divided mass, separately withdrawing coke fines from the coking zone, and introducing at least a portion of the withdrawn coke fines into the said spray of reduced crude entering the coking zone.

2. In a coking process wherein hot hydrocarbon liquid is contacted with pre-formed coke particles to produce additional coke, the improvement which comprises introducing heated hydrocarbon liquid into a coking zone as a high velocity spray directed tangentially to the coking zone, and before the spray changes direction of flow commingling with said spray a quantity of finely divided coke as coke-forming nuclei for coking of the introduced spray.

3. A process for coking which comprises the steps of fractionating a crude oil to produce a reduced crude of about 15 API gravity, heating the stream of reduced crude to a temperature of the order of 1000° F., tangentially injecting the hot feed as a high velocity spray into an upper portion of a cyclonic coking zone, immediately contacting the spray of atomized feed with recirculated hot coke fines before the spray changes direction within the cyclonic coking zone, producing coke on said fines, accumulating produced coke in a lower portion of the coking zone in the form of a dense phase fluidized bed, continually withdrawing coke from said bed, separating residual vapors and fine coke particles, and introducing a portion of said separated coke particles into the entering spray of atomized feed.

4. A process for coking a heavy hydrocarbon liquid which comprises heating a stream of such liquid to an elevated temperature of about 1000° F., spraying the heated charge stream into an upper portion of a coking zone, introducing a separate stream of coke fines from the process into the spray of hot atomized feed, imparting cyclonic motion to said spray and commingling coke fines in an upper part of said coking zone, converting the said charge into lower boiling products and simultaneously depositing on said coke fines a quantity of coke produced from said introduced charge, discharging coarser particles continuously from the lower portion of said coking zone, withdrawing finer particles continuously from said coking zone, and recycling at least a part of the withdrawn finer particles to said separate stream being commingled with atomized feed within the coking zone.

5. The method for producing gasoline, gas, oil and coke from a crude oil stream which comprises the steps of subjecting the crude oil stream to a fractionation step to produce a gasoline fraction, a gas oil fraction and a residual reduced crude fraction, heating the reduced crude fraction to about 1000° F., injecting the hot reduced crude into a cyclonic coking zone as a high velocity spray, commingling with said spray within said coking zone a suspension of coke fines produced in the coking process, contacting the coke fines and feed spray for a time sufficient to produce a deposit of fresh coke on said coke fines, separating the produced coke and hydrocarbon vapors, separately withdrawing product coke from a lower part of the coking zone, separating hydrocarbon vapors and coke fines, injecting the separated coke fines into said suspension, and subjecting the separated hydrocarbon vapors to said fractionation step for the recovery of gasoline and gas oil fractions.

6. The process of claim 2 which includes the additional steps of introducing in the lower portion of the coking zone a highly heated fluidizing gasiform fluid to maintain the product coke in a mobile dense phase and to elutriate finely divided coke from the bulk of the product, and separating the gasiform fluid and finely divided coke, said separated finely divided coke comprising at least a part of the said quantity of finely divided coke commingled with said spray.

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