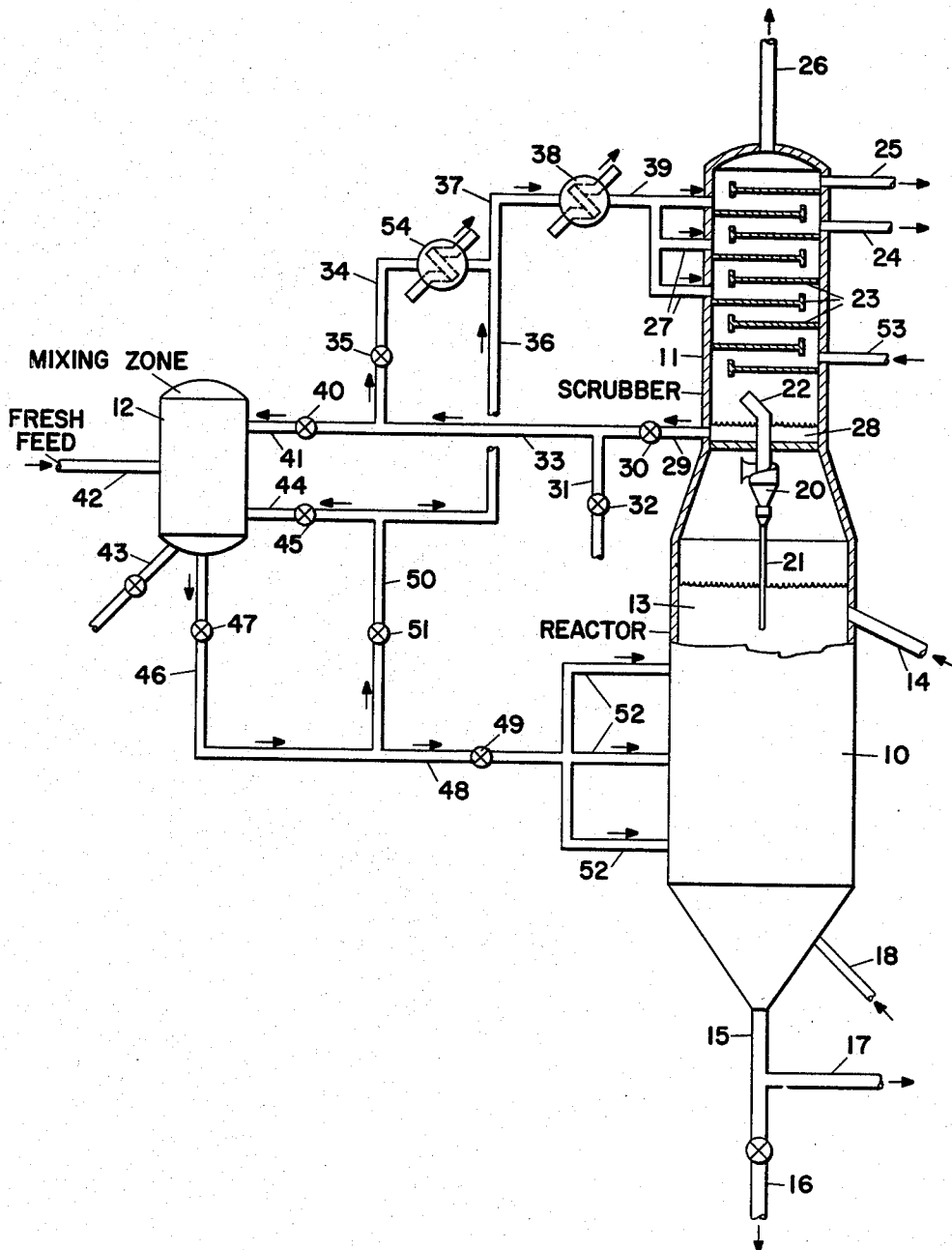


Dec. 6, 1960

H. N. WEINBERG ET AL
COKING AND SCRUBBING SYSTEM

2,963,418

Filed Nov. 12, 1957



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COKING AND SCRUBBING SYSTEM

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Filed Nov. 12, 1957, Ser. No. 695,844

6 Claims. (Cl. 208—34)

The present invention is concerned with an improved means for treating the heavy end material separated from the vaporous products of a coking reaction zone. More particularly, it deals with a system whereby the viscous end fractions are made easier to handle, continuous liquid circulation maintained, and increased flexibility of operation realized.

In recent years, there has been developed, in the petroleum industry, the well known fluid bed process for pyrolyzing relatively heavy hydrocarbons. The process, commonly referred to as fluid coking, consists chiefly in introducing an oil feed into a highly turbulent mass of hot, inert particles maintained at a temperature in the range of 800 to 1200° F. Upon contact with the hot solid particles, the oil is converted into vaporous reaction products and carbonaceous material which is continuously deposited upon the contact solids. Normally, at least a portion of the particles coated in this manner are withdrawn from the coking vessel, and circulated to a combustion zone wherein oxidation of part of carbonaceous material serves to heat the solids to requisite high temperatures. The heated solids are then recirculated to the reaction bed thereby providing thermal energy for the conversion process.

Typically, the feed has an initial boiling point of about 600° F. or higher, an A.P.I. gravity ranging from 0° to 20°, and a Conradson carbon residue content of about 5 to 40 wt. percent. Suitable contact solids for fluid coking include, among others, sand, coke particles, ceramics, glass beads, and the like, and preferably range from 40 to 500 microns in diameter.

Gases, generally after passing through a solids separation step, are withdrawn overhead from the reaction zone and passed into a scrubbing and fractionation unit wherein less desirable heavy end material and fine solid particles are removed from the vaporous conversion products. This heavy end fraction, normally boiling above 700° F., is characteristically a rather viscous, tar containing material, unsuitable for product recovery as such. It has, heretofore, been standard procedure to recycle this heavy material, substantially to extinction, to the coking bed wherein it undergoes further cracking to give desired light end fractions. Normally, a portion of the heavy hydrocarbon end material is cooled and recycled back to an intermediate section of the scrubbing unit wherein it serves as a scrubbing agent to further condense heavy material and recover coke fines escaping from the reactor.

However, the handling of this heavy recycle material has caused appreciable difficulties. Due to its viscous, tarry nature, it has tended to deposit carbonaceous residue on structural walls, and to plug conduits thereby causing excessive pressure drops in the system. Over a length of time, fluid flow may be completely blocked, and an unscheduled shutdown of the entire coking system necessitated.

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The present invention presents a system whereby this viscous, scrubber bottom material is more easily transported while simultaneously providing added flexibility of operation, and smaller apparatus for feeding the reaction zone. More specifically, the heavy end fraction is withdrawn from the scrubbing vessel, and at least a portion of it, preferably in a continuous manner, is sent to a mixing zone wherein it is contacted with substantially all the fresh hydrocarbon oil feed to be introduced into the reaction bed. Since the feed is of comparatively low viscosity, the mixture thus obtained is considerably less viscous than the heavy end fraction itself. Further, the ratio of total fresh oil feed rate to circulating scrubber bottoms is sufficiently high to result in the mixture having viscosity and carbon depositing characteristics more like the fresh oil feed than the heavy end fraction. Thereafter, a portion of the mixture is recirculated back to the scrubbing zone, and a second portion introduced into the reaction bed by means of the feed nozzle system heretofore employed for injection of fresh oil feed directly into the conversion zone. By way of clarification, it should be noted that fresh feed, as such, no longer exists in the system after the fresh feed has been introduced into the mixing zone.

Additionally, it should be clearly understood that the present invention is not directed to the broad principle of diluting scrubber bottoms recycle by adding an extraneous material, as for example, a portion of the oil feed. The present invention is a distinct step forward over the prior art by utilizing substantially all the fresh feed as a diluent agent without incurring excessive liquid hold-ups. As is readily appreciated, a considerably less viscous material is thus obtained. In former systems, any extraneous diluent liquid was passed into the scrubber bottom liquid holdup zone. Such an operation necessitates an unduly large scrubber bottom section, and limited operation flexibility if a diluting effect comparable to that presently taught is to be obtained. While in the past, an extraneous gas oil stream was provided on a standby basis to supply some purge during an upset, practice has proven many times that difficulties and uncertainties have restricted and/or prevented the extraneous stream from providing adequate purge. Plugging of feed nozzles, pumps and other equipment causing shutdown of the unit thereby resulted.

In accordance with the present invention, feed is continually passing through the slurry recycle system at high rate and is returned to the feed surge drum or tank.

Since, in accordance with the present invention, essentially all the fresh feed serves as a diluent, liquid handling difficulties are minimized. Further, the quantity of material in the slurry recycle system is no longer dependent solely on the amounts of bottoms fractions in the reactor overhead vapors and thus a large quantity of liquid may be continuously circulated throughout the slurry system. Highly desirable added flexibility is realized in that continuous circulation and purging of the slurry system is insured even in the event of an emergency upset or temporary dislocation in the conversion system. Temperature control of the scrubber zone may be readily maintained even if a part, or all, of the cooling effect of the scrubber unit is lost (failure of pumparound cooler), due to the heat removal capacity of the fresh feed. While cooling and diluting the heavy end fraction, the feed undergoes necessary preheating and thus the quantity of externally provided feed preheat required is reduced. Additionally, all the fresh feed and extinction recycle material may be introduced solely as a mixture through the coker feed nozzles, thereby eliminating prior art separate injection means for the recycle material and the fresh

feed. Further, better distribution of total oil feed into the coking reactor is obtained.

The various aspects of the present invention will be more clearly understood by referring to the following description, example and accompanying drawing.

The figure depicts a fluid bed reaction system operating in accordance with the present teachings.

Turning to the drawing, there is shown a conversion system consisting essentially of reactor 10, scrubbing and fractionation vessel 11, and mixing zone 12. While scrubber 11 is in direct superimposed relationship with respect to reactor 10, as is normally preferred, the present invention may find application when the conversion unit and fractionator are two distinct, unattached vessels, or even when the fractionation zone is within the reactor itself. Similarly, while it is normally preferable to have a distinct mixing zone 12 in the form of a surge drum having a substantial liquid holdup capacity, i.e. 0.3 to 1.0 gallon/gallon/hr. of fresh oil feed, the mixing of heavy recycle ends and fresh feed may be performed in an average size or slightly enlarged portion of the circulating conduits.

With respect to reactor 10, there is contained therein a highly turbulent bed 13 of inert solid particles, e.g. sand, at a temperature of about 950° F. Fluidizing gases such as steam, nitrogen, hydrocarbons, etc. provided through line 18, serve to maintain the solids bed in the form of a pseudo-liquid phase. Solids are withdrawn, either continuously or intermittently, and passed by lines 15 and 17 to a burner zone, not shown. After the temperature is sufficiently raised by oxidation of occluded carbonaceous residue, the solids are recirculated to the reaction bed by line 14, thus supplying requisite thermal energy. Due to the continuous deposition of carbonaceous material characteristic of the coking reaction, a portion of the solids is removed from the burner side of the system, finding use as fuel, or as a unique carbon solid.

As will be later more fully described, hydrocarbon oil (the mixture of fresh oil feed and heavy ends), suitably preheated, is introduced into the conversion zone by multiple injection nozzles 52 or other conventional injection means, disposed circumferentially and longitudinally about the reactor shell. Upon contact with the hot solids, the hydrocarbons are converted to lighter materials boiling in the naphtha, gas oil ranges, and more volatile constituents. The gases then normally flow into a separator 20, e.g. one or more cyclones, wherein practically all of the entrained solids are removed and returned to the reactor bed by dipleg 21. While generally utilized, the separator may be eliminated when the presence of solids in the vapor fractionation step can be tolerated, or is even desired. Thereafter, the gases flow into scrubber 11.

Within the scrubbing unit, there is contained a plurality of baffle plates 23, or other conventional means such as sheds or jet trays, for promoting commingling of fluids. Relatively cool liquid and/or gas is introduced into the scrubber by injector 27 and line 53. While at least a portion of this quenching-stripping fluid is heavy end material recycled from the scrubber bottom holdup section 28, other hydrocarbons such as a recycled intermediate fraction, steam, inerts, etc. may be utilized. The coker vapors are introduced into the scrubber by conduit 22 at a temperature generally in the range of 950 to 1050° F., and pass upwardly in countercurrent flow to descending stripping liquid. Desired constituents are thus fractionated and removed overhead by lines 24, 25, and 26. Typically, a gas oil fraction is removed by line 24, a naphtha range material by line 25, and light gases boiling below about 140° F. by conduit 26.

Heavy ends material, e.g. boiling above 700° F., and normally above 1000° F., is condensed from upflowing vapors and settles to form holdup zone 28, having a temperature of about 650 to 775° F.

Up to this point, the description has been generally directed to features commonly known in the art.

In accordance with the present invention, scrubber bottoms are removed by line 29 having valve 30 therein, and at least a substantial portion (generally between 30% and 70%) is passed through valve 40 and line 33 and 41 to mixing zone 12. While normally all the heavy end material is internally recycled to extinction back to the scrubbing and reaction units, line 31 is fitted with valve 32 as a means for withdrawing scrubber bottoms from the system. Of course, taps may be placed at other points in the bottoms flow pattern.

As indicated formerly, mixing zone 12 is preferably a unit of substantial holdup capacity, i.e. greater than 0.3 gal./gal./hr. of fresh oil feed. Thus, in the event of disruption in the conversion system, the reservoir in the mixing zone continues to supply necessary liquid streams to the scrubbing zone. This permits continuous withdrawal of a liquid stream from the lower portion of scrubber 11. The liquid stream acts as a purge for the scrubbing zone in that it removes sedimentary material passing from zone 13 through separator 20 and conduit 22. It frequently occurs that oil feed to the reactor must be withdrawn while continued coke circulation is essential. Even though flow of hydrocarbon gases from the reactor is interrupted, flow of fluidizing gases, e.g. steam or other gas, continues. Thus, sedimentary material (fine coke particles) still enter into the scrubbing zone. If this material is not rapidly removed, it will continue to concentrate and ultimately render the entire system inoperable due to the clogging of pumps, lines, and the like.

Fresh oil feed, such as a South Louisiana crude, and normally at temperatures of about 200–400° F., is introduced into mixing zone 12 by line 42. When steady state conditions exist, the fresh feed forms an equilibrium mixture with material withdrawn from the slurry pumparound circuit (which is itself an equilibrium mixture of fresh feed which previously entered the system plus the heavy end material of the reactor vapors). The viscosity of the feed-end material circulating in the slurry system is considerably lower than the slurry pumparound of previous systems, generally being 40% to 70% of that which would be encountered if the present invention were not practiced.

While not shown, mixing zone 12 may contain a stirrer element, baffles, trays, etc. for facilitating good mixing of the two streams. Line 43 permits withdrawal of liquid from the vessel, if desired.

The fresh oil-heavy end mixture is withdrawn by line 46, valve 47 serving to accurately control the quantity of liquid flow. A portion of the mixture is then passed by means of line 48, and valve 49 into multiple injector 52 wherefrom it is introduced into the reaction zone 13. While the feed will be preheated to some extent due to the original heat content of withdrawn scrubber bottoms, a preheater or the like may be inserted in line 49, if desired.

An additional portion of the mixture flows through line 50 containing valve 51, thence through lines 36, 37 and 39 and multiple injector 27 back into the scrubbing zone. For flexibility, line 44 and valve 45 are indicated as a means of additional flow rate control. Similarly, the drawing indicates that some of the feed-heavy ends mixture withdrawn from the scrubber bottom 28 may be directly recirculated to the fractionation zone through line 34 and valve 35.

As a means of controlling temperature in the scrubbing operation, one or more coolers 38 and/or 54 are provided for altering the temperature of the various circulating liquid streams. Usually, the recycled material enters the scrubber at about 400 to 600° F.

Tabulated below is a compilation of data applicable to the system described.

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Table 1

	Broad Range	Preferred Range
Percent of withdrawn scrubber heavy ends sent to mixing zone.....	30 to 70	50 to 60
Ratio of heavy ends equilibrium mixture to fresh feed as introduced into the mixing zone.....	0.25 to 2.0	0.5 to 0.8
Ratio of mixture used as reactor feed to mixture recirculated to scrubber.....	0.60 to 4.0	1.0 to 2.5

The present invention is particularly desirable as applied to fluid bed coking since the nature of the fresh hydrocarbon feed is such as to contain considerable quantities of heavy end precursors and viscous constituents, these heavier fractions tending to gather to form scrubber bottom liquids. However, the concept of mixing scrubber recycle with substantially all the fresh feed to the unit and then passing portions of the mixture formed to the reactor and scrubber, respectively, may be applied to other conversion systems, such as visbreaking, reforming, catalytic cracking, etc. By thus operating, liquid transportation difficulties are minimized, and a highly flexible system obtained.

What is claimed is:

1. In a conversion system wherein the vaporous products from a coking zone are passed to a scrubbing zone for separating a heavy end liquid fraction therefrom, the improvement which comprises the steps of withdrawing said heavy end liquid fraction from said scrubbing zone, mixing about 30 to 70% of said withdrawn heavy end liquid fraction with substantially all the fresh residual oil feed to be introduced into said coking zone in a mixing and surge zone separate and distinct from said coking and scrubbing zones, maintaining a substantial liquid holdup in said mixing and surge zone to insure continuous circulation of liquid to said scrubbing zone at all times, withdrawing the residual oil feed-heavy end liquid mixture thus formed, circulating at least part of the withdrawn mixture to the upper portion of said scrubbing zone and passing the remainder of said withdrawn mixture as feed oil directly into said coking zone.

2. The improvement of claim 1 wherein said fresh feed is a hydrocarbon oil having an initial boiling point above 600° F., and an API gravity of about 0 to 20°, and said heavy end liquid is characterized by an atmospheric boiling point greater than 700° F.

3. In a coking system wherein a residual high boiling hydrocarbon oil is fed into a coking zone containing a mass of inert solid particles maintained at a coking temperature, said residual high boiling oil thus being converted to gasiform material and carbonaceous residue which is deposited on said solid particles, and wherein

said gasiform material is passed into a scrubbing zone for the recovery of desired products and the condensation of heavy end constituents, the improvement which comprises the steps of withdrawing said condensed heavy end constituents from the bottom portion of said scrubbing zone, mixing in a mixing zone about 30% to 70% of said withdrawn condensed heavy end constituents with substantially all the fresh residual oil feed before being introduced into said coking zone, withdrawing from said mixing zone the mixture thus formed and passing only a portion thereof to the upper portion of said scrubbing zone as scrubbing liquid and passing the remainder of said mixture as feed oil directly into said coking zone.

4. The improvement of claim 3 wherein said coking zone contains a fluid bed of hot, inert particles at a temperature in the range of about 900 to 1200° F.

5. The improvement of claim 3 wherein said coking zone contains a relatively dilute, rapidly moving gaseous suspension of hot inert solid particles.

6. In a conversion system wherein the vaporous products from a coking zone are passed to a scrubbing zone for separating a heavy end liquid fraction therefrom, the improvement which comprises the steps of withdrawing said heavy end liquid fraction from said scrubbing zone, mixing at least a portion of said heavy end liquid fraction with substantially all the fresh residual oil feed to be introduced into said coking zone in a mixing and surge zone separate and distinct from said coking and scrubbing zones, maintaining a liquid holdup in said mixing and surge zone of between about 0.3 and 1.0 gallon/gallon/hour of fresh residual oil feed to insure continuous circulation of liquid to said scrubbing zone at all times, withdrawing the residual oil feed-heavy end liquid mixture thus formed from said mixing and surge zone, circulating at least part of the withdrawn mixture to the upper portion of said scrubbing zone and passing the remainder of said withdrawn mixture as feed oil directly into said coking zone.

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