

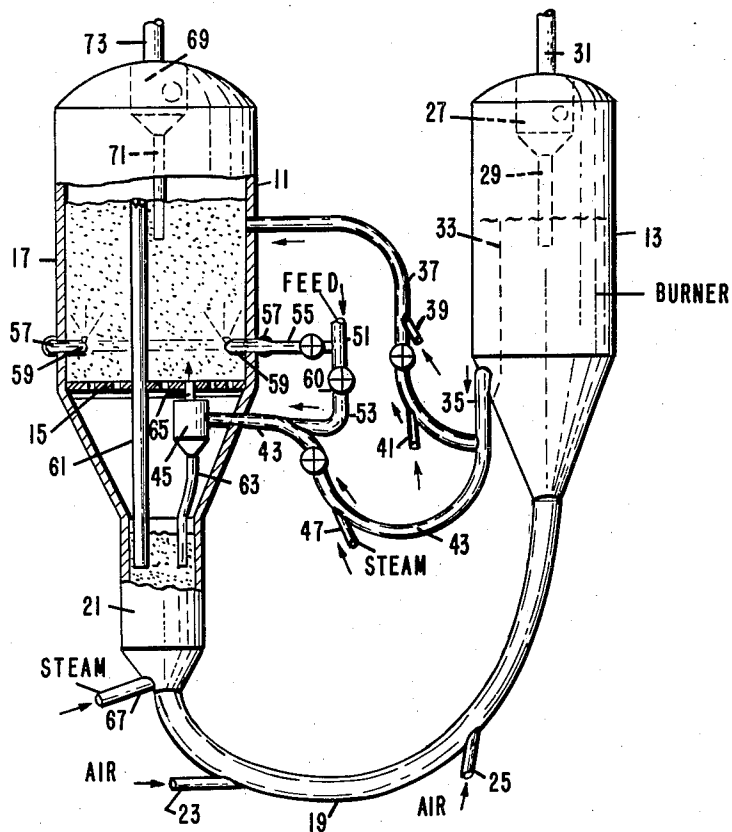
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COMBINATION TRANSFER LINE AND FLUID BED COKING SYSTEM

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COMBINATION TRANSFER LINE AND FLUID BED COKING SYSTEM

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The present invention relates to a combination transfer line and fluid bed coking system for the conversion of heavy residual hydrocarbon oils, such as petroleum residua and the like. The invention relates also to a coking process wherein the oil to be coked is first contacted with a relatively hot stream of solid particles and later the vapors resulting from such contact are cracked at lower temperatures.

Numerous suggestions have been made in the prior art for converting heavy hydrocarbon oil such as petroleum residua to more favorable products such as gas oil and motor fuel. Such processes are always accompanied by a certain amount of degradation to coke and to gas. The coke and gas thus produced are ordinarily of much less value than the gas oil and motor fuel which are the preferred products. It is usually desirable to produce as much high quality gas oil as possible when converting heavy residua. The reason for this is that a good quality gas oil can readily be catalytically cracked to produce motor fuel of high quality and of relatively high economic value.

In coking to produce gas oil considerable difficulties are frequently encountered in carrying over into the gas oil metallic compounds which are potent contaminants for cracking catalysts with which the gas oil is later to be contacted. The prior art has suggested various means for minimizing the carryover of these metal contaminants. It has been suggested that the vapors from a first coking operation, for example in a fluid bed coker, can be passed through a guard bed, that is a mass or bed of solid particles maintained at a lower temperature than the primary coking bed. Although this is reasonably effective to remove the objectionable metal compounds, the system has certain deficiencies.

In the first place the conventional fluid coking bed must be kept at a reasonably high temperature, usually above about 1000° F. to accomplish coking in a reasonable time or with a reasonable throughput. Experience has demonstrated that a better distribution of products from a coking operation may be obtained if the coking operation is carried out at a temperature below 1000° F., for example around 950° F. or even lower. While the lower temperature operation provides superior product distribution it also causes serious operating difficulties unless the feed rate is kept very low. The tendency of the bed to agglomerate and to bog and lose its fluidity increases very rapidly as the temperature is lowered. To state this another way experience shows that beginning at 900° F. the feed rate to a fluid bed may be doubled for about every 35° F. rise in temperature. This figure may vary somewhat for different feed stocks and

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different types of solid particles used in the bed but it is roughly accurate for most commercial operations.

The coking of hydrocarbon oils introduced at a feed preheat temperature around 600° F. requires in the neighborhood of 500 B. t. u. of heat energy/lb. of feed. Of this, the vaporization of the feed requires at least half or somewhat more than half. With the average feed stock the heat required for cracking, as distinguished from evaporation, is in the neighborhood of 40% of the total heat requirements.

According to the present invention the feed is preferably contacted first for a very short time with a hot stream of solid particles, the temperature of the solids, the feed rate, and the time of contact being adjusted as nearly as practicable so as to vaporize most of the feed but not to crack it appreciably. The stream of solids and feed, largely but not entirely vaporized, is passed quickly through a separating device so as to remove most of the hot solids and to pass the vapors directly into a fluidized bed of catalytically inert solids at a substantially lower temperature. As a specific example, the stream with which the feed is first contacted may have a temperature in the neighborhood of 1050° F. whereas the bed may have a temperature in the neighborhood of 950° F. Obviously these temperatures may be varied but in general the stream temperature should be above 1000° F. and the bed temperature 25–150° lower.

This arrangement has a number of advantages. In the first place the very high boiling components of the feed, which tend most strongly to cause bogging of the bed, are deposited on the hot particles of the stream, most of which never enter the bed but are taken directly to a stripping zone. This removes most of the high Conradson carbon constituents early in the coking process. At high temperatures, bogging is not a problem but it becomes a serious problem as temperatures drop toward 900° F.

The metallic constituents which are usually in the heavy ends of the feed tend also to be deposited on the solid particles with which the feed is first contacted. Some of them may be vaporized and carried into the bed but if so they are promptly redeposited upon the solids in the bed because of their lower temperature.

This system makes possible a faster feed rate to a low temperature bed. Since the components which cause bed bogging have been substantially removed, the vapors can be fed at a substantially greater rate, thus reducing the size of the reactor for a given throughput. This reduction in some cases may be as much as 50% or more.

In the process of the present invention it is preferred to feed at least a major part of the feed stock into the hot stream of solids. As will be pointed out below, it may be necessary in some cases to feed part of the solids and/or part of the feed to the bed directly. Under optimum conditions all of the feed is preferably contacted first with the stream of hot particles, conditions such as feed rate, stream and bed temperatures, and contact times being adjusted to give the desired results.

The invention will be more clearly understood by reference to a specific embodiment which is to be understood as not limiting the invention but as merely being exemplary.

Referring to the attached drawing which shows some-

what diagrammatically an elevation of a coking system a reactor vessel 11 and a burner vessel 13 of more or less conventional type constitute the main elements. Vessel 11 preferably contains a perforated grid 15 to support a fluid bed of hot solid particles 17. The particles may be of various materials which are inert catalytically such as sand, pumice, metal shot, ceramic materials and the like. Particles of petroleum coke which are produced directly in the coking process are usually preferred and will be referred to herein as the solids used. It will be understood that other solids are equally useful in many cases.

A return line comprising a suitable bend 19 is provided to convey the spent coke particles from a stripping zone 21 at the bottom of reactor vessel 11 back to the burner 13. The solids are fluidized with an oxidizing gas such as air which may be introduced through one or more lines such as 23, 25 to propel the solids and also to burn them to supply heat. The combustion gases are taken off overhead through a suitable cyclone 27, entrained solids being returned to the burner bed through a return line 29 while the flue gases pass overhead through a line 31.

The reheated solids in the burner 13 overflow a partition 33 and pass into a standpipe 35 from which they may be returned to the coking vessel. Two return lines are shown, line 37 leading to an upper part of the bed 17 with provision being made to introduce a fluidizing and lifting or aerating gas such as steam through one or more lines 39, 41 as is well known in the art.

The second return line, which is preferably the primary return line in this invention, is indicated at 43 and it passes into a cyclone separator 45 located just below the grid 15. One or more taps 47 may be provided for injecting steam or other inert gas to lift and propel the solids into the cyclone.

Fresh oil feed is introduced through a line 51 having a branch 53 leading into the transfer line 43 which carries the hot solids from the burner into the cyclone 45. The other branch 55 leads to a manifold 57 equipped with a plurality of nozzles 59 which project at a plurality of suitable points into the fluid bed 17. Valves 60 may be provided in this line to control a division of the feed or to completely shut off one line or the other.

The solids in the fluidized bed 17 overflow into a line 61 which leads into the stripper 21. The solids line from the bottom of cyclone 45 indicated at 63 also leads into this stripper whereas the gas line therefrom passes through the grid into the bed as indicated at 65.

Means are provided for feeding a stripping gas such as steam into the bottom of the stripper through a line 67. Thus the solids from both the bed 17 and from transfer line 43 flow into the stripper and the vapors occluded therein are stripped and carried upwardly through the grid 15 into the fluid bed. These vapors as well as the steam assist in fluidizing the bed and of course the vapors are cracked therein to the extent determined by bed temperature and contact time.

The product vapors from the coking bed 17 pass out through a separator or cyclone 69, entrained solids being returned to the bed through the line 71. The products are taken overhead through line 73 to suitable recovery apparatus not shown.

It is believed that the operation of this system in the process will be obvious from the above description. It is preferred that all or most of the feed is introduced into line 43 so that it can be vaporized substantially in the short contact time required for passage into and through the cyclone 45. Preferably this time is less than 2 seconds and is frequently less than 1 second, with a solids temperature in line 43 of 1050° F. With higher temperatures the contact time should be less and vice versa.

The temperature of the bed is determined by several

factors. If the bed is supplied with solids primarily by entrainment from cyclone 45, these solids will have been cooled appreciably by their contact with the feed, having yielded the required heat for vaporization. They are further cooled in the bed by supplying the required heat for cracking. They may be still further cooled by introducing part of the feed, preferably a minor part through the nozzles 59. On the other hand the bed temperature may be raised, if required, by increasing the flow of solids through line 37 directly from the burner. Alternatively a heat exchanger may be inserted in line 37 so that cooler solids may be fed into the bed than into the transfer line 43 and cyclone 45.

Other arrangements can be made as desired to regulate the relative temperatures of the transfer line and the bed, as will be obvious to those skilled in the art.

The system described above has the following advantages:

(1) By minimizing contact time at high temperature, the product distribution obtained is essentially the same as if the entire coking reaction had been carried out at low temperature;

(2) A much smaller volume of fluid bed is required to maintain operability at 950° F. Since a very large proportion of the coke will be formed in the high temperature short contact time riser where high feed rates can be employed. (Laboratory data have shown that feed rate to a coker is essentially limited by the rate of coke production);

(3) Ash carryover in the overhead product is minimized by the low temperature in the fluid bed;

(4) A reduction in steam required to maintain fluidization velocities is achieved by utilizing the products from the high temperature transfer line reactor;

(5) Little or no loss of uncoked feed to the burner is realized due to the high temperature stripping zone. What is claimed is:

1. A fluidized solid process of coking heavy hydrocarbon oil which comprises feeding at least a major portion of the oil into a relatively dispersed flowing stream of catalytically inert solid particles at a temperature above 1000° F., contacting said oil with said particles for a period of time sufficient to evaporate substantial fractions of the feed but not sufficient to substantially crack the vapors, separating the vapors from said solids, passing the vapors into a fluid bed of catalytically inert solids at a temperature below 1000° F., contacting said vapors with said bed for a period of time sufficient to substantially crack said vapors, passing the solids from both said bed and said stream to a stripping zone, stripping occluded hydrocarbon vapors from the solids in said zone and passing said stripped vapors through said bed, transferring said solids to a heating zone and reheating said solids and returning them to said stream and said bed to continue the process.

2. Process according to claim 1 wherein part of the solids are taken directly from the heating zone to the bed and part are taken through the stream and then into the bed.

3. Process according to claim 1 wherein the fresh oil feed is divided between the stream and the bed.

4. Process according to claim 1 wherein substantially all of the feed is contacted with the stream for a period of not more than 2 seconds, the stream being at a temperature of at least 1050° F.

5. Apparatus for fluid coking residual oils which comprises, in combination, a vertically disposed reactor, support means for supporting a fluid bed of high temperature solids in said reactor, a cyclonic separating means below said support means adapted to discharge fluids upwardly through said support means and separated solids downwardly, stripping means below said cyclonic separating means in said vessel, conduit means for introducing a reactant stream including high temperature solids tangentially into said cyclonic separating means, means for

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circulating solids from said fluid bed and from said cyclonic separating means to said stripping means conduit means for removing stripped solids from said stripping means, and conduit means for removing gasiform conversion products from the upper portion of said reactor. 5

6. Apparatus of claim 5 which further comprises external heating means for reheating said stripped solids and means for circulating stripped solids from said stripping means to said heating means and for returning reheated solids to said first mentioned conduit means and to said fluid bed. 10

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7. Apparatus of claim 5 which further comprises conduit means for introducing a residual oil into the lower portion of said fluid bed.

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