

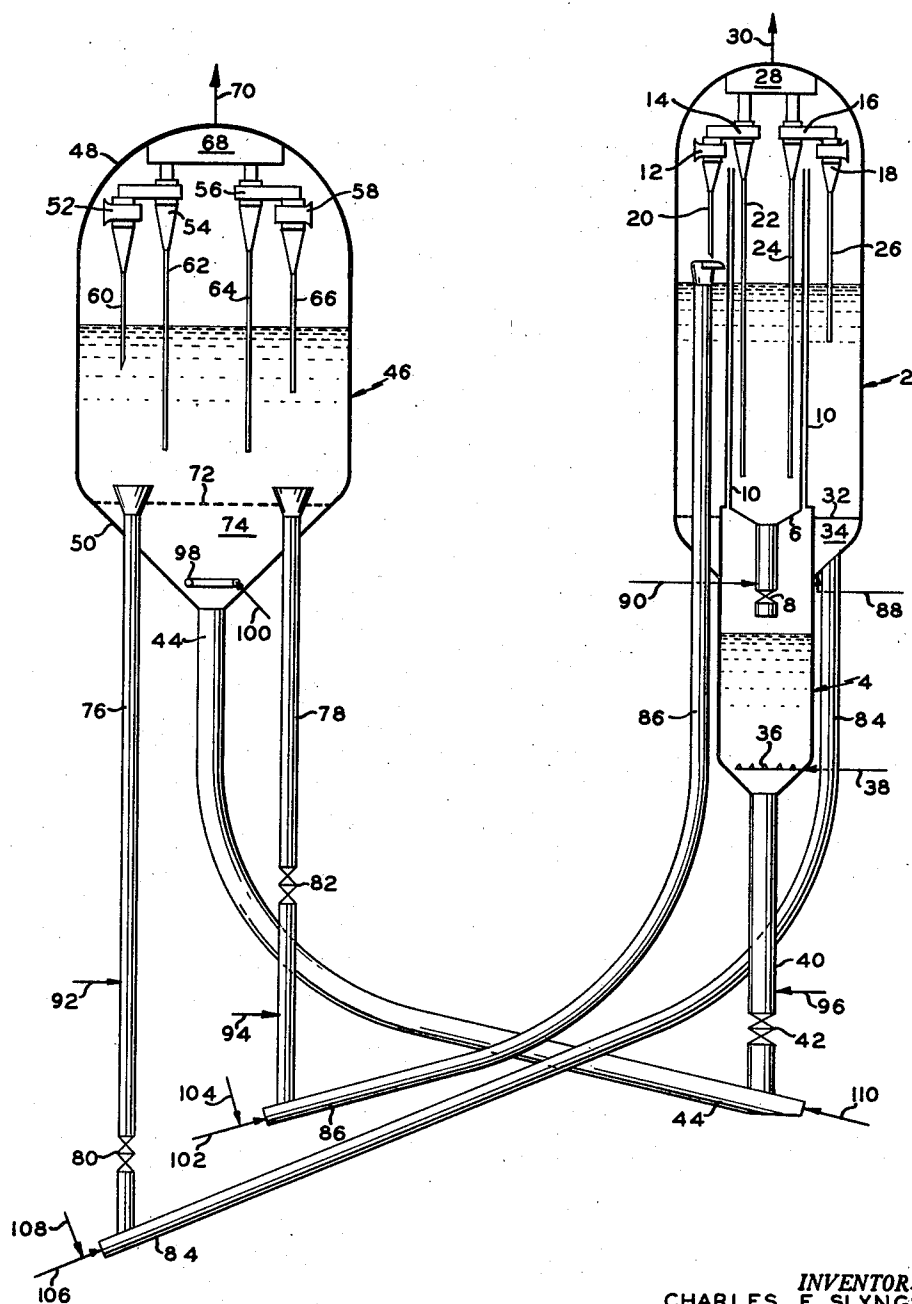
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MEANS FOR CONVERTING HYDROCARBONS

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MEANS FOR CONVERTING HYDROCARBONS

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This invention relates to improvements in the conversion of fluid reactants in the presence of subdivided solid particle material, and more particularly relates to a conversion process wherein different fluid materials in gaseous, vaporous or atomized state are passed in contact with separate streams of fluidized solid particle material under desired conditions of time, temperature and pressure.

The present invention is particularly directed to the fluid catalytic cracking of hydrocarbon feed materials of different boiling range under severity conditions of treatment more suitable to obtain conversion of the hydrocarbon feeds to desired boiling range products. In a particular aspect the present invention is directed to the method and means for effecting segregated cracking of selected hydrocarbon feed materials in the presence of finely divided catalytic material and the recovery of desired conversion products thereof.

The present invention, although capable of more general application, is directed to the method and means for effecting the cracking of hydrocarbon feed materials such as gas oils, topped crudes, residual oils and other high boiling hydrocarbon fractions known as reduced crudes or combinations of these materials in the presence of finely divided catalytic material. When effecting the cracking of hydrocarbons such as gas oils and high-boiling range materials, there is a tendency in many commercial processes operating today to overcrack certain components of the hydrocarbon feed while the remaining components of the feed are insufficiently cracked due to improper conditions of conversion severity. Furthermore, these hydrocarbon feeds contain constituents which are not completely vaporized at the temperature of contact with the catalyst and unless properly atomized or mixed with the catalyst in the desired ratio the catalyst becomes swamped and wetted with these liquid constituents causing agglomeration of the catalyst with a resultant substantial reduction in the overall conversion efficiency of the process. In commercial operations separation of conversion products and adsorbed hydrocarbons from the catalyst has always presented its problems since hydrocarbon product material as well as incompletely converted hydrocarbon material is entrained with the catalyst and must be recovered therefrom to maximize the efficiency of the hydrocarbon conversion process. Accordingly, the present invention is directed, among other things, to the method and means for minimizing the difficulties hereinbefore mentioned, and to a method of operation for effecting the segregated cracking of hydrocarbon feed materials of different boiling range and improving the efficiency of separation and recovery of hydrocarbons from the catalytic material.

An object of this invention is to provide an economical method of high operating efficiency for the segregated catalytic conversion of hydrocarbon feed materials to desired products.

Another object of this invention is to more efficiently recover hydrocarbon product material from finely divided catalytic material employed in the segregated cracking of hydrocarbons.

Other objects and advantages of the method and means of this invention will become more apparent from the following description.

For a better understanding of the method and means

of this invention, reference is now had to the drawing wherein a side-by-side reactor-regenerator arrangement is diagrammatically shown. The reactor chamber 2 is provided with a coaxially positioned cylindrical stripping chamber 4 of smaller diameter than the reactor chamber which extends from within the lower portion of the reactor downwardly through the bottom thereof and segregated therefrom as hereinafter described. The top of the stripping chamber 4 is capped by a funnel shaped member 6, the stem of which extends downwardly into the stripping chamber and which extension is provided with a flow control valve 8 positioned adjacent the discharge end of the funnel stem. The funnel shaped member forming the top of the stripping chamber separates a fluid bed of catalyst in the lower portion of the reactor chamber from the catalyst in the stripping chamber with the stripper chamber being vented and in open communication with the upper portion of the reactor chamber through a plurality of open end vent conduits 10 communicating therebetween. The upper portion of the reactor chamber is provided with a plurality of cyclone separators 12, 14, 16 and 18 having diplegs 20, 22, 24 and 26 respectively wherein entrained catalytic material is separated from gaseous material passing through the plurality of cyclone separators. The gaseous material passes to plenum chamber 28 provided with withdrawal conduit 30 through which the gaseous material is recovered. In the lower portion of the reactor chamber a foraminous member or grid means 32 is positioned substantially horizontally across the reactor chamber and is an annular member within the annular space formed by the walls of the stripping and reactor chambers to form an annular distributor chamber 34 therebelow. The annular grid member 32 is a partially perforated member which is non-perforated in a portion thereof above the discharge of conduit 34 and perforated in the remaining portion thereof in a manner to obtain relatively uniform distribution of a catalyst-oil suspension introduced into the bottom portion of a dense fluid bed of catalyst maintained thereabove in the reactor. It is contemplated, however, in another embodiment to eliminate grid 32 and extend conduit 34 sufficiently into the reactor to provide a discharge means on the end thereof which will discharge a catalyst-oil suspension from each side of the riser, generally horizontally into the annular space between the stripper and reactor walls. In addition, fluidizing gaseous material such as steam is introduced to the bottom portion of the annular space by a suitable distributor ring positioned beneath the discharge of conduit 34. A distributor means 36 supplied by conduit 38 is positioned in the lower portion of the stripping chamber for the introduction of gaseous material. Positioned within the stripping chamber and beneath the stem of funnel 6 is a pan or suitable deflector plate employed for distributing the finely divided catalyst or contact material discharged by valve 8 into the stripping chamber. An open end conduit 40 containing flow control valve 42 extends substantially vertically downwardly from the bottom of the stripping chamber and is connected at its lower end to a transfer conduit 44 extending into a regeneration chamber positioned adjacent to the reactor-stripper vessel. The regeneration chamber 46 being of relatively larger diameter than the reactor and positioned by the side thereof is provided in this specific embodiment with a hemispherical head member 48 and a conical bottom member 50. It is to be understood, however, that the bottom of the regenerator may be formed by a hemispherical or dish-shaped member rather than employing the conical bottom as shown. A plurality of cyclone separators 52, 54, 56 and 58 provided with diplegs 60, 62, 64 and 66 are positioned in the upper portion of regenerator 46 for recovery of entrained particle material from gaseous material. These cyclone

separators are connected to plenum chamber 68 and withdrawal conduit 70 for the removal of gaseous material from the regenerator chamber as more fully discussed hereinafter. In the specific arrangement of apparatus shown, a grid member 72 is positioned substantially horizontally across the lower portion of the regenerator to form a distributor chamber 74 therebelow into which transfer conduit 44 discharges. A plurality of open end standpipes 76 and 78 containing flow control valves 80 and 82 respectively extend from above grid 72 within the regenerator substantially vertically downwardly there-through and are connected at the base thereof with transfer conduits 84 and 86 respectively. Transfer conduit 84 connected to standpipe 76 is an elongated reactor conduit which discharges into distributor chamber 34 in the bottom of reactor chamber 2 whereas transfer conduit 86, connected to standpipe 78, on the other hand, is a reactor conduit which passes upwardly through the annular distributor chamber 34 into the upper portion of the reactor chamber and terminates above a relatively dense fluid bed of contact material maintained in the lower portion of the reactor chamber. In the apparatus described herein, provisions are made for adding fluidizing gaseous material to distributor chamber 34 by conduit 88 as well as for adding aerating gaseous material to the stem or withdrawal conduit of funnel 6 above valve 8 by conduit 90. Furthermore, provisions are made for adding aerating gaseous material to each of the standpipes by conduits 92, 94 and 96, as shown, to maintain contact material flowing downwardly therethrough in a flowable condition. Suitable means such as a distributor ring 98 supplied by conduit 100 is provided within distributor chamber 74 beneath the regeneration chamber for adding additional regeneration gaseous material to the distributor chamber as desired. It is contemplated, however, in the apparatus of this invention to eliminate distributor grid 72 and to replace it with, for example, a regeneration gas distributor manifold.

In the method of this invention employing the apparatus hereinbefore described, a first hydrocarbon feed such as a fresh gas oil feed heated to a temperature of about 500° F. or higher is introduced by conduit 102 to transfer conduit 86, either with or without dispersion steam introduced by conduit 104, wherein the hydrocarbon is mixed with hot regenerated catalyst withdrawn from the regenerator by standpipe 78. The catalyst entering transfer conduit 86 is substantially at regeneration temperatures in the range of from about 1025° F. to about 1200° F. or higher and sufficiently high to provide a catalyst to oil suspension at a temperature above about 900° F. The thus produced high temperature catalyst-oil suspension is passed at a relatively high velocity in the range of from about 25 to about 60 feet per second through the transfer reactor conduit for discharge in the upper portion or dilute phase of the reaction zone and above a dense fluid bed of catalyst maintained in the lower portion of the reaction zone. The catalyst to oil ratio employed in transfer reactor conduit 86 may be in the range of from about 4 to about 14:1, the specific ratio being dependent in part upon the temperature and severity of cracking conditions desired therein. Furthermore, the velocity conditions employed in passing the suspension through the reactor will be selected as a function of the desired degree of conversion severity and the contact time permissible within the transfer line reactor. Generally, the contact time will be in the range of from about 1 to about 4 seconds.

Simultaneously with the above, a second hydrocarbon feed which may be the same as but preferably more refractory than the first hydrocarbon feed is introduced by conduit 106 either with or without dispersion steam admitted by conduit 108 into transfer conduit 84 wherein the second hydrocarbon feed is mixed with a separate stream of hot regenerated catalyst withdrawn from the regenerator by standpipe 76. Generally, the catalyst to

oil ratio of the suspension formed in and passed through transfer conduit 84 will be in the range of from about 2 to about 14 to 1 to form a suspension having a temperature in the range of from about 800 to about 950° F. The thus produced suspension is passed at a velocity in the range of from about 15 to about 40 feet per second through the riser 84 for distribution in the dense fluid bed of catalyst maintained in the lower portion of the reaction zone by distributor zone 34. Accordingly, the more refractory or second hydrocarbon feed may be subjected to the same or less severe temperature conversion conditions for a greater period of time than that encountered by the feed in conduit 86, with the residence time controlled in part by the depth of the catalyst bed maintained in the reactor chamber. It has been found when operating in accordance with the above described method of operation that more selective conversion of the hydrocarbon feed into desired products is obtainable and a more versatile arrangement of apparatus is provided for the refiner.

In reactor 2, the velocity of the entering suspension is considerably reduced by reason of the substantial increase in cross-sectional area of the reaction zone. That is, the suspension introduced by conduit 84 into distributor zone 34 is sufficiently reduced in velocity so that the entering catalyst is maintained above grid 32 in a state of phase separation comprising a lower dense phase of catalyst having a bed density in the range of from about 20 to about 40 pounds per cubic foot and an upper dilute phase of lower particle concentration, the dilute phase constituting a disengaging zone wherein the catalyst settles out or disengages itself from the rising stream of hydrocarbon vapors emitted from the dense bed of catalyst. The suspension introduced to the reactor by conduit 86 into the dilute phase above the dense bed of catalyst also encounters a substantial reduction in velocity so that the catalyst separates from hydrocarbon material and settles onto the bed of catalyst therebelow. During conversion of the hydrocarbon feeds in the riser-reactors and the dense fluid bed of catalyst, deposits on the catalyst in the form of adsorbed hydrocarbons which are difficultly vaporizable and carbonaceous deposits substantially decrease the catalyst particle activity. These deposits are then removed by a combination of steps involving stripping and regeneration, thereby restoring activity to the catalyst and reheating of the catalyst to a sufficiently elevated temperature for reuse in the process.

Accordingly, in combination with the improved arrangement of conversion steps hereinbefore described, catalytic material entraining hydrocarbonaceous material is continuously removed from above the bottom of the dense fluid bed of catalyst in the reaction zone and passed to a separate or segregated stripping zone. The stripping zone employed in the method of this invention is a separately confined or segregated stripping zone which extends downwardly from the reaction zone in a manner to permit substantially uniform withdrawal of catalyst from the dense bed of catalyst thereabove and adapted to permit maintaining the pressure in the upper portion of the stripping zone substantially equal to the pressure in the upper portion of the reaction zone. Accordingly, in the method of this invention, an elongated segregated stripping zone is provided which extends downwardly from a point within the dense fluid bed of catalyst in the reaction zone to a point a substantial distance below the bottom of the reactor, which is separated from the reaction zone in the upper portion by a mass of catalyst developing hydrostatic pressure and formed by a funnel shaped member 6 provided with a flow control valve 8 in the stem or conduit of the funnel. Valve 8 controls the rate of catalyst withdrawn from the reaction zone to permit maintaining a desired bed level therein. The catalyst settling into the funnel increases in concentration or density in the direction of flow which has the effect of squeezing or freeing entrained hydrocarbon vapors from

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the catalyst, substantially reducing the volume of hydrocarbons entrained therewith and development of hydrostatic pressure therein. Thus, in passing from the bed of catalyst in the reaction zone into the withdrawal funnel, preliminary stripping of the catalyst occurs and the introduction of aerating gas to the funnel stem above the valve not only maintains the catalyst in a flowable condition, but facilitates this preliminary stripping of entrained hydrocarbons from the catalyst.

The catalyst in the funnel stem or discharge conduit is discharged through valve 8 into the enlarged stripping zone wherein it immediately releases adsorbed hydrocarbons from the catalyst by reason of a relatively sudden release of pressure and dispersion of the catalyst particles in a stripping medium. The stripping medium, such as steam, is introduced to the lower portion of the stripping zone for flow upwardly therethrough countercurrent to the downflowing catalyst and at a velocity suitable to maintain the catalyst within the stripping zone in a state of phase separation comprising a lower dense phase and an upper dilute phase thereabove. Valve 8 is positioned within the upper part of the stripping zone so that operation with a maximum dense bed level and a minimum dispersed phase is permitted. Such an arrangement is particularly advantageous operationally since the stripper zone becomes an additional stage of cracking of the difficultly vaporizable hydrocarbons remaining on the catalyst under conditions of reduced hydrocarbon partial pressure while maintaining the stripper at an elevated temperature which may be equal to, above or slightly below reactor temperature. The fluid stripping medium such as steam introduced to the lower portion of the stripping zone flows upwardly therethrough at a velocity in the range of from about 1 to about 1½ feet per second with the stripped hydrocarbons and stripping gas being collected in the upper portion of the stripping zone above the dense phase for passage directly to the upper portion of the reaction zone through a plurality of open end vent conduits 10 in open communication therewith. In a preferred embodiment the vent conduits from the stripper discharge near or substantially adjacent to the inlet of the series of connected cyclones. Generally, the stripped products and stripping gas will be at a lower temperature than the temperature of the hydrocarbons discharged from the high temperature riser-reactor 86 and therefore will have a quenching effect upon these hydrocarbon vapors, thereby minimizing the tendency for overcracking of these hydrocarbons to occur.

In a specific embodiment the temperature of the suspension in reactor conduit 86 is maintained at a temperature substantially higher than the temperature of the suspension in transfer conduit 84 and in the dense fluid bed by employing a higher catalyst to oil ratio which may be in the range of from about 2 to about 5 times higher than that employed in transfer reactor conduit 84. Accordingly, the high temperature catalyst discharged above the dense fluid bed imparts heat to the dense fluid bed of catalyst upon settling thereinto, thereby efficiently utilizing and recovering this available heat energy for cracking of hydrocarbons in the dense fluid bed of catalyst.

The stripped catalyst is continuously withdrawn from the bottom of the dense fluid bed of catalyst in the stripper through a spent catalyst standpipe 40 provided with flow control valve 42 and discharged into a transfer conduit 44 for passage to a regeneration zone 46. During passage of the catalyst from the dense bed in the reactor through the stripper to the spent catalyst transfer conduit 44, the catalyst stream passes through several phases of materially different pressures, as well as several changes in density. That is, the catalyst undergoes a pressure increase due to the head of pressure developed in the dense fluid bed of catalyst in the reactor, which is further increased by that developed in the discharge conduit or

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stem of funnel 6 and may amount to 5 or more pounds increase. Thereafter the catalyst passing through valve 8 then experiences a sudden pressure drop of about 6 or more pounds upon discharge into the stripper and upon passing down through the stripper and standpipe 40 the catalyst undergoes a gradual increase in pressure to a degree sufficient to pass the catalyst to the regeneration zone when mixed with gaseous material.

Concurrently with the above changes in pressure, the catalyst stream also goes through a plurality of changes in density. For example, the stream of catalyst may have a density of from about 20 to about 25 pounds per cubic foot leaving the dense bed in the reactor and upon passing into the funnel 6 the stream of catalyst undergoes a further increase in density which may be in the order of from about 4 to about 10 pounds per cubic foot more. However, upon discharging the catalyst stream into the enlarged stripper, the catalyst stream decreases to a density generally less than 20 pounds per cubic foot. Thereafter, the catalyst stream on its downward flow through the stripper and the standpipes undergoes a gradual increase in density so that the density is raised to a level comparable to or even in excess of that within the stripper inlet. In addition to the above enumerated changes in density of the downwardly flowing catalyst stream, additional alternating changes in the catalyst stream density may be effected by placing a plurality of downwardly sloping disc and donut shaped baffles within the stripper zone. These alternating changes in the catalyst stream pressure and density have been found to be most effective in the removal of adsorbed hydrocarbons from the catalyst, thereby minimizing the loss of valuable hydrocarbons passed to the regeneration zone.

At the lower end of standpipe 40, the spent or contaminated catalyst is discharged into a transfer conduit 44 wherein it is mixed with an oxygen containing gas such as air introduced by conduit 110 and the mixture is passed at a relatively high velocity in the range of from about 30 to about 50 feet per second through transfer conduit 44 into a distributor zone 74 positioned in the bottom of regenerator 46. A relatively high ratio of carrier gas to catalyst is maintained in transfer conduit 44 so that the catalyst is in a higher dispersed phase condition having a concentration in the range of from about 1 to about 2 pounds per cubic foot. Although partial combustion of carbonaceous deposits on the catalyst may take place within transfer conduit 44, generally the velocity therein is sufficient to permit the major portion of the combustion to be carried out within the dense fluid bed of catalyst in the lower portion of the regeneration zone. It is contemplated in an embodiment of this invention to employ a relatively inert carrier gas in transfer conduit 44 or a carrier gas containing insufficient oxygen concentration to effect any appreciable rise in temperature of the dilute suspension due to partial combustion of carbonaceous material with the discharge of the suspension being above the dense fluid bed of catalyst in the regeneration zone. That is, transfer conduit 44 is shown terminating at the conical bottom of the regeneration zone in a distributor zone 74 below grid 72. It is contemplated, however, to extend the riser conduit vertically upwardly so that it discharges either in the upper portion or above the dense fluid bed of catalyst maintained in the lower portion of the regeneration zone. In any of these arrangements, oxygen containing regeneration gas required to effect combustion of the carbonaceous deposits on the catalyst is also introduced into the lower portion of the dense fluid bed by a distributor ring or manifold 98 supplied by conduit 100. That is, when employing the specific apparatus shown in the drawing a portion of the oxygen-containing regeneration gas will be employed as carrier gas with the remaining portion being introduced to the bed by manifold 98. However, when extending the riser

into the regenerator so that it discharges in the upper portion or above the dense fluid bed of catalyst a substantial proportion of the regeneration gas will be supplied to the lower portion of the bed through a suitable manifold similar to manifold 98. In this latter arrangement, it is contemplated to eliminate the grid shown in the drawing and to modify the bottom of the regenerator with a dish-shaped bottom rather than the conical bottom shown.

In the specific apparatus shown, the suspension in transfer conduit 44 enters distribution zone 74 wherein the velocity of the suspension is substantially reduced due to the enlarged distribution zone prior to passing through grid 72 into the dense fluid bed of catalyst thereabove undergoing regeneration. The regenerator bed temperature is generally maintained in the range of from about 1025° F. to about 1400° F., preferably below about 1200° F. When discharging the suspension in transfer conduit 44 above the bed of catalyst in the regenerator as hereinbefore indicated the suspension will be at a relatively low temperature substantially below regeneration temperatures, thereby effecting cooling of the dispersed phase and minimizing the tendency of after-burning to occur in the regenerator cyclones. Gaseous combustion products are removed from the regenerator chamber by plenum chambers 68 and conduit 70. Regenerated catalyst is withdrawn from the dense fluid bed at an elevated temperature by standpipes 76 and 78 containing flow control valves 80 and 82 respectively. Standpipe 76 feeds hot regenerated catalyst to transfer reactor conduit 84 and standpipe 78 feeds hot regenerated catalyst to transfer reactor conduit 86, wherein is formed the catalyst-oil suspensions hereinbefore discussed.

Although not specifically shown in the drawing, it is to be understood that embodiments of this invention include arrangements of the apparatus wherein the stripper is positioned adjacent to the side of the reactor either within or external thereto rather than being coaxially positioned as shown in the drawing. Furthermore, the stripper chamber may be provided with a plurality of vertically disposed baffle members to resemble a cart wheel in cross section.

The methods and arrangements of apparatus shown and discussed herein are practical in very large fluid catalyst systems in which great strength, economy of construction and ease of operation are more important and more difficult to achieve than in many chemical apparatus of similar size. To illustrate the application of the above described invention by way of example, reference is had to the following data representing preferred operating conditions thereof.

Example

Fresh feed, #/hr. -----	265,044
Catalyst, #/hr. -----	1,910,000
Steam, #/hr. -----	2,650
Recycle feed, #/hr. -----	192,767
Slurry, #/hr. -----	7,703
Steam, #/hr. -----	1,928
Catalyst, #/hr. -----	850,000
Transfer reactor conduit 86:	
Catalyst density, #/cu. ft. -----	5.37
Velocity, ft./sec. -----	46.0
Discharge temperature, ° F. -----	950
Transfer reactor conduit 84:	
Catalyst density, #/cu. ft. -----	6.28
Velocity, ft./sec. -----	32.2
Reactor:	
Catalyst dense phase density, #/cu. ft. --	35
Pressure dilute phase, p.s.i.g. -----	20.9
Pressure above grid, p.s.i.g. -----	26.3
Catalyst bed temperature, ° F. -----	900
Stripper:	
Dilute phase pressure, p.s.i.g. -----	20.9
Catalyst dense phase density, #/cu. ft. --	30

Stripping steam, #/hr. -----	13,800
Temperature, ° F. -----	900
Stripper standpipe 40:	
Catalyst density, #/cu. ft. -----	30
Catalyst velocity, ft./sec. -----	6.55
Pressure at base of standpipe, p.s.i.g. ----	31.8
Catalyst transfer conduit 44:	
Catalyst density, #/cu. ft. -----	4.34
Velocity, ft./sec. -----	45.4
Air, #/hr. -----	80,000
Steam, #/hr. -----	3,460
Catalyst, #/hr. -----	2,863,868
Regenerator:	
Catalyst bed density, #/cu. ft. -----	30
Regenerator temperature, ° F. -----	1,150
Regeneration pressure dilute phase, p.s.i.g. -----	16.2

It is to be understood that the foregoing is presented by way of example only and that the invention is not to be unduly restricted thereby since modification may be made to the method and apparatus of this invention without departing from the spirit thereof.

We claim:

1. An arrangement of apparatus for contacting fluidizable solid material with gasiform material which comprises a regenerator chamber positioned adjacent to a unitary reactor-stripper vessel, said unitary vessel comprising an upper cylindrical reactor chamber and a lower cylindrical stripper chamber of smaller diameter extending from within the lower portion of the reactor chamber downwardly through the base thereof to form an annular section in the lower portion of said reactor chamber, an annular grid member positioned across said annular section, a portion of said grid member being non-perforated thereby forming an annular distributing chamber in a portion of said annular section, the top of said stripper chamber formed by a funnel shaped member attached at its upper periphery to the cylindrical wall of said stripper chamber and provided with valve means in the funnel stem adjacent the bottom of the stem, at least one open end vent conduit extending from the upper portion of said stripper chamber to the upper portion of said reactor chamber, a first standpipe extending downwardly from the bottom of said stripper chamber, a first transfer conduit connected to the base of said first standpipe and extending to the bottom of said adjacent regenerator chamber, a second standpipe extending downwardly from within the lower portion of said regenerator chamber, a second transfer conduit connected to the base of said second standpipe and extending upwardly through said reactor chamber for discharge in the upper portion thereof, a third standpipe extending downwardly from within the lower portion of said regenerator chamber, a third transfer conduit connected to the base of said third standpipe which extends into said annular distributing chamber terminating beneath said non-perforated portion of said grid member, means for introducing gasiform material to the lower portion of said stripper chamber and said regenerator chamber and means for removing gasiform material from the upper portion of said reactor chamber and said regenerator chamber.

2. An arrangement of apparatus for contacting fluidizable solid material with gasiform material which comprises a regenerator chamber positioned adjacent to a unitary reactor-stripper vessel, said unitary vessel comprising an upper cylindrical reactor chamber and a lower cylindrical stripper chamber of smaller diameter extending from within the lower portion of the reactor chamber downwardly through the base thereof to form an annular section in the lower portion of said reactor chamber, an annular grid member positioned across said annular section, a portion of said grid being non-perforated thereby forming an annular distributing chamber in a

portion of said annular section, the top of said stripper chamber formed by a funnel shaped member attached at its upper periphery to the cylindrical wall of said stripper chamber and provided with valve means in the funnel stem adjacent the bottom of the stem, at least one open end vent conduit extending from the upper portion of said stripper chamber to the upper portion of said reactor chamber, a first standpipe extending downwardly from the bottom of said stripper chamber, a first transfer conduit connected to the base of said first standpipe and extending to the bottom of said adjacent regenerator chamber, a second standpipe extending downwardly from within the lower portion of said regenerator chamber, a second transfer conduit connected to the base of said second standpipe and extending upwardly through said reactor chamber for discharge in the upper portion thereof, a third standpipe extending downwardly from within the lower portion of said regenerator chamber, a third transfer conduit connected to the base of said third standpipe which extends into said annular dis-

tributing chamber terminating beneath said non-perforated portion of said grid member, means for introducing gasiform material into said annular distributing chamber, means for introducing gasiform material to the lower portion of said stripper chamber and said regenerator chamber and means for removing gasiform material from the upper portion of said reactor chamber and said regenerator chamber.

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