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CONTROLLING PARTICLE SIZE IN FLUID COKING
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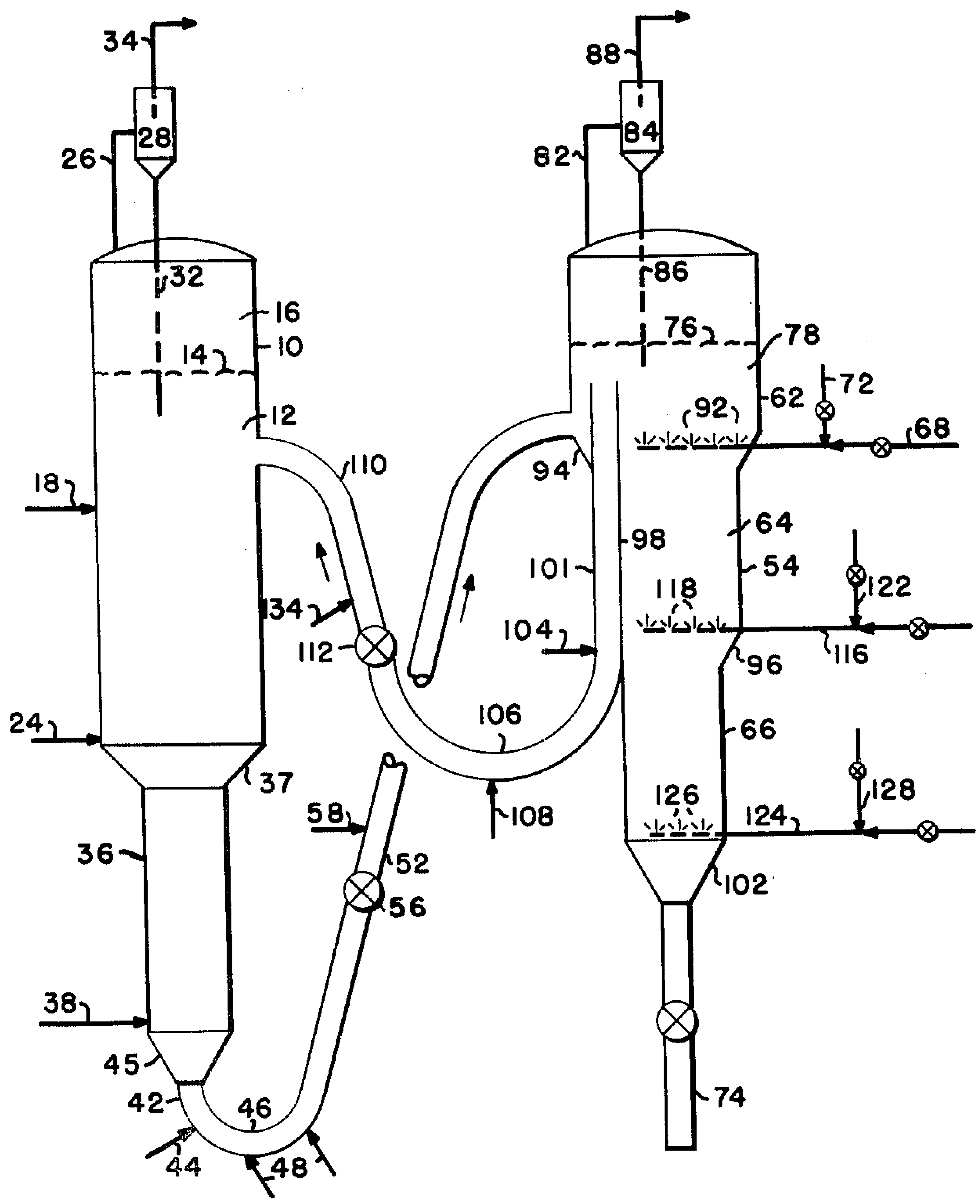

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CONTROLLING PARTICLE SIZE IN FLUID COKING

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This invention relates to fluid coking and more particularly relates to maintaining the desired particle size distribution in the circulating streams and in the unit.

In the process for coking crude petroleum oil residuum where a fluid coke bed is employed, the particle size of the coke is of great importance. If there are too many very fine particles (less than about 50 microns in diameter) agglomeration of these particles results and there is loss of fluidity of the fluid bed. An excess of large particles (greater than about 600 microns in diameter) results in slugging and poor circulation.

It is known in the prior art to elutriate fine particles from a mixture of coarse and fine particles. Most of such elutriation has been done in the dilute phase and this requires large quantities of extraneous gas in a process such as fluid coking wherein it is desirable to take only a small portion of the elutriated stream as product. Also it is known in the prior art to elutriate and preferentially burn the coarse particles of coke in an elutriator burner.

One of the problems in the fluid coking of residual petroleum oil or other heavy oil feeds is the control of particle size of the coke particles in the unit. There is a gradual increase in size of the coke particles being circulated because coke is made from the oil feed and forms or is deposited on the surface of the coke particles in proportion to the surface available. In addition, some agglomerates are normally formed by several coke particles ticking together. As the circulating coke particles become coarser, fluidization becomes poor, circulation becomes erratic and contacting efficiency decreases.

A similar condition exists in the conventional coking unit burner zone. Combustion is in proportion to surface and since the smaller coke particles have a relatively larger surface, weight for weight, than the larger or coarser particles they will therefore be more easily and readily burned by the oxygen-containing gas in the burner zone. It is desirable to remove coke particles coarser than the preferred size range as product coke from the coking unit.

According to the present invention the combustion or burner zone is constructed as an elutriator so that elutriation of coke particles and preferential burning of certain ranges of particle seize is carried out within the burner vessel or zone. Either the coarse particles or the fine particles may be preferentially burned using the present invention.

More specifically the burner vessel of the present invention to be used in fluid coking has two or more sections of increasing cross-sectional area increasing from the bottom to the top of the burner vessel. Air or gas lines are provided for each section so that by adjusting the gas flow rates to one or more of the sections, elutriation as desired is effected and a selected particle size coke is burned. The burner vessel functions both as a burner zone and as a dense phase elutriator for a fluid coking unit with the added provision and advantage that the oxygen-containing gas can be injected at the desired region to selectively burn coarse or fine coke particles in the system. The fluid coke bed in the burner vessel is a continuous one and the elutriation does not depend on or utilize disperse phase separation.

An additional advantage of the present invention is that it allows selective burning of the finer coke particles or coke fines and withdrawing the coarsest coke from the coking unit as coke product. As above pointed out, in fluid coking there is coke particle growth and a net coke production over that required to be burned to supply the heat of coking or cracking in the reactor vessel. The process of the present invention permits burning a higher percentage of the coke film deposited on the fines or finer coke particles so that the finer coke particles remain smaller longer and in this way reduce the attrition requirements which comprise jet attrition of the coke particles by a high velocity gas stream.

In the drawing, the figure is a diagrammatical showing of one form of apparatus adapted to carry out the process of the present invention but the invention is not to be restricted thereto.

Referring now to the drawing, the reference character **10** designates a vertically arranged cylindrical reactor or coking vessel containing a fluidized dense bed **12** of solid finely divided inert particles such as coke or the like. The dense bed **12** has a level indicated at **14** with a dilute or disperse phase **16** thereabove. The inert solids of the fluidized bed **12** have a particle size between about 20 and 1500 microns, preferably between about 75 and 400 microns and may comprise petroleum coke, or other coke, coke formed in the process, spent cracking catalysts, pumice, carborundum, alumina or other refractory materials.

The fluidized bed **12** is maintained at a temperature between about 800° and 1600° F., preferably about 900° F. to 1100° F. When coking to produce motor fuel such as gasoline, temperatures in the lower range of about 800° to about 1200° F. will be used, whereas, when coking at extremely high temperatures to produce chemicals such as unsaturated hydrocarbon gases and aromatic hydrocarbons, temperatures in the higher range of about 1200° F. to about 1600° F., preferably about 1250° to 1450° F., will be used.

The preheated oil feed to be converted is shown in the drawing as being introduced directly into the dense fluidized highly turbulent bed **12** in the reactor **10** through feed line **18** for distributing the oil feed on the hot inert solids coming from the burner as will be later described in greater detail. Steam may be introduced along with the feed through line **18** or by a separate line, if desired. The oil feed is preferably preheated in any suitable manner to a temperature between about 500° and 700° F. before being introduced into the reactor **10**. The oil feed comprises a residual petroleum oil such as tar, pitch, crude residuum, heavy bottoms or other similiar hydrocarbon stock having an API gravity between about —10° and 20°, a Conradson carbon between about 5 and 50 wt. percent and an initial boiling point between about 650° and 1200° F. Steam may be introduced at one or more points **24** to assist in maintaining the bed **12** in fluidized condition.

The fluidized bed **12** is maintained as such by the upflowing hydrocarbon gases and vapors formed by the coking of the oil feed and by the steam added to the process. The superficial velocity of the gases and vapors passing upwardly through the bed **12** is between about 0.5 and 4 feet per second when using finely divided coke of about 50 to 400 microns, and, at a superficial velocity of about 1 to 2 feet per second, the density of the fluidized bed will be about 40 lbs. per cu. ft. but may vary between about 15 and 60 lbs. per cu. ft. depending on the gas velocity selected and the particular particle size range.

Vaporous products of coking leave the bed **12** and the top of vessel **10** and pass through line **26** into cyclone separator **28** arranged above the top of the reactor vessel **10**. The vaporous reaction products leaving the coking vessel 10 contain entrained solids and the cyclone separator 28 or other gas-solids separating device is used to separate or recover the entrained solids and return them to the dense fluidized bed 12 through dipleg 32. More than one cyclone separator in stages may be used and the cyclone separator or separators may be arranged internally of the reactor 10, if desired.

The separated reaction vapors pass overhead from the cyclone separator 28 through line 34 and are further treated in any suitable manner to recover gas, gasoline, gas oil, etc.

Coke particles are withdrawn or passed downwardly from the lower portion of the dense bed 12 into the upper portion of a stripping zone or vessel 36 which is shown as having a smaller diameter than reactor 10 and which preferably extends down from reactor 10 as a cylindrical continuation as an integral structure so that one continuous fluid bed 12 is formed extending from level 14 to the bottom of the stripping vessel 36. A funnel-shaped or inwardly flared annular section 37 joins the larger diameter bottom section of reactor vessel 10 and the top section of the smaller diameter stripping vessel or section 36. Other forms of stripping vessels may be used.

Steam or other stripping gas is introduced through one or more lines 38 into the bottom portion of the stripping zone 36 to remove volatile hydrocarbons from the coke in the stripping zone and pass them upwardly into the dense fluidized bed 12 in reactor 10. The temperature in the stripping zone is between about 800 and 1600° F. and the velocity of the upflowing gas in the stripping zone may be between about 0.4 and 2.0 feet per second to maintain a dense fluidized solids mixture.

Stripped coke particles are removed from the bottom of the stripper vessel 36 through line 42 to which fluidizing gas may be added through one or more lines 44. The bottom portion of the stripping vessel 36 is of a larger diameter than line 42 and a funnel-shaped or flared annular section 45 joins the top of line 42 with the bottom of stripping vessel 36. Line 42 is formed as a U-bend 46 and the solids therein are maintained in a fluidized condition by the introduction of a fluidizing gas such as steam through line or lines 48. Operation of U-bends is described in Packie Patent 2,589,124, granted March 11, 1952, and a further description is not necessary here. The solids in the bottom of the U-bend 46 are maintained fluidized.

As above pointed out, the coke particles during coking increase in size because of the formation and deposition of more coke on the coke particles circulating between the reactor and burner vessels and those coarse particles having a particle size bigger than about 500 to 1500 microns must be removed from the unit or somehow reduced in size if they are to remain in the unit. According to the present invention the coarse particles are separated in an elutriator-burner and removed from the unit as product coke. The elutriator-burner is so constructed and operated that any selected particle size coke may be burned to supply heat of cracking or coking in the reactor 10.

The upflow leg 52 of U-bend 46 is provided with a variable restriction such as a slide valve 56 to assist in the control of circulation of solids. Steam or the like is introduced into riser 52 through line 58 above the restriction 56 to control the rate of flow of solids to a vertically arranged burner 54 having two or more sections of increasing cross sectional area, increasing from the bottom to the top. Upflow leg 53 may empty into the base of the upper largest diameter section 62 of burner 54 or into the top of the intermediate diameter section 64. In the drawing upflow leg 52 is shown as emptying in the bottom portion of section 62.

In the specific form of the apparatus shown in the drawing, the burner vessel 54 has three sections arranged one above the other with the sections being of different cross sectional areas. The top cylindrical section 62 is the largest diameter one. The next lower cylindrical section 64 is of a smaller diameter and the bottom cylindrical section 66 is of the smallest diameter. Each section has a line for the introduction of an oxygen-containing gas and another line for introducing inert gas such as steam, nitrogen, gaseous hydrocarbons or the like.

The uppermost section 62 has a valved line 68 for introducing oxygen-containing gas such as air and a valved line 72 connected to line 68 for the introduction of an inert gas. The valves in lines 68 and 72 may be operated to introduce both oxygen-containing gas and inert gas into the upper section 62. The other sections of the burner have similar lines as will be described hereinafter.

The coking or cracking operation in reactor 10 is endothermic and the heat for coking is supplied by burning part of the coke formed to heat the coke particles in the burner 54 and then circulating the heated coke particles back to the reactor 10. The temperature in the burner 54 is between about 1000° F. and 1700° F. The superficial velocity of the gas flowing up through the burner 54 is between about 0.3 and 4.0 ft./sec. and is sufficient to maintain the coke particles in the burner 54 in a fluidized condition. Coke equivalent to about 5 wt. percent of the feed is burned to supply heat of coking at about 1000°–1700° F. and the rest of the coke is withdrawn as product. Preferably, the coarsest fluid coke particles are withdrawn as product and these are withdrawn through valved bottom outlet line 74 leading from the bottom of the lowest and smallest diameter section 66 of burner 54. The product coke is quenched or cooled in any suitable manner or may be passed to a calcining zone or the like.

Combustion gases containing fines leave the top or upper surface 76 of bed 78 in the burner 54 and the top of burner 54 through line 82 and pass into a dust separating means 84 such as a cyclone separator to separate gas from solids which are returned to the fluid solids bed 78 through dip leg 86. The separated gas passes overhead through line 88 to the atmosphere but may be passed through a waste heat boiler or heat exchanger to recover heat from the hot combustion gas.

The fluidized bed 78 is a continuous one and extends from the upper surface 76 for the height of the burner 54 substantially down to the valve in line 74. The line 68 extends into the lower portion of the top largest cross-sectional area section 62 of burner 54 and at its inner end submerged in the fluid bed 78 are nozzles or the like 92 which direct the gas upwardly. The inner submerged end of line or pipe 68 in the section 62 may be straight or may be in the form of a ring or other shape.

The upper portion of the next smaller diameter section 64 of the burner 54 is connected to the bottom section of larger section 62 by a funnel-shaped or flared annular section 94. The bottom portion of section 64 is connected to the top of the next lower smaller diameter section 66 by a funnel shaped wall or flared section 96 which is formed as a part of an annulus because of the location of the withdrawal well 98 presently to be described. The lower end portion of the smaller section 66 is connected to smaller diameter product withdrawal pipe 74 by funnel-shaped or flared annulus 102.

Fluidized hot coke is withdrawn from the larger section 62 of burner vessel 54 through withdrawal well 98 which forms a standpipe 101 provided with one or more aeration or fluidized taps 104 to maintain the solid particles in the standpipe in a fluidized condition. The well 98 extends above the top outlet end of upflow leg 52 and preferably below level 76 of bed 78. The upper end of the withdrawal well 98 extends above the inlet line 52 which is used to transfer coke from the reactor to the burner to prevent coarse coke particles introduced through line 52 from falling down into the well 98.

Standpipe 101 empties into line 106 which is also U-shaped and provided with an aeration tap or fluidizing gas line 108 at the base of the U to maintain the coke particles in a fluidized condition. Solids from the U-bend are passed through riser 110 provided with a valve or other restriction orifice 112. Steam or other gas is introduced into riser 110 above valve 112 through line 114 and the amount of steam introduced controls the rate of flow of solids through riser 110. The riser 110 empties into an intermediate portion of reactor vessel 10 directly into dense fluidized solids bed 12.

Intermediate section 64 is provided with a valved line or pipe 116 similar to line 68 above described in connection with top section 62 of elutriator-burner vessel 54. Line 116 extends into the dense fluidized bed 78 near the bottom of section 64 and is provided with upwardly directed nozzles 118 for introducing elutriating and fluidized gas into section 64 of burner 54. A second valved line 122 communicates with line 116 for introducing inert gas such as steam alone or in connection with the oxygen-containing gas.

A similar valved line 124 is provided for lowest and smallest diameter section 66 and extends into the lower portion of section 66 and into dense fluidized bed 78. Line 124 has upwardly directed nozzles 126 for introducing elutriating and oxygen-containing gas into the burner 54. A second valved line 128 communicates with line 124 so that either air or inert or both may be introduced into section 66.

The elutriator burner 54 functions as a dense phase elutriator with the improvement that the oxygen-containing gas can be injected at the desired or selected region or zone to selectively burn coarse or fine coke particles in the system or fluid coking unit. This is an important feature in a system such as fluid coking where there is coke particle growth and a net coke production as it permits selectively burning the finer coke particles and withdrawing the coarsest coke as product coke. Also this permits burning a higher percentage of the coke deposited on the finer coke particles so that they remain small for a longer time and in this way reduce the requirement for grinding or affecting attrition of the larger coke particles to smaller coke particles. With the present invention it is also possible to selectively burn coarse coke particles if need arises.

Control of coke particle size is effected by adjusting the relative air rates to the various sections 66, 64 and 62 of the elutriator-burner 54. For example, to selectively burn coarse particles, the amount of air passing through line 124 and into lower section 66 is increased. This results in a higher gas velocity in section 66 and causes removal of fines or finer coke particles overhead from section 66 and the percent of large coke particles in section 66 increases. While some air is supplied to sections 64 and 62 most of the air is supplied to section 66 to selectively burn the larger coke particles as the burning takes place in section 66.

If it is desired to selectively burn fine coke particles, the relative amount of air passing through line 68 is increased as compared to lines 116 and 124 and less air is passed through lines 116 and 124 and more inert gas is pased through lines 116 and 124.

The result of this is to increase the percent of coke fines burned by supplying most of the air to the section 62 where they are concentrated. Because of the dense phase elutriation, the finer coke particles increase in the upper portion of bed 78 in section 62. The relative amounts of air and inert gas being introduced into the sections 62, 64, 66 can be varied as desired to obtain the desired dense phase elutriation.

Data from a pilot plant test show that the percentage of coarse material in normal fluid coke product can be increased by dense phase elutriation. They further show that a dense phase elutriation system can be staged since the separation factor did not decrease when the quantity of coarse material was increased. One is primarily interested in concentrating the coarse coke fraction on 20 mesh and coarser. Pertinent data for four of the pilot elutriator runs are shown below.

Run	14A	15A	14B	15B
Superficial Gas Velocity:				
Minimum, (in pipe)	1.0		0.44	
Maximum, (at baffles)	2.8		1.3	
Wt. Percent on 20 Mesh in:				
Coke feed	6.5	18.8	7.2	20.5
Coke product	7.8	23.3	9.5	26.6
Separation Factor:				
Wt. Percent on 20 mesh in feed / Wt. Percent on 20 mesh in product	1.20	1.24	1.32	1.30

The above separations were obtained in a two foot section of 6″ pipe with coke flow rates of about 4000 #/hr./ft.^{2} of horizontal cross section. The 6″ pipe contained four baffles 6″ apart. The top two baffles were 5.02″ in diameter and the lower two baffles were 4.45″ in diameter. These baffles were added to obtain velocity gradients and reduce backmixing simulating what would take place in the diameter staged elutriator shown in the drawing. Elutriation velocities should be limited to below about 8 ft./sec., preferably below 2.8 ft./sec.

One advantage for dense phase elutriation is the low gas velocity required to obtain separation of the coarse coke materials from the bulk of the coke. These dense phase data show that a 4 baffled section will give a separation factor of 1.3 with a superficial velocity of 0.44 ft./sec. in the vessel. As mentioned previously, the separation factor in Runs 15A and 15B showed that increasing the concentration of coarse material did not reduce the separation factor, and therefore simple staging permits further concentration of the coarse material.

In one example, the coke passing through line 52 to the burner 54 comprises particles having a size between about 4 mesh and 200 mesh. The burner is operated to burn some of the coke and the heated coke particles are returned to the reactor 10 through line 110. To compensate for the growth of the coke particles during coking, it is possible with the present invention to burn the coke deposited on the finer particles so that they remain smaller longer and this reduces attrition or grinding requirements to produce seed coke. The burner is so arranged that the larger coke particles or coarsest particles are withdrawn as product coke and the finer particles are burned to supply the heat of coking in the reactor. Or the larger coke particles can be selectively burned in lowest section 66.

The sections 66, 64 and 62 of the burner increase in diameter in the order given and each section is provided with an inlet gas line for introducing mixtures of air and an inert gas such as steam, or air alone or steam alone. Where mixtures of air and an inert gas are introduced, the relative amounts of the air and the inert gas may be varied as desired. The superficial velocity of the gas passing up through lowest and narrowest section 66 will be the highest and will preferably be between about 2 and 8 feet/sec. The superficial velocity in the next higher and wider section and middle section 64 will be lower than that in section 66 and will be between about 0.5 and 4 feet/sec. The superficial velocity of the top widest section 62 will be between about 0.4 and 2 ft./sec.

When it is desired to remove the maximum of coarse coke particles from bottom burner outlet line 74, the gas being introduced into the bottom section 66 will be substantially steam introduced through line 128 so that there is substantially no burning of the coke particles, but there is dense phase elutriation. The burning of coke to provide heat for the coking step is carried out by introducing some air into middle section 64 and the major portion of air into top section 62 to burn the finer coke particles. Or inert gas may be supplied to the middle section 64 through line 122 and air introduced only into the top section 62 through line 68.

In one example where it is desired to carry out a coking operation in reactor 10 at a temperature of about 975° F. and coke having a particle size between about 4 and 200 mesh at a temperature of about 975° F. is passed through lines **46** and **52** to the top section **62** of the coke burner **54**, the burner has the dimensions set forth hereinafter when coking about 3800 barrels per day of a residual oil having an API gravity of about 1.9°, a Conradson carbon of about 35 wt. percent and an initial boiling point of about 950° F. and about 5000 pounds per hour of steam are added to the reactor **10** through line **24**. The oil feed in line **18** is preheated to about 650° F. The coke to feed oil ratio by weight going to reactor **10** is about 10/1.

The dimensions of one specific burner are as follows: Section **66** is about 2 feet in diameter and 12 feet high up to the flared section **96**. The flared section is 2 feet high measured vertically and not on the angle.

Middle section **64** is 12 feet high measured from the top of the flared section **96** to the bottom of the next higher flared section **94** and is about 5 feet in diameter. The flared section **94** measured along a vertical line like section **96** is about 3 feet. The top section **62** has a diameter of about 12 feet measured from the top of flared section **94** and has a height of about 20 feet.

For recovering about 200 tons/day of coke having a size between about 35 mesh and 4 mesh through line **74**, the superficial velocity of the gas passing up through section **66** is about 2.0 feet/sec. and this gas comprises steam from line **128** to elutriate out the fines or finer coke which passes up into sections **64** and **62**.

The superficial velocity of the gas from line **116** and **122** plus the gas leaving section **64** and passing up through middle larger section **64** is about 0.5 feet/sec. and this gas comprises steam to elutriate coke fines by a dense phase elutriation. Fine coke particles from middle section **64** pass upward into the top section and then pass through well **98** and are returned to the coking reactor **10** to supply the heat of coking. About 100 tons per hour of coke at a temperature of about 1125° F. are returned to the reactor **10**.

The superficial velocity of the gas passing up through the top section **62** and is about 2.5 feet/sec. and this gas comprises air plus the gases leaving section **64**. The coke mixture in top zone **62** has a particle size between about 100 mesh and 28 mesh. In this specific example, the coke fines and finer coke particles are burned in top zone **62** to remove deposited coke and maintain the smaller particle size longer. All of the coke circulated from the reactor passes through lines **42** and **52** to the bottom of section **62** so that fines or finer coke particles in the circulated coke mixture pass to section **62** to be burned and also finer coke particles are elutriated up from the middle and lower elutriating sections **64** and **66**.

If it is desired to recover less coarse coke from line **74**, some of the coarse coke particles will be burned in the lowest section **66** by introducing air alone through line **124**. Burning will also be done in middle section **64** by introducing air alone. Some burning will also be carried out in top section **62** by introducing air and steam through lines **68** and **72**.

During the operation of the process, the operation of the burner **54** may be changed periodically or as desired, if different particle size distributions of the coke mixture in the unit are desired or if the size of the coke particles withdrawn as product through line **74** is to be changed.

The coke particles from the reactor introduced into the bottom portion of top section **62** of the burner **54** are mixed into the finely divided coke fluidized mixture in top section **62** and the coarser coke particles fall down into middle section **64** where additional elutriation takes place. The low velocity employed in this section **64** minimizes top to bottom mixing and effects selective settling of the coarser particles in the dense fluidized bed as shown in the data presented above. Some of the finer particles in section **64** may be carried back into section **62** while the coarser particles proceed downward into the lower section **66**.

As the coarsest coke particles pass down into bottom section **66** the coarsest coke particles are stripped of the fine particles and then pass down into withdrawal line **74**.

The withdrawn coke particles are quenched or cooled in any desired manner. Preferably they arr used to generate the steam used in the elutriating step either by direct quenching with water or by indirect heat transfer.

What is claimed is:

1. A process for fluid coking hydrocarbon oils including a reaction zone and a burner zone wherein coke particles are maintained in a dense fluidized condition and are circulated between said reaction zone and said burner zone and coarse product coke is withdrawn as product, the improvement which comprises providing said burner zone with a continuous vertical series of sections of increasing cross-sectional area increasing from the bottom to the top, providing in said burner zone a single dense fluidized bed consisting essentially of coke particles extending as a continuous fluid bed through said sections, introducing an oxygen-containing gas into the lower portion of each section and adjusting the gas flow rates to the various sections to effect dense phase elutriation of fine coke particles from the product coke stream and burning of coke particles to provide heat of coking for said reaction zone.

2. A process according to claim **1** wherein coke particles are withdrawn from said reaction zone and passed to the upper portion of said burner zone and heated coke particles to be recycled to said reaction zone are withdrawn from said burner zone and said coarse coke particles are withdrawn from the bottom portion of the bottom section of said burner zone.

3. A process according to claim **1** wherein the desired average particle coke size is maintained with minimum attrition by using a substantial inert oxygen-containing gas in the bottom section of said burner zone and utilizing air in the top section of said burner zone to selectively burn the smaller coke particles.

4. A process for elutriating and burning coke particles in a burner zone for supplying heat for a fluid coking zone which comprises withdrawing coke particles from said coking zone and passing them to one of a series of vertically arranged elutriating zones of increasing cross-sectional area from the bottom to the top in said burner zone wherein said coke particles are maintained as a single dense fluidized bed extending as a continuous bed through said elutriating zones to elutriate the smallest coke particles in a dense phase, introducing elutriating gas into the lower portions of said elutriating zones, said elutriating gas comprising air in one or more of said elutriating zones and comprising mostly of inert gas in at least one of said zones whereby to control the coke particle size in said zones by controlled burning of fines or coarse coke, and withdrawing coarse product coke from the bottom elutriating zone.

5. A process according to claim **4** wherein the superficial velocity of the gas in said elutriation zones is between about 0.3 and 3.0 feet/sec.

6. A process for elutriating and burning coke particles in a burner zone for supplying heat for a fluid coking zone which comprises withdrawing coke particles from said coking zone and passing them to upper zone of a series of vertically arranged elutriating zones in said burner zone to elutriate the smallest coke particles in a dense phase, maintaining said fluid coke particles in a single dense fluidized bed extending as a continuous bed through said elutriating zones, at least one of said elutriating zones being of increasing cross-sectional area from the bottom to the top, introducing elutriating gas into the lower portions of said elutriating zones, said elutriating gas introduced into the lowest elutriating zone being substantially inert, said elutriation gas introduced into the other of said elutriating zones comprising controlled amounts of air to control the burning of fine coke particles and withdrawing coarse product coke from the lowermost elutriating zone.

7. A process according to claim **4** wherein the elutriating gas introduced into the lowermost elutriating zones comprises air to selectively burn coarse coke particles.

8. A process for elutriating and burning coke particles in a burner zone for supplying heat for a fluid coking zone which comprises withdrawing coke particles from said coking zone and passing them to one of a series of vertically arranged elutriating zones in said burner zone to elutriate the smallest coke particles in a dense phase, providing in said burner zone a single dense fluidized bed consisting essentially of fluid coke particles extending as a cointinuous bed through said elutriating zones, at least one of said elutriating zones being of increasing cross-sectional area from the bottom to the top introducing elutriating gas into the lower portions of said elutriating zones to elutriate fine coke and concentrate it in the elutriating zone in the upper portion of said burner zone, said elutriating gas comprising inert gas in the lowermost elutriating zone and air in the uppermost elutriating zone whereby controlled burning of fine coke is carried out in the elutriating zone where the fine coke is concentrated and withdrawing coarse coke product from the lowermost elutriating zone.

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