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FLUID COKING

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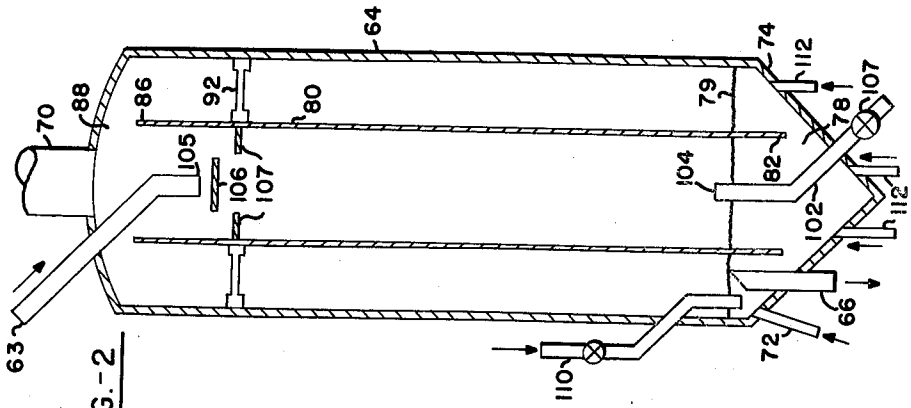


FIG. - 2

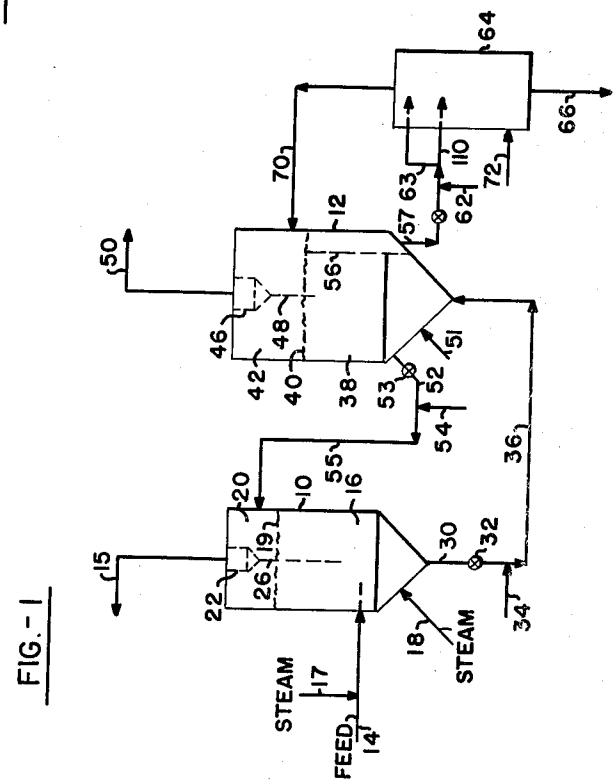


FIG. - 1

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FLUID COKING

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This invention relates to thermal cracking and fluid coking and more particularly relates to a process and apparatus for controlling the particle size of the coke particles in the unit.

In fluid coking the coke particles as a fluidized bed in the reactor are contacted with oil feed and the oil feed cracked. When the oil feed is cracked, one of the products is coke which is deposited on the coke particles and as a result the coke particles grow or increase in size and if this is allowed to continue the coke particles become too large to be properly fluidized and the fluid bed may become defluidized.

Coarser particles of coke are withdrawn as product coke from the coking unit and hence it is necessary to supply smaller or finer coke particles as seed coke to the coking unit. It is also desirable to remove fines or extremely small coke particles from the coarse coke product being withdrawn from the process.

In some of the prior art patents, water has been used to quench the coarse coke product to be withdrawn and this quenching forms steam which is used to elutriate fines from the coarse coke product. In some fluid coking plants, this has not been entirely satisfactory and the poor elutriator vessel performance is probably due to slugs or large batches of coke dumped into the elutriator vessel which causes an immediate rise in elutriator solids bed temperature. Since the quench water is under elutriator solids bed temperature control, the quench water control valve opens up and injects a large amount of water into the quenching zone. The periodic slugs of hot coke and quench water tend to cause poor control of elutriation. Since good elutriation depends on steady operation, separation of fines from the product coke is usually poor.

According to the present invention, a quench-elutriator vessel is provided which gives controlled separation of fine and coarse coke particles by maintaining separate elutriation and quench zones. More specifically, the elutriator vessel is provided with a separate central vertical internal elutriation tube in which elutriation with steam is carried out. Hot coke particles from the burner vessel are introduced into the upper portion of the elutriation tube and pass down countercurrent to steam introduced into the lower portion of the elutriation tube for upward passage therethrough. The velocity of the steam is controlled by an external hand control valve and flow meter.

Coarse coke particles flow out of the bottom of the elutriation tube into a dense fluid bed quenching zone of coke particles in the bottom of the vessel surrounding the elutriation tube. Quench water is introduced into the bottom dense fluid bed of coke particles forming an annulus around the elutriation tube so that the water is flashed to steam and the steam formed is passed upwardly around and not up through the elutriation tube. The elutriated coke fines and steam leave the open end at the top of the elutriation tube and steam leaves the dense fluid bed of coke surrounding the elutriation tube and leave the top of the elutriator vessel for return to the burner in the coking unit. In this way fines are returned to the coking unit and this assists in maintaing the proper proportion of fines in the circulating coke solids to provide good fluidity of the bed in the reactor and burner.

Attrition of the coke particles to provide fines is also usually required. Coarse coke particles as product are withdrawn from the dense bed of coke particles in the bottom of the elutriator vessel.

With the present invention, better coke particle size control is obtained by maintaining separate zones for the elutriation and quenching of the hot coke. In addition, there are less fines in the coarse product coke withdrawn from the coking unit and this is the preferred product. As pointed out above the present invention also provides a high proportion of fines in the circulating coke and this provides smoother coke circulation and better fluid beds in the coker reactor and burner. More fines are retained in the system and this will allow lower attrition steam requirements.

The fluid coking process is a well known process and is described in Pfeiffer et al. Patent No. 2,881,130, granted April 7, 1959, and the disclosure of this patent is incorporated herein by reference thereto.

In the drawing:

FIG. 1 represents a diagrammatical showing of the entire process; and

FIG. 2 represents a vertical cross-sectional view of one form of an enlarged quench-elutriator vessel of the present invention.

Referring now to the drawing, the reference character **10** designates a coking vessel and reference character **12** designates a burner vessel. Liquid hydrocarbon feed is introduced or sprayed into coking vessel **10** through line **14**. Liquid feeds suitable for the present invention are heavy or reduced crude petroleum oils or vacuum bottoms or residual hydrocarbon oil which cannot be vaporized without decomposition. Such oil feeds may have an API gravity between about —10° and 20°, and a Conradson carbon between about 5 and 50 wt. percent. The oil feed can be preheated by conventional means, not shown, or by exchange with the reactor vapor products discharged from line **15** to between about 400 and 800° F. and is introduced into the dense fluidized turbulent coke bed **16** in the coking vessel **10**. Preferably the oil feed is introduced into the fluidized bed **16** at a multiplicity of points. The highly turbulent nature of the fluidized bed **16** also assists in causing rapid dispersion of the oil feed throughout the bed **16**.

Preferably the oil feed is mixed with between about 0.25 and 0.50 wt. percent steam on the oil feed to assist in dispersing the oil feed in the bed **16**. The steam is introduced through line **17**. The coking vessel **10** contains coke particles ranging in size between about 40 and 5000 microns with most of the particles being between about 75 and 2500 microns. Steam is also introduced through line **18** into the bottom portion of the fluid bed of coke **16** to function as a stripping gas to remove or displace hydrocarbon vapors from the coke. Stripping gas velocity is between about 0.3 and 5.0 ft./sec. The stripping gas may be injected into the dense fluid coke bed through nozzles at high velocity to cause attrition or grinding of the larger coke particles to maintain the desired coke particle size. To be effective as an attrition gas, the steam is introduced at supersonic velocities.

The coke particles within the bed **16** are maintained in a turbulent fluidized condition by the gases and vapors passing upwardly therethrough. The gases and vapors include the fluidizing and stripping gas and the vapors and gases formed by coking or cracking of the oil feed. The fluidized bed **16** has a level indicated at **19** superimposed by a dilute phase **20**. The average superficial velocity of the upflowing gaseous material is between about 0.5 and 5.0 ft./sec. depending on the size of the coke particles making up the bed **16**. The density of the fluid bed **16** may be between 30 and 50 lbs./cu. ft. The temperature in

the bed 16 and vessel 10 is maintained between about 850° F. and 1200° F. Higher temperatures up to about 1800° F. may be used in processes for cracking the oil feed to olefins, diolefins, aromatics, etc., and coke.

The pressure in coking vessel 10 may be between about 1 and 100 p.s.i.g. The hydrocarbon oil feed rate may be between about 0.1 and 3.0 weight of oil per hour per weight of solids (w./hr./w.) present in the fluid bed 16. In the fluid bed 16, the oil feed is cracked or converted to hydrocarbon vapors and coke. The vaporous hydrocarbons are lower boiling hydrocarbons and these hydrocarbons leaving the bed 16 and passing into the dilute phase 20 carry entrained solids. In the dilute phase 20, there is some settling of solids.

The vapors and gases passing up through dilute phase 20 are passed into gas-solids separating means 20 such as one or more cyclone separators in series arranged inside and at the top of coking vessel 10 for separating entrained solids from vapors and gases which pass out overhead through line 15. The separated solids are returned to or above the dense fluidized bed 16 through dip leg 26.

The vapors and gases passing overhead through line 15 are further treated as desired and may be fractionated to separate gasoline from higher boiling hydrocarbons and gas and the higher boiling hydrocarbons may be recycled to the coking vessel or removed from the system as product. They may also be used to preheat the oil feed to the reactor.

To supply heat for the coking vessel 10, coke particles are circulated from vessel 10 to external burner vessel 12 where partial combustion of the coke particles occurs and the coke particles are heated to a higher temperature. Coke particles are withdrawn from the bottom portion of the coking vessel 10 through standpipe 30 having a control valve 32 at its lower end and suspended in a fluidizing gas introduced through line 34 below valve 32 and the resulting suspension is passed through line 36 into the lower portion of burner vessel 12. The burner vessel is preferably a two phase burner where the coking particles settle out to form a dense fluidized turbulent bed 38 having a level indicated at 40 superimposed by a dilute phase 42. In the burner vessel 12, a portion of the coke is consumed by burning and the remainder of the coke particles are heated to a temperature between about 50° F. and 300° F. higher than the temperature in coking vessel 10, that is, between about 1050° F. and 1250° F. Other types of burners such as a high velocity transfer line burner or the like may be used instead of the fluid bed burner.

The combustion gas passes up into dilute phase 42 and there is some separation and settling of the entrained coke solids. The combustion gas then passes into gas solids separation means 46 such as one or more cyclone separating means located inside and at the top of burner vessel 12 to separate entrained solids which are usually returned to above the dense fluidized bed 38 through dip leg 48. Hot combustion gas passes overhead through line 50 and may be passed through a waste heat boiler or other heat exchanger means to recover heat from the combustion gas before venting it to the atmosphere. Air is introduced into the bottom portion of burner vessel 12 through line 51.

The gases passing up through burner vessel 12 maintain the coke particles in a dense turbulent fluidized condition. The gases pass up through the bed 38 at an average superficial velocity between about 0.5 and 5.0 ft./sec. and the density of the fluid bed 38 is between about 30 and 50 lbs./cu. ft. The hot coke particles are withdrawn from dense fluidized bed 38 in burner vessel 12 through standpipe 52 having a control valve 53 and steam or the like is introduced below the valve 53 through line 54 and the suspension passed through line 55 and recycled to the upper portion of coking vessel 10.

Another portion of the heated coke particles is withdrawn from burner vessel 12 and from a well formed by vertically extending partition 56 which extends up from the bottom of burner vessel 12. The coke particles flow down from the well into standpipe 57 extending downwardly from the well and provided with control valve 58. Gas such as steam or the like is introduced into the withdrawn coke particles below valve 58 to form a dilute suspension which is passed through line 63 into the vertically arranged quench elutriator vessel 64 diagrammatically shown in FIG. 1 and in greater detail in FIG. 2 or the solids may flow down through standpipe 57 and control valve and be introduced as such as a dense fluidized stream without further introduction of suspending gas through line 63 into quench elutriator vessel 64. Quench water is introduced through line 72 into the lower portion of elutriator vessel 64 and large cooled coke particles are withdrawn from the bottom portion of vessel 64 through line 66. A gaseous suspension containing fines or finely divided elutriated coke particles is passed overhead through line 70 and returned to burner vessel 12 along with the steam formed from the quench water.

Referring now to FIG. 2, the quench-elutriator vessel is shown in greater detail. The vessel 64 has an inverted conical bottom 74 but the shape is not critical and a rounded bottom or other forms may be used. The vessel 64 is cylindrical and has a substantially uniform diameter for substantially its entire length. The vessel has a rounded top ending in outlet line 70 heretofore referred to. A fluidized bed of coke solids 78 having a level indicated at 79 is collected in the lower portion of vessel 64 as will be presently described. Solids outlet line 66 extends up into vessel 64 above the lower end of tube 80 and maintains the fluidized bed 78 in vessel 64.

The vessel 64 is provided with a vertically arranged internal open-ended hollow elutriation tube or pipe 80 which is coaxial with the vessel 64 and has its lower end 82 spaced above and from bottom portion 74 of the vessel 64 and has its upper end 86 spaced from the top of vessel 64 as at 88 so that the tube 80 is entirely within the vessel 64. The tube 80 is shown as being cylindrical and of uniform diameter, but the diameter need not be uniform and other shapes of tube 80 may be used. The tube or pipe 80 is supported and held rigid in vessel 64 in any conventional manner such as by horizontal arms or supports 92 which are preferably secured at one end to the inner wall of the upper portion 75 of vessel 64 and at the other end to the outside wall of the tube 80. The elutriation tube 80 is provided to elutriate and separate fines from the coke particles and to return the separated fines to the burner vessel 12. A steam line 102 is provided which is shown as extending through the bottom portion 74 of vessel 64 and into the lower portion of elutriation tube 80. The outlet end 104 of line 102 is preferably provided with a plurality branch distributor each having a perforated cap outlet. The steam is at a temperature between about 300° F. and 1000° F.

The inner open end of steam line 102 terminates at 104 above the lower end of elutriation tube 80 and centrally thereof to direct steam upwardly in the tube 80. Coke particles to be elutriated are withdrawn from the burner vessel 12 through line 63 and introduced into the upper end of the tube 80 by the downwardly directed open end 105 of pipe or line 63. Directly beneath the outlet end 105 of the pipe 63 in the tube 80 is a disc 106 and donut construction 107 for distributing the coke particles from pipe 63 uniformly over the cross-sectional area of the elutriator tube 80.

Steam pipe or line 102 has an external control valve 107 which can be used manually or automatically to control the velocity of the steam for elutriation being introduced through line 102. The superficial velocity of the steam in elutriator tube 80 should be between about 3 and 30 ft./sec. The exact quantity of steam to be added through line 102 will depend on the desired cut point of

the coke particles size, the size distribution of the coke particles being introduced through line **63**, the coke feed rate to the tube **80** and the required ratio of coke feed to net coke product to be withdrawn from the unit.

At high net coke production rates, the elutriation efficiency falls off a small amount since it is dependent to some extent on coke loading and at such high rates, it is preferred to by-pass the elutriator tube **80** with some of the hot coke by passing it through by-pass valved line **110** provided as a branch line from line **63**. By-pass line **110** conducts hot coke from the burner vessel **12** and line **63** directly into the quenching dense fluid bed **78** below the level indicated at **79**. The open bottom end of line **110** is normally arranged below the level **79** of fluidized solids.

Fine coke particles are elutriated from the downflowing coke mixture in the elutriator tube **80** by the upflowing steam from line **102** and the steam and entrained coke fines or fine coke passes up through the top outlet end of tube **80** and into outlet line **70** for return to the dilute phase of the burner vessel **12** as shown in FIG. 1. Coarse coke particles flow out of the bottom of the elutriator tube **80** into the dense bed quenching zone **78** to be cooled by flashing water into steam.

Quench water or other liquid for cooling the coarse coke mixture introduced into the bottom portion or quench portion **78** of elutriator quench vessel **64** is introduced into the coke mixture through one or more lines **72** to quench and cool the coarse coke particles which are to be withdrawn as product through line or standpipe **66** and also to fluidize the coke particles in bed **78**. The upper end of standpipe **66** determines the level **79** of dense bed **78** but the bed level could also be controlled by withdrawing coke from the bottom of the bed and controlling the withdrawal rate with a level controller and valve. The fluidized bed **78** also seals the bottom of tube **80** to prevent steam from entering the tube **80** from quench bed **78**. Only enough quench liquid is introduced to be vaporized or flashed to steam so that the temperature of the quenched coke product is above the condensation point of water and so that no water is present as such in the fluidized bed **78**. Additional fluidizing gas such as steam may be supplied through one or more lines **112** into the bottom **74** of elutriator vessel **64**, if desired.

The vaporized quench liquid as steam and some entrained coke fines leave dense fluidized coke bed **78** and pass up around and exterior to the elutriator tube **80** and through an annular passageway and leave vessel **64** through the passageway **88** between the top of tube **80** and the top of vessel **64** and join the elutriation steam and entrained fines from the top of tube **80** for return to the burner vessel **12** through line **70**.

In the normal operation, hot coke particles will be passed through line **63** only and the downflowing coke particles will be contacted countercurrently by steam rising from outlet **104** of steam line **102**. At a given steam rate the free fall velocity of a certain diameter coke particle will be exceeded and a high percentage of coke particles smaller than this size will be entrained overhead through line **70** and a high percentage of coke particles larger than this size will fall to the bottom of tube **80** and pass into the quench section or quench bed **78**. The separation will not be perfect. A few large particles will go overhead and some small ones will go down. The "fractionation" depends on the loading. Water introduced through line **72** is flashed into steam and the steam is transported to the burner vessel **12** by overhead line **70** after passing through the annulus between the elutriator tube **80** and the quench vessel **64** and passageway **88** leading to line **70**.

The two principal variables affecting separation by elutriation are the elutriating gas velocity and the rate of feed coke particle mixture into the elutriator tube or column. In order to remove a major portion of the fines from the coarse coke, the elutriating gas velocity should be at least 1.5 to 3.0 times, that is, about twice the free fall velocity of the largest particle tube taken overhead. As the gas velocity is increased less of the coke fines fall to the bottom with the coarse material. If the gas velocity exceeds the free fall velocity of any particles of the coarse fraction, some of these coarse particles will be carried overhead and contaminate the fines.

For practical purposes, the elutriating gas velocity may range from about 3 ft./sec. if it is desired to recover fines of about 150 micron diameter and fines to about 30 ft./sec. if the solids to be carried overhead are to include particles of about 1,000 micron diameter.

The solids feed rate to the elutriator tube also has a pronounced affect on the degree of separation of fines from coarse. For a given gas velocity, as the coke feed rate increases, the amount of fines going to the bottom increases. If there is any amount of coarse material going overhead because the gas velocity exceeds the free fall velocity of the fines actually desired, an increase in the solids or coke feed rate will decrease the amount of coarse material going overhead. At the same time, the total amount of material going overhead decreases in proportion to the amount dropping to the bottom. Consequently, there is an optimum ratio of solids feed rate to gas rate for each gas velocity which will give only a small amount of coarse material going overhead and only a small amount of fines going to the bottom.

For example to separate approximately 250 micron and smaller coke particles (free fall velocity about 4 ft./sec.) from coarser coke particles, the following Table I shows the best range of coke feed rate in pounds to steam rate in cubic feet at a given steam velocity in feet per second in order to get good separation of coke fines in elutriator tube **80**.

Table I

Gas velocity, ft./sec.:	Rate of coke feed rate to gas rate lb./cu. ft.
4	0.05–0.075
5	0.075–0.125
6	0.125–0.20
8	0.15–0.25
10	0.25–0.35

In a specific example feeding about 30,000 barrels per day of residual petroleum oil having a gravity of about 8.2° A.P.I., an initial atmospheric boiling point of about 600° F. and a Conradson carbon of about 16.7 wt. percent are introduced into coking vessel **10** along with about 10 wt. percent steam on the fresh oil feed. The density of the fluid coke bed in vessel **10** is about 45 lbs./cu. ft. and the temperature of the coking fluid bed in vessel **10** is about 970° F. The pressure in vessel **10** is high enough to overcome the pressure drop through the recovery equipment and is slightly above atmospheric pressure. Vaporous products pass overhead and are cooled, condensed and fractionated to separate lower boiling products as follows and coke formed:

In the following table, MM equals 1 million.

Gas, C_3 minus	.96 MM lbs./day
C_4	960 barrels/day
C_5–430° F.	6,200 b/d
430–1015° F.	16,900 b/d
Gross coke	2.24 MM lbs./day
Coke, particle size range	40 to 5,000 microns

About 530,000 pounds of the gross coke per day are burned in burner vessel **16** to supply the heat required for the coking process or step in vessel **10**. The temperature in the burner vessel is about 1150° F. The circulation rate of coke solids between the coking vessel **10** and burner vessel **12** is about 50 tons per minute.

The vessel **64** in this example as shown in FIG. 2 is a straight sided one or a cylindrical one of a uniform diameter of about 8 feet and a total height of about 32 feet. The pipe **63** has an internal diameter of about 10 inches.

The elutriator tube **80** is of a uniform diameter of about 4 feet and is about 26 feet long. The top outlet line **70** has an internal diameter of about 3 feet. Steam line **102** has an internal diameter of about 6 inches and extends to level **104** or the outlet end **104** slightly above the inlet end of pipe **66**. The top of tube **80** is spaced at **88** from the top of vessel **64** a distance of about 1 foot. The disc **106** is about 1 foot in diameter and the associated donut **107** has a ring section of about 6 inches wide. The disc **106** is about **1** foot below the outlet **105** of line **63** and the donut **107** is about 1 foot below the disc **106**. The bottom **82** of tube **80** is about 5 feet above the lowest point of bottom **74** of vessel **64**. The uppermost part of coarse coke product drawoff line **66** is at a slightly lower level than the top or outlet **104** of steam line **102**, that is, about 7 feet above the lower end **82** of tube **80**. About 247,500 pounds of coke per hour having a particle size distribution as follows:

Mesh, retained on:	Wt. percent on mesh
8	2.0
14	2.6
20	1.0
28	0.4
35	1.2
48	9.2
65	32.2
100	31.5
150	12.3
200	5.7
325	0.2
Pan	1.7

at a temperature of about 1150° F. and a density of about 40 lbs./cu. ft. are introduced through line **63** into elutriator tube **80**.

Steam at a temperature of about 350° F. and in an amount of about 14,000 lbs. per hour is introduced into the lower portion of elutriator tube **80** through line **102** to have a superficial velocity of about 7.9 ft./sec. in tube **80**. Or the feed rate of steam can be given as 100 cubic feet per second. Under these conditions the following separation is accomplished:

Stream lb./hr. of Coke mesh (Tyler)	Fine product 177,000	Coarse product 70,500
8		5.5
14		3.7
20		1.0
28		0.5
35		1.4
48	0.8	11.0
65	9.0	35.1
100	41.5	29.4
150	29.2	9.1
200	15.1	2.9
325	0.4	0.0
Pan	4.0	0.4

The coke fines returned to vessel **12** in conjunction with attrition maintain the desired and selected proportion of 0 to 150 micron fines of or above about 30 to 70 wt. percent of the circulating coke mixture to maintain optimum fluidity of the coke mixture in the coking vessel, the burner vessel, standpipes, etc.

About 1.7 MM pounds per day of coarse coke particles at a temperature of about 1000° F. are flowed down from the bottom of tube **80** into dense quenching bed **78**.

About 120 cubic feet of dense fluidized coke mixture having a density of about 40 lbs./cu. ft. at a fluidizing velocity of about 2.0 ft./sec. and a temperature of about 300° F. are retained in fluid bed **78** in the bottom of vessel **64**.

About 0.22 lb. of water per pound of solid introduced into quenching fluid bed **78** is introduced into bed **78** through line **72** to cool the coarse coke particles in fluidized bed **78** to a temperature of about 300° F.

About 1.7 MM lbs. per day of coarse coke having a particle size between about 40 and 5000 microns are withdrawn as coke product through line **66** and sent to storage.

By recovering coke fines and recycling them to the unit, the amount of attrition steam needed in the stripping section **18** is reduced.

The level of solids in the bottom of the elutriator tube **80** is slightly higher than that of the solids in bed **78** around tube **80**.

The amount of steam passing through line **102** may be varied as desired by external valve **107** to change elutriating conditions in tube **80** so that more or less coke fines may be separated or larger or smaller sizes than a selected size may be separated from the coke mixture. The steam control will also permit optimizing the elutriation conditions if coke feed rate to the elutriator tube changes.

What is claimed is:

1. In a process wherein high boiling hydrocarbons are thermally cracked in a fluid coking process and coke particles are circulated between a coking zone and a coke burning zone to partially burn the coke particles to supply heat of cracking and wherein fluid coking particles are withdrawn from said burning zone and wherein coke fines are separated from admixture with coarse coke particles and the coke fines are returned to said burning zone and coarse coke particles are withdrawn as product coke, the improvement which comprises withdrawing a portion of the coke mixture from said burning zone and passing it to the upper portion of a vertically arranged central confined elutriating passageway surrounded by an annular chamber, said elutriating passageway and said annular chamber communicating at the bottom to form a quenching zone, introducing said mixture of coke fines and coarse coke particles into the upper portion of said central confined elutriating passageway, elutriating coke fines from said coke mixture by the countercurrent action of upflowing steam introduced as a separately controlled stream into the lower portion of said confined elongated elutriating passageway to separate coke fines overhead from coarse coke particles, passing the separated coarse coke particles into said quenching zone, injecting water into said coarse coke particles in said quenching zone to cool said coarse coke particles and form steam which passes upwardly through said annular zone and which entrains coke fines from the coarse coke particles, combining the last mentioned steam containing entrained coke fines with the steam and coke fines leaving said central confined elongated elutriating zone overhead and passing the combined stream to said burner zone and removing coarse coke particles as product coke from said quenching zone.

2. In a process wherein high boiling hydrocarbons are thermally cracked in a fluid coking process and coke particles are circulated between a coking zone and a coke burning zone to partially burn the coke particles to supply heat of cracking and coke particles are withdrawn as product coke, the improvement of recovering and returing coke fines from a portion of the withdrawn coke mixture to said coking unit and withdrawing coarse coke product which comprises withdrawing a portion of the coke mixture from said burning zone and passing it to the upper portion of a vertically arranged elongated central confined passageway surrounded by an annular concentric zone, passing a separate stream of gas up through said central confined passageway for countercurrent treatment of said coke mixture to elutriate coke fines overhead from coarse coke particles, returning the elutriated fines and gas to said coking unit, passing the separated coarse coke particles to a bottom quenching zone concentric with said central confined passageway and communicating with said annular zone, introducing a vaporizable liquid into said quenching zone beyond the confines of said central confined passageway to flash the liquid into vapor to cool the coarse coke particles and to fluidize said coarse coke particles, passing the formed vapor upwardly in said

annular zone surrounding said confined central passageway but outside of said central passageway and withdrawing cooled coarse coke particles from said quenching zone as a coke product.

3. A process according to claim 2 in which the separate effluents from said central confined passageway and the upper portion of said annular zone are combined and returned to said coking unit.

4. An apparatus of the character described including in combination a vertically arranged vessel having a top outlet and a bottom outlet, a vertically arranged hollow open-ended tube entirely within said vessel and having its upper end spaced from and discharging into said vessel top outlet, said tube having its lower end spaced from the bottom of said vessel, a pipe extending through the wall of said vessel and into the upper portion of said tube and opening downwardly for introducing solids downwardly in said tube, distributing means in said tube and directly below the outlet of said pipe, a second pipe extending through the wall of said vessel and into the lower portion of said tube, said second pipe having its outlet end opening upwardly for the introduction of upflowing gas, said second pipe having a control valve exterior to said vessel, said vessel bottom outlet extending through the wall of said vessel and upwardly from the bottom thereof and above the bottom portion of said tube whereby solids passing from the bottom of said tube accumulate in the bottom portion of said vessel to seal the bottom of said tube, means for introducing a quenching liquid which is flashed on contact with the accumulated solids into the bottom portion of said vessel to fluidize accumulated solids therein, said bottom outlet being used to withdraw solids from said vessel.

5. An apparatus of the character described including in combination a vertically arranged vessel having a top outlet and a bottom outlet, a vertically arranged hollow open-ended tube entirely within said vessel and having its upper end spaced from and discharging into said vessel top outlet, said tube having its lower end spaced from the bottom of said vessel, a pipe extending through the wall of said vessel and into the upper portion of said tube and opening downwardly for introducing solids downwardly in said tube, a second pipe extending through the wall of said vessel and into the lower portion of said tube, said second pipe having its outlet end opening upwardly for the introduction of upflowing gas, said second pipe having a control valve exterior to said vessel, said vessel bottom outlet extending through the wall of said vessel and upwardly from the bottom thereof and above the bottom portion of said tube whereby solids passing from the bottom of said tube accumulate in the bottom portion of said vessel to seal the bottom of said tube, means for introducing a fluidizing medium into the bottom portion of said vessel to fluidize accumulated solids therein, said bottom outlet being used to withdraw solids from said vessel.

6. An apparatus according to claim 5 wherein said tube is an elutriation tube, said solids are hot fluid coke particles having a size range between about 40 and 5000 microns and said fluidizing medium is a quenching liquid which is flashed on contact with the accumulated solids and said second pipe is used to separately introduce elutriation steam into said elutriator tube.

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ALPHONSO D. SULLIVAN, *Primary Examiner.*