

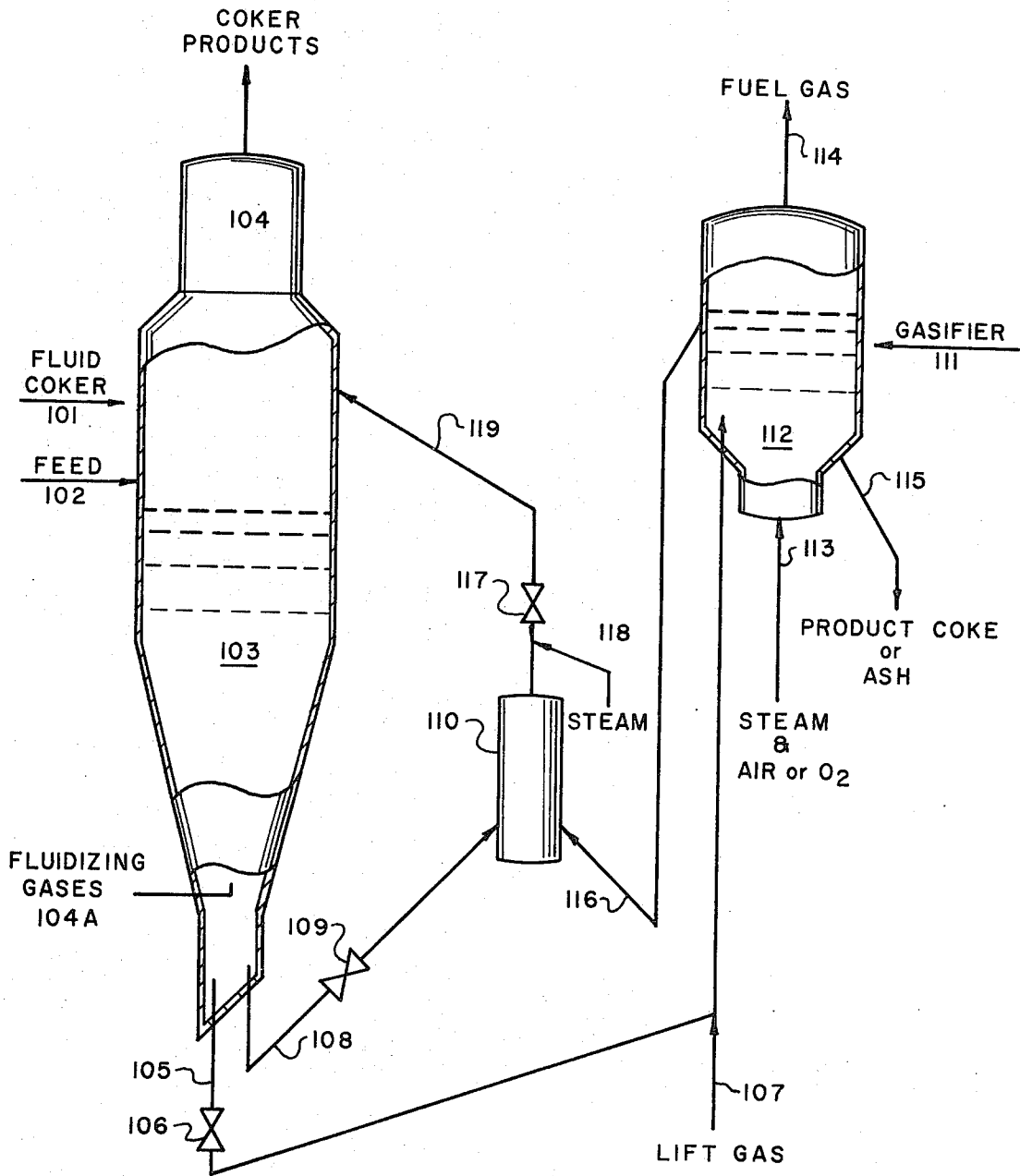
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3,694,346

INTEGRATED FLUID COKING/STEAM GASIFICATION PROCESS

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## INTEGRATED FLUID COKING/STEAM GASIFICATION PROCESS

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5 Claims

### ABSTRACT OF THE DISCLOSURE

The mixing of hot gasifier coke and cold reactor coke in a dense phase riser to exchange heat to be used in the coking reactor not only eliminates the need for the separate heater vessel, as well as high temperature slide valves, in a conventional fluid coking/steam gasification process, but also results in additional coker hydrocarbon products.

### BACKGROUND OF THE INVENTION

This invention relates to an integrated fluid coking/steam gasification process.

In an effort to increase the commercial worth of the coke product from a conventional fluid coking process such as the one described in U.S. Pat. 2,700,642 (filed May 8, 1951 by W. J. Mattox) efforts were made to steam gasify the coke to produce hydrogen and carbon monoxide which had a greater commercial value. The earliest efforts tried used only a two vessel system as shown by FIG. 1 in U.S. Pat. 2,527,575 (filed Dec. 4, 1945 by B. E. Roetheli). In this process the coke produced in the coker was fed directly into the steam gasifier. Some of the non-gasified coke was then transferred back to the coker to supply the heat required in the coker. However, such a process was very difficult to control because of the tremendous variation in the gasifier temperature. This temperature variation made controlling the heat input to the coker from the gasifier coke very undependable. Attempts at controlling the heat input by the use of slide valves in the transfer line were unreliable because of the extremely high temperature of the gasifier coke (1500°–2200° F.). Because of these difficulties a third burner vessel was employed generally between the coking reactor and the gasifying reactor. In such schemes the coke produced in the coking reactor was transferred to either the burner reactor, gasifier reactor or part to both. The hot coke (about 1800° F.) from the gasifier was transferred to the burner reactor operating at a temperature between 1100° and 1500° F. By transferring the gasifier coke to the burner vessel the control problems were substantially reduced although at a large capital expenditure for the second reactor. The heat needed in the coker was then supplied by the non-burned coke in the burner vessel. Thus the temperature fluctuation in the burner reactor was not great and the coke from this reactor much cooler (1000°–1300° F.) there was a substantial improvement in coker heat input control. Typical of the three vessel system is that shown in FIG. 2 of U.S. Pat. 2,527,574.

The advancements and variations in the prior art on integrated fluid coking/steam gasification process is exemplified by the following U.S. patents: 2,657,986 (filed Aug. 15, 1946 by F. T. Barr et al.); 2,657,987 (filed Oct. 12, 1946 by F. T. Barr et al.); 2,741,549 (filed Dec. 17, 1946 by F. R. Russell); 2,885,350 (filed Jan. 20, 1954 by J. W. Brown et al.); 2,888,395 (filed Mar. 29, 1954 by V. E. Henny); 2,894,897 (filed May 28, 1954 by H. E. Post); 2,917,451 (filed Dec. 31, 1954 by F. A. W. Leffer); and 2,985,512 (filed Apr. 14, 1959 by W. F. Arey, Jr.). As can be seen by an examination of the above exemplary

prior art the three reactor system which utilizes a burner reaction had undergone many changes and improvements, but a system without a burner reactor such as the invention described hereinafter had not been successfully developed.

It is an object of this invention to provide an integrated fluid coking/steam gasification process that overcomes the above mentioned disadvantages.

It is another object of this invention to provide an integrated fluid-coking/steam gasification process that does not utilize a separate burner reactor.

These and other objects will become apparent from the ensuing description of this invention.

### SUMMARY OF THE INVENTION

In an integrated fluid coking/coke gasification process that does not employ a conventional burner reactor, hot coke (1300°–2200° F., preferably 1600°–1800° F.) from a gasifier reactor is combined with cold coke (900°–1000° F., preferably 950°–975° F.) from a fluid coking reactor in a suitable means, such as a vertical dense phase riser, to obtain a mixture of coke having a temperature between 1000° and 1700° F., preferably between 1100° and 1400° F. This coke mixture is then recirculated to the fluid coking reactor to supply the heat requirements of that reactor.

### DESCRIPTION OF THE DRAWING

The figure is a cross-sectional drawing of the apparatus used in one embodiment of this invention.

### PREFERRED EMBODIMENTS OF THE INVENTION

A heavy hydrocarbon feed is introduced into fluid coker 101 by line 102 so as to contact a bed 103 of fluidized particles at a temperature between 900° and 1000° F. In this bed the feed is partially cracked to produce valuable light gaseous and liquid hydrocarbon products and coke. The gaseous and liquid products are carried upward to a fractionator 104 by the gases produced in situ and by the gases from line 104A used to fluidize bed 103. These products are then separated into the coker products desired. The coke produced in bed 103 then passes in part to a vertical dense phase riser 110 by line 108, and in part to gasifier 111 by line 105. The coke in the gasifier is then reacted with steam and air or oxygen from line 113 to produce fuel gas (H<sub>2</sub> and CO) which is removed from the gasifier by line 114. Part of the non-gasified coke which has been heated to temperatures between about 1300° and 2200° F. is removed from the gasifier and transferred to the vertical dense phase riser 110 by line 116. If desired part of the gasifier coke may be removed by line 115 and used to recover metals such as V and Ni in the ash and coke products.

In the vertical dense phase riser 110 the hot gasifier coke is mixed with the cold fluid coker coke to obtain efficient heat transfer between the coke. This mixture is transferred by line 119 to fluid coker 101 to provide the heat necessary for that reaction.

In general any type of carbonaceous material can be used in this process. Typical feeds used in a fluid coker would include crude oil, shale oil, heavy residua from a fractionator, atmospheric and crude vacuum bottoms, pitch, asphalt, other heavy hydrocarbon petroleum residua, or mixtures thereof. It is also possible to use a deashed coal, as well as, various other types of coals.

The feed contacts of the fluidized bed 103 which may comprise inert particles such as silica, alumina, zirconia, magnesia, alundum, mullite or the like. The bed could also comprise synthetically prepared or naturally occurring materials such as pumice, clay, kieselguhr, diatomaceous

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earth, bauxite or the like. However, preferably the bed will comprise coke particles having a diameter between about 40 and 400 microns, because such coke particles provide a large surface area on which additional coke can form.

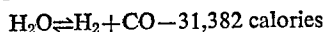
The bed is maintained in a fluidized condition by the fluidizing gases introduced at about the bottom of bed 103 from line 104A. Typical fluidizing gases would include N<sub>2</sub>, H<sub>2</sub>, steam, or flue gases. Also the gases generated in situ aid in the fluidization of bed 103.

To achieve the desired coke formation in the fluid coker the temperature of the fluidized bed should be maintained between 900° and 1000° F., preferably between 950° and 975° F. To maintain this temperature it is necessary to continuously add heat to bed 103. The amount of heat needed will vary depending upon the quantity and type of coker feed, whether or not the feed has been preheated before entering fluid coker 101 and to what temperature it has to be preheated, as well as, the temperature of the fluidizing gas. Therefore a dependable, highly flexible method of supplying heat to the fluid coker bed must be available. As stated hereinbefore the presently used method of a large, expensive burner reactor has many disadvantages that this invention has now eliminated.

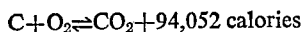
According to the preferred embodiments of this invention a portion of the coke produced in the fluid coker is transferred to the gasifier 111 by line 105. A lift gas, such as N<sub>2</sub>, flue gas and steam, preferably steam, from line 107 may be used to help transfer the coke to the gasifier. The amount of coke transferred will depend upon the rate of gasification and withdrawal of coke in the gasifier. It is preferred to transfer only as much coke as will be transferred to the dense phase riser and converted to a gaseous stream in the gasifier. In this manner the amount of low valuable coke produced will be held to a minimum and the amount of valuable light hydrocarbons produced in the coker increased. Since this amount may vary greatly, control means 106, preferably a slide valve, is used to regulate the rate of coke flow to the gasifier.

In the gasifier the coke is contacted with the particles that comprise fluidized bed 112. These particles may be composed of any of the materials that can be used in the fluid coker bed 103, but preferably the particles will be the same as those in the fluid coker bed, and most preferably they will be coke particles having a diameter between about 40 and about 400 microns.

Bed 112 is fluidized by the gases from line 113, as well as, by the gases produced in situ. The steam introduced through line 113 reacts with the coke to produce the desired fuel gas



Since this is a highly endothermic reaction it is also necessary to introduce air or oxygen into the bed in order to maintain the gasifier bed temperature between 1300° and 2200° F., preferably between 1600° and 1800° F. These oxygen-containing gases react exothermally with the coke as follows:



Because of this means to control both the temperature and the fluidity of bed 112, large variations in the temperature will occur in the bed with changes in the quantity of coke being gasified. Therefore the coke withdrawn from the gasifier 111 and transferred to the vertical dense phase riser 110 by line 116 may vary greatly in temperature.

In order to stabilize the temperature of the coke that goes from the riser 110 back to the fluid coker 101, cold coke (~950° F.) from the fluid coker is mixed with the hot coke from the gasifier in riser 110. In order to have the mixture of coke at the desired temperature of between 1000° and 1700° F., preferably between 1100° and 1400° F., control means 109, preferably a slide valve, is used to regulate the flow of the cold coke to the riser 110. This

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is an effective temperature control device since the temperature of the cold coke from fluid coker 101 does not fluctuate greatly. Therefore if the temperature of gasifier coke is very hot, large amounts of cold coke can be transferred to riser 110 and because of the stability of the cold coke temperature the amount needed can be determined accurately. If the temperature of the hot coke decreases sharply then control means 109 can reduce the rate of cold coke flow to the proper level. In this manner the coke from riser 110 to fluid coker 101 is maintained at the desired constant temperature.

If desired a second temperature control means 117 can be employed. The control means, preferably a slide valve, could prevent large amounts of coke at temperatures above the desired level from entering fluid coker 101 through line 119. In conjunction with control means 117, steam could be introduced through line 118 into line 119 to cool off the hot coke by the endothermic reaction



The steam from line 118 could also be used as a lift gas to aid the transfer of coke if desired. It is also possible that the steam from line 118 could be used even without control means 117.

By the use of the just described process to supply the heat needed in the fluid coker not only has a complicated, expensive burner vessel with its own fluidization and temperature control problems been eliminated, as well as, unreliable high temperature slide valves, but also greater coker product recovery is achieved as shown by the following example.

#### EXAMPLE I

Coke and valuable light hydrocarbons are produced in an integrated fluid coking-gasification process as described by this invention where the fluid coker is operated at a temperature of about 950° F. and the temperature of the gasifier is between 1600° and 1800° F.

A portion of the coke produced is transferred to the gasifier to be gasified and a second portion of the coke from the fluid coker is transferred to a vertical dense phase riser where it is contacted with enough hot coke from the gasifier to result in a coke mixture having a temperature of about 1200° F. This coke mixture is then introduced into the fluid coker to supply the necessary heat requirements.

Once this process is operating on a continuous basis a sample of the gaseous and liquid hydrocarbon product is removed and compared with the gaseous and liquid hydrocarbon product produced in the conventional fluid coking process. This comparison is seen in the table below.

	Typical coker products (wt. percent of fresh feed)				Coke to gasifier
	C <sub>3</sub> -	C <sub>4</sub>	C <sub>5</sub> /430	430/950	
Conventional fluid coking process.....	9.1	1.9	15.7	50.2	23.1
Process of this invention..	14.4	1.9	15.7	50.2	17.8

From this data it is clear that over a 50% increase in the valuable C<sub>3</sub>- product is obtained over the conventional fluid coking process. This is accomplished not by decreasing the amount of valuable, light other products produced, but by converting more of the less valuable coke to the more valuable light products as can be seen by the decrease in the amount of coke going to the gasifier.

This product distribution from the coker can also be varied by the greater reliable flexibility of this process. Thus with the process of this invention the temperature of the coke mixture recycled can be varied to produce the desired product distribution. This flexibility is illustrated in Example II.

#### EXAMPLE II

The process of this invention is operated according to the conditions described in Example I except the coke

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mixture is controlled in the vertical dense phase riser so as to result in a temperature of about 1050° F. This lower temperature coke mixture is then fed into the fluid coker in quantities sufficient to provide the necessary heat requirements. An analysis of the coker light products yields the following data.

	Typical coker products (wt. percent of fresh feed)				
	C <sub>3</sub> -	C <sub>4</sub>	C <sub>5</sub> /430	430/950	Coke to gasifier
Process of this invention which recycles 1,050° F. coke mixture to coker.....	11.8	2.2	16.2	52	17.8

Comparing this product distribution with the previous example when the recycle coke mixture was about 1200° F. clearly indicates the increased process flexibility available with the process of this invention.

We claim:

Having described, illustrated and given specific examples of our invention, what we claim as novel, useful and unobvious, and desire U.S. Letters Patent is:

1. An integrated fluid coking/gasification process which does not utilize a conventional burning zone which comprises:

introducing a heavy carbonaceous material into a fluid coking zone operating at a temperature between about 900° and about 1000° F., a portion of said material being converted to coke;

contacting a portion of said coke in a gasifying zone operating at a temperature between about 1300° and about 2200° F. with a sufficient amount of steam and a free oxygen containing gas to heat said portion of coke to a temperature between about 1300° and about 2200° F.;

contacting a portion of said heated coke with another portion of coke from the fluid coking zone in a dense phase riser, said portion of said heated coke and said another portion of coke being in quantities sufficient to bring said temperatures of said coke portions in said dense phase riser to between about 1000° and about 1700° F. after said contacting in said riser; and

transferring a portion of said cokes after said contacting to said fluid coking zone, said portion being suffi-

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cient to supply any heat needed in operating said fluid coking zone.

2. A process according to claim 1 wherein said portion of said coke in said gasifying zone operating at a temperature between about 1600° and about 1800° F. is contacted with a sufficient quantity of steam and a free oxygen-containing gas to heat said portion of coke to a temperature between about 1600° and about 1800° F.

3. A process according to claim 2 wherein said temperatures of said coke in said dense phase riser is between about 1100° and about 1400° F.

4. In an integrated fluid coking/gasification process which does not utilize a conventional burning zone and wherein a portion of coke at a temperature between about 1300° and about 2200° F. from a gasifying zone is transferred to a fluid coking zone to provide the heat needed in said fluid coking zone, the improvement which comprises:

first contacting said portion of coke from said gasifying zone with a portion of coke at a temperature between about 900° and about 1000° F. in a dense phase riser until said portions of coke in said dense phase riser are at a temperature between about 1000° and 1700° F.; and

transferring said contacted portions at a temperature between 1000° and 1700° F. to said fluid coking zone, said contacted portions being of sufficient quantity to provide the heat necessary to operate said fluid coking zone.

5. A process according to claim 4 wherein said portions of coke in said dense phase riser are at a temperature between about 1100° and about 1400° F.

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HERBERT LEVINE, Primary Examiner

U.S. Cl. X.R.

201—31, 44; 48—197, 206