July 10, 1973 V. D. ALLRED 3,745,110

THERMAL DECOKING OF DELAYED COKING DRUMS

Filed May 5, 1971 2 Sheets-Sheet 1

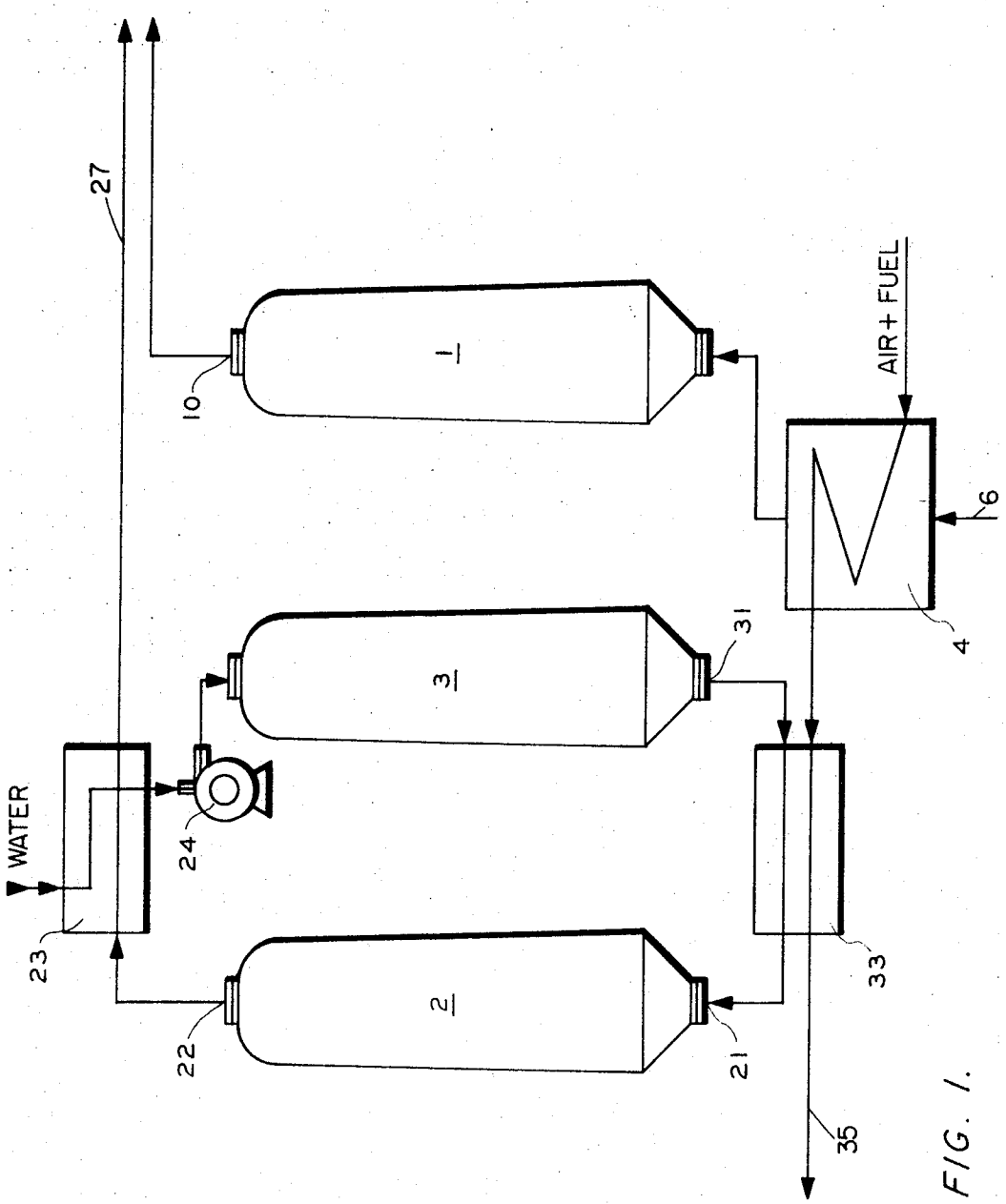


FIG. 1.

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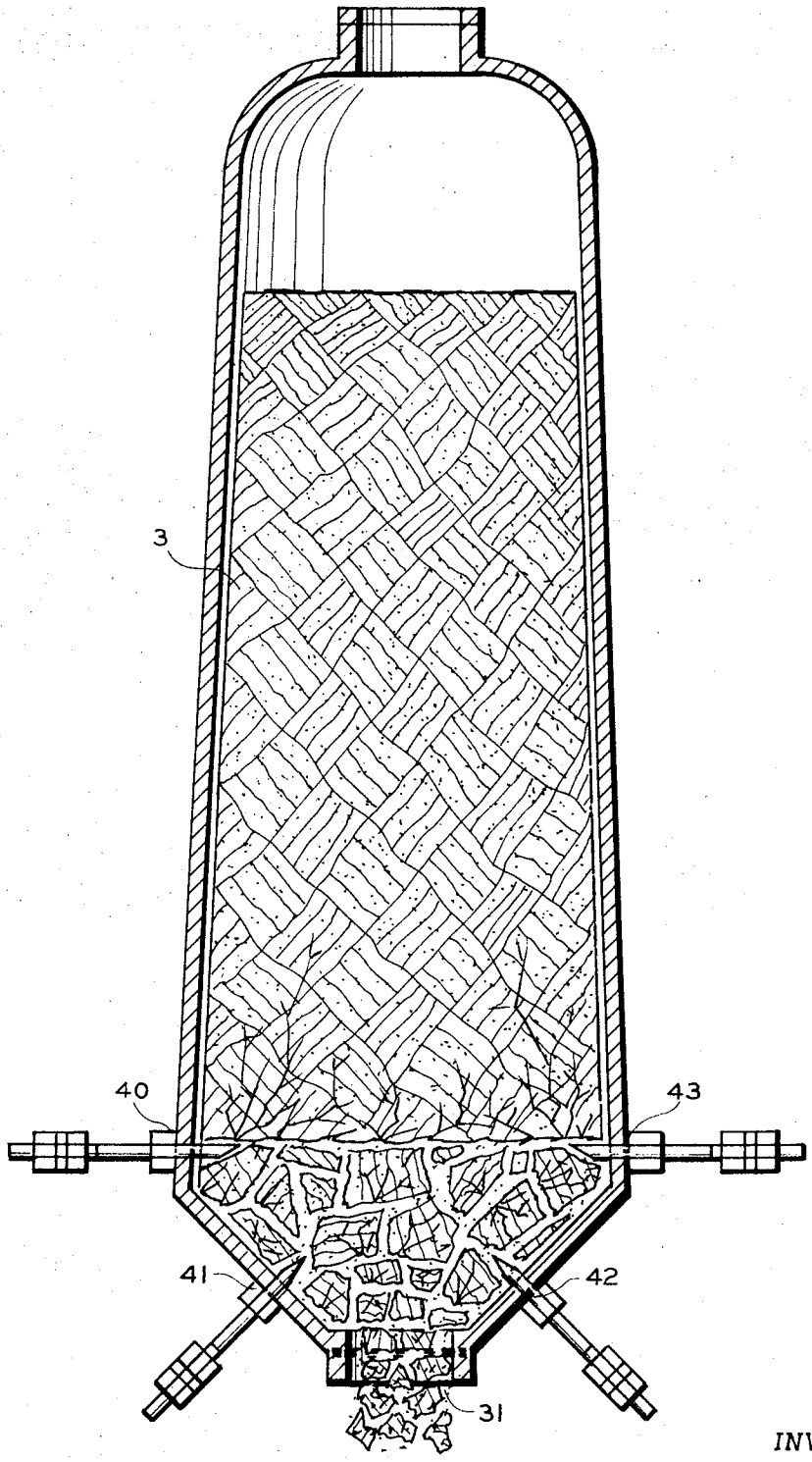


FIG. 2.

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THERMAL DECOKING OF DELAYED COKING DRUMS

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Int. Cl. C10g 9/14
U.S. Cl. 208—131 9 Claims

ABSTRACT OF THE DISCLOSURE

After completion of the delayed coking process and before removal of the coke from the coking drum, steam or other hot gases, e.g., at 1100 to 1500° F. are circulated through the drum to shrink the coke away from the drum walls and facilitate discharge of coke from the drum. Preferably the drum tapers gradually from bottom to top and a bottom outlet of the drum communicates with a device for comminuting the coke.

CROSS REFERENCES TO RELATED APPLICATIONS

No related U.S. patent applications are known to the inventor.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to the delayed coking of hydrocarbons generally classified in U.S. Patent Office Class 208, subclass 131, Class 202–221, Class 202–241, Class 201–2 and Class 201–3.

The delayed coking process for the formation of coke from hydrocarbons is long established and well known. Briefly, the process consists of heating such hydrocarbons to temperatures sufficient to cause them to coke and immediately and rapidly running the hot hydrocarbons into a relatively quiescent chamber generally known as a "coking drum." Coking occurs in this drum with the non-cokable volatilized hydrocarbons being evolved, generally from the top of the drum, and conveyed to other refining processes. After the coking is complete, the coke drum is usually unloaded by removing large manhole covers or doors from the top and bottom of the drum which is, in most cases, a vertical cylinder with conical or rounded ends. The delayed petroleum coke is a hard dense material which is removed from the drum only with difficulty. Probably the most common method of removal of the coke is the use of high pressure e.g., 800 to about 2000 p.s.i.g. water drills which cut out chunks of the coke and permit them to fall through the lower outlet of the drum. This process is continued until the drum is empty after which it is again refilled with hot cokable hydrocarbons.

The disadavntages of these processes include the difficulty in maneuvering the high pressure water drills in the relatively confined space of the coke drum, the time required to cut out chunks of relatively hard dense coke, and the need for handling the "green" or uncalcined coke and transporting it to a calciner.

Description of the prior art

A search in the United States Patent Office disclosed the following prior art: U.S. 2,218,130 which shows a water jet for cutting coke; U.S. 2,302,299 which shows coke cutting water nozzles **12** at points **2** and **3**; U.S. 2,390,197 which shows lift means **15–17**; and U.S. 2,941,928 which shows a cutter **21** and which injects steam through inlet **27** to sweep away hydrocarbons and prevent coke deposition on the rotating shaft **13** which drives a circular cutter mechanism. Coking and calcining in a single unit is taught by U.S. 3,391,076.

SUMMARY OF THE INVENTION

General statement of the invention

According to the present invention, hydrocarbons are conventionally coked in delayed coking drum and circulation of steam or other hot gases, e.g., nitrogen, methane, hydrogen, carbon monoxide or carbon dioxide or combinations thereof, are circulated through the drum to shrink the coke away from the drum walls and to facilitate discharge from the drum. Preferably this circulation is accomplished after the delayed coking process is substantially completed and before removal of the coke from the drum.

None of the above patents appear to disclose the use of high temperature gases to cause contraction of the coke mass filling the drum in order to facilitate its removal from the drum. It has been discovered that contact with these hot gases causes the coke to shrink, effectively separating it from contact with the walls of the drum and greatly facilitating the otherwise notoriously difficult removal of the coke from the drum.

Utility of the invention

Cokes are used for a variety of well known industrial purposes including the inoculation of carbon into steels and other alloys and the production of electrodes for aluminum refining and other purposes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a "swing" system employing three coke drums according to preferred embodiments of the present invention.

FIG. 2 shows schematically a tapered coke drum comminution device for use in the practice of preferred embodiments of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Starting materials

Hydrocarbons: The hydrocarbons for use with the present invention can be any of those which can be subjected to delayed coking. Particularly preferred are petroleum residua, i.e., vacuum tower bottoms, atmospheric tower bottoms, thermal tars, steam cracker bottoms, etc.

Other usable hydrocarbons include Gilsonite and coal tar pitches, shale oil and tar sand residua.

Hot gases: While steam is the preferred hot gas, other gases which can be employed comprise nitrogen, methane, hydrogen, carbon monoxide, carbon dioxide, or other thermally stable unreactive gases, and combinations of the foregoing. In general the composition of the hot gas is not narrowly critical so long as the gases do not undesirably react with the coke produced.

Of course, the conventional processes for the preparation of delayed coke sometimes injects steam or other gases during the coking process. The present invention must be carefully distinguished by its teaching that the gases are injected after the coke is substantially complete. Of course, the present invention can also include the conventional step of injecting gases into the coker during the coking process if this is desirable in connection with the particular hydrocarbon being coked.

Temperature: The temperature of the gases employed will be in the range of from about 1000 to about 1800° F., more preferably from about 1100 to about 1500° F., and most preferably from 1200 to 1300° F.

Pressure: The pressure, while not narrowly critical, will preferably be in the range of from about atmospheric to about 5 atmospheres. Pressure will, in most instances, be nearly atmospheric, but elevated pressures can be utilized where desired, e.g., to maintain a higher degree of satura-

tion of the gases being injected at the temperature in question. Further, sharp increases or decreases in pressure including the cyclic increases or decreases in pressure can be employed where desirable to further augment the loosening of the coke from the drum.

Time: While also not narrowly critical, the duration of the injection of hot gases will generally be in the range of from about 1 to about 48 hours, more preferably from about 6 to about 24, and most preferably 12 to about 18 hours. These times are measured from the substantial completion of the coking process. In general, routine trial runs will readily establish the minimum time necessary to obtain adequate shrinkage and loosening of the coke.

Example: A reduced crude oil **6** from the distillation of crude petroleum is heated to a coking temperature of 1000° F. (generally such heating will be in the range of from 700 to 1200, and more preferably from 880 to about 960° F.) in a coking furnace **4** shown in FIG. 1. The hot hydrocarbons from this coking furnace pass into coke drum **1** until the coke drum is about three-quarters full. This filling of the coke drum is done over a period of approximately 22 hours. The vaporized portions of the hydrocarbons fed to the coke drum pass out of the drum through the top outlet **10** and go onto a distillation or partial condensation in which they are separated into fractions which are recovered. After the coke drum is about three-quarters full, addition of hydrocarbons is discontinued. The coke remains as a solid mass in the shape of the coke drum which is approximately 15 feet in diameter and about 60 feet high. (Coking times are generally in the range of from about 6 to about 30 hours, more preferably from 12 to about 20 hours, during which time the hot hydrocarbon polymerizes and solidifies as delayed coke.)

Superheated steam at a temperature of approximately 1300° F. is then injected through the bottom of the drum.

While coke drum **3** is being filled, coke drum **2**, previously filled with coke, is injected with steam at 1350° F. through its bottom outlet **21**, the steam passes upward through the body of coke in drum **2** and exits through top outlet **22** into a steam-water heat exchanger **23** which generates additional quantities of steam. The effluent **27** from heat exchanger **23** contains waste heat and volatiles which can be recovered by conventional partial condensation processes.

Approximately 24 pounds of steam are injected per pound of coke. The steam injection is continued for approximately 16 hours during which time the coke shrinks away from the walls of the coke drum.

Simultaneously, steam generated in heat exchanger **23** is pumped into coke drum **3** by means of compressor or blower **24**. This steam has an entry temperature of approximately 250° F. However, coke drum **3** is full of coke which has been steamed as previously described for coke drum **2**. The 250° F. steam therefore serves to cool the 1250° F. coke in coke drum **3**. Steam exits from the bottom outlet **31** of coke drum **3** at a temperature of approximately 1250° F. This steam passes through heater **33** where it is further heated to an outlet temperature of about 1300° F. by heat exchange with the combustion gases **35** exiting from coker furnace **4**. Exit steam from heater **33** is then injected into coke drum **2** as described above.

All three of the coke drums are operated on a "swing" basis so that, upon the completion of the coking in coke drum **1**, coke drum **1** is treated as described above for coke drum **2**, coke drum **2** is then treated as described above for coke drum **3**. The contents of coke drum **3** are then discharged as described below in connection with FIG. 2.

FIG. 2 shows a detail of coke drum **3** after completion of the cooling cycle described above. The substantially unbroken coke mass has shrunk away from the sidewalls of the drum. The walls of the coke drum are tapered slightly to aid in dislodging the coke mass. A series of pneumatic or hydraulically powered chisels are inserted into inlets **40, 41, 42** and **43** which have been uncapped at this point in the process. These tools are then operated to provide a shearing action on the coke. Broken coke then falls through bottom outlet **31** of coke drum **3**. The mass of unbroken coke gradually slides down until all of it has been fragmented by the action of the chisels and has fallen through outlet **31**. It is important to note that the coke emerges in a substantially dry state ready for calcining or shipment.

It is an important advantage of the present invention that the coke product does not require drying as is necessary with coke which has been dislodged by conventional hydraulic drilling, the fines of the valuable coke product are preserved and the product coke can be segregated by its position in the coke drum. This is advantageous because it is well known that coke at the bottom of the drum has a higher coefficient of thermal expansion and a higher density than that produced in the upper portion of the coke drum.

MODIFICATIONS OF THE INVENTION

It should be understood that the invention is capable of a variety of modifications and variations which will be made apparent to those skilled in the art by a reading of the specification and which are to be included within the spirit of the claims appended hereto. For example, the entire bottom of the coke drum may be hinged so that the solid core of coke may be dropped out without any substantial crushing. Alternatively, the solid mass of coke can be lowered gradually through the opening left by the removed bottom and the mass can be sawed or otherwise broken into pieces of manageable size.

What is claimed is:

1. In a process for the delayed coking of hydrocarbons, the improvement comprising circulating hot gases having a temperature of from about 1000 to about 1800° F. through a delayed coking drum to shrink the coke away from the drum walls and facilitate discharge from the drum by allowing coke to fall from the upper portion of the drum as the lower portion of the coke is removed. said circulation of hot gases occurring after said delayed coking process is substantially complete and prior to the removal of the coke from the drum, wherein said coke drum is a substantially vertical cylinder except that the diameter of said drum gradually increases from the top to the bottom of the principal section of the drum.

2. A process according to claim **1** wherein the hot gases comprise steam.

3. A process according to claim **1** wherein the hot gases comprise gases selected from the class consisting of: steam, nitrogen, methane, hydrogen, carbon monoxide, carbon dioxide and combinations of the foregoing.

4. A process according to claim **1** additionally comprising comminuting the coke after its dislodgement from the walls of said drum, said comminution being accomplished by means of a comminution device located in communication with a bottom portion of said coke drum.

5. A process according to claim **1** wherein the hot gases have a temperature in the range of from about 1100 to about 1500° F.

6. A process according to claim **3** wherein the hot gases have a temperature in the range of from about 1100 to about 1500° F.

7. A process according to claim **4** wherein the hot gases have a temperature in the range of from about 1100 to about 1500° F.

8. A process according to claim **1** wherein the coke is comminuted by reciprocating comminution devices projecting into the interior of the coke drum.

9. A process according to claim **8** wherein there are present a plurality of said coke drums and wherein steam passing through a first coke drum containing a coke mass which has previously been shrunken away from its walls, cools said coke drum, is itself heated and then enters another drum containing a mass not yet shrunken

away from the walls at initial introduction of such steam at temperatures of from about 1100° F. to about 1500° F.

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201—2; 202—221, 241