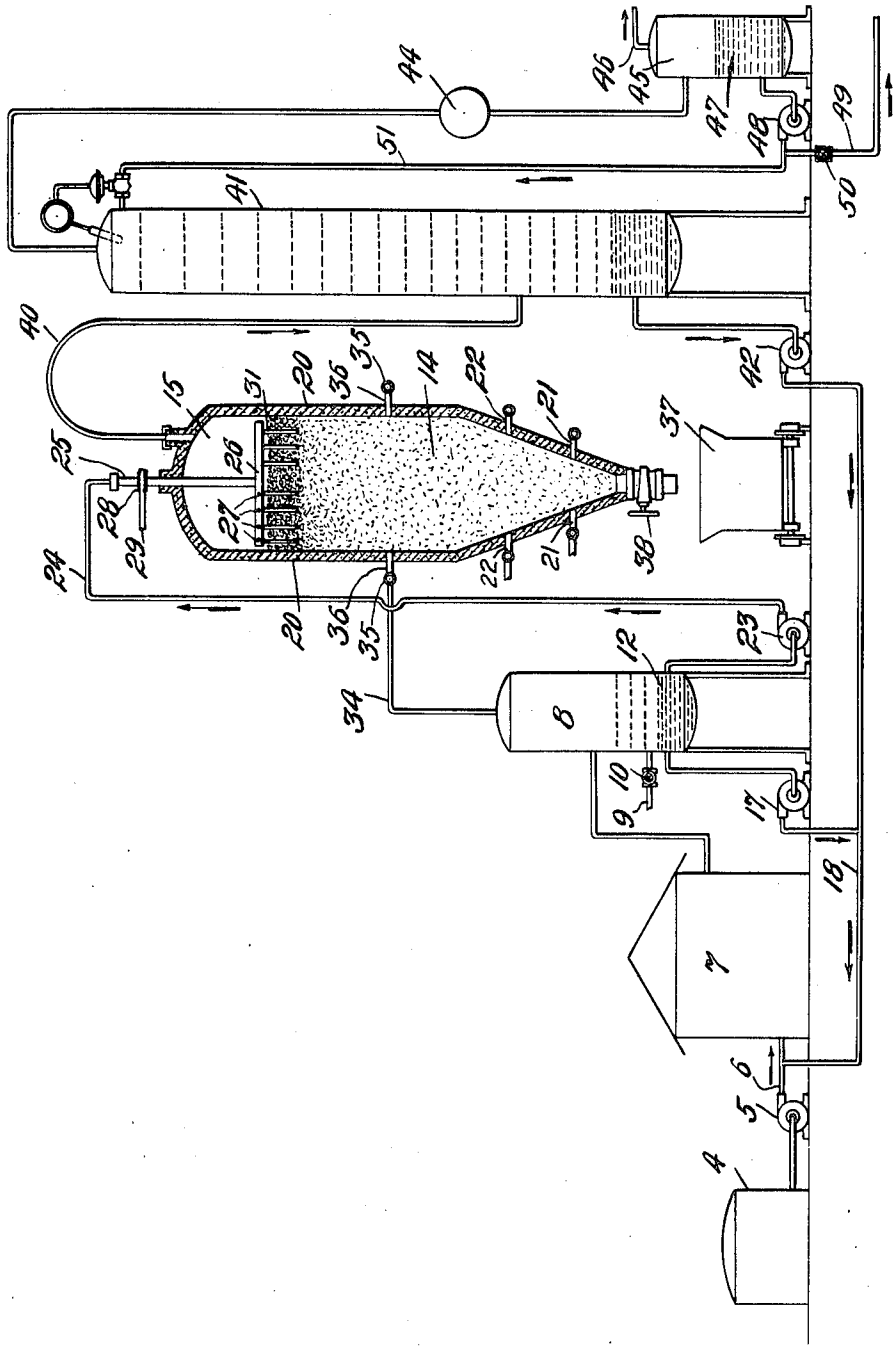
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CRACKING HYDROCARBONS IN THE PRESENCE OF GRANULAR COKE

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CRACKING HYDROCARBONS IN THE PRESENCE OF GRANULAR COKE

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1 Claim. (Cl. 196—55)

1

This invention relates to the refining of petroleum and aims to provide an improved method of cracking hydrocarbons.

It is a particular object of my invention to provide a method of cracking hydrocarbons in the vapor phase so that a high yield of aromatics (benzene, toluol and styrene) and of unsaturates (ethylene, butylene and butadiene) is obtained.

In the refining of petroleum is has long been common practice to crack petroleum hydrocarbons, usually under pressure, in stills having metal walls through which heat is supplied. If the cracking be continued to the extent necessary to produce the desired high yield there is deposited on the walls of the still a hard, tenacious crust which builds up in thickness until it becomes necessary to interrupt the cracking operations and remove the crust from the walls of the still. This is a troublesome and expensive operation. When the cracking is not continued to the end point, there remains a by-product of low value commonly known as "pressure tar."

Another process which has been used to some extent involves spraying petroleum hydrocarbons upon a bed of coke which is heated from below. The bed upon which the petroleum is deposited becomes, after a time, a dense mass so that it is necessary to discontinue operations in order to remove the bed and start afresh. Furthermore, the volatile fractions tend to vaporize as soon as they are heated to their boiling points and consequently may fail to reach the high temperature of the coke bed which is necessary for the production of any appreciable quantity of aromatics or unsaturates.

I have discovered that hydrocarbons in the vapor phase may be cracked continuously to yield a high percentage of the aromatics and unsaturates. In accordance with my invention, hydrocarbons are introduced into a deep incandescent bed of loose granular coke at a point spaced below the top of the bed so that they are forced to flow through a substantial portion of the bed. The desired temperature of the bed is maintained by burning coke at the bottom of the bed and depletion of the bed is prevented by coking liquid hydrocarbons at the top of the bed.

Other features, objects and advantages of my invention will in part be pointed out and in part become apparent in connection with the following detailed description of a mode of practicing my invention, reference being made to the accompanying drawing which shows, somewhat diagrammatically, an apparatus for carrying out my method.

2

The apparatus illustrated in the drawing includes a tank 4 from which the charging stock is delivered, by means of pump 5 and conduit 6, to heater 7 and thence to flash pot 8 where volatile fractions of the stock are distilled off. The volatilization of those fractions may be increased by steam delivered to flash pot 8 through pipe 9 controlled by valve 10. It is of importance that this distillation be carried out at a temperature which is less than the coking temperature of the stock, and which may be in the neighborhood of 900° F.

The vaporized fractions are introduced into a deep bed 14 of loose granular coke contained in chamber 15 and rendered incandescent by burning coke at the bottom of the bed. The supply of coke in chamber 15 is maintained by feeding the liquid fractions 12 to the top of bed 14 where they are coked. If the quantity of the liquid fractions 12 in flash pot 8 should be greater than is required for this coking operation, the excess may be recycled through heater 7 by means of pump 17 and conduit 18.

The chamber 15 is of the type illustrated and described in my co-pending applications, Serial No. 401,701, filed July 10, 1941 (which issued as Patent No. 2,323,501 on July 6, 1943), and Serial No. 407,409, filed August 19, 1941. The walls 20 are composed of a refractory material and are provided with inlets 21 for the admission of air to support combustion at the bottom of the bed 14. Inlets 22 are provided for the admission of steam or natural gas, or both, to prevent the temperature in the combustion zone from becoming higher than is desired. The liquid fractions 12 are fed to the chamber 15 by means of pump 23 and conduit 24 which communicates with hollow shaft 25. Radial arms 26 are fixed to the hollow shaft 25 and are provided with orifices 27 through which the liquid fractions 12 are fed to the top of bed 14 where they are coked.

The shaft 25 is mounted for rotary movement and is driven as by means of pulley 28 and belt 29. Rabbling fingers 31 are attached to arms 26 and project downwardly into the upper portion of coke bed 14 so that they rake the upper portion of the bed when shaft 25 is rotated and prevent the formation of a crust. The speed of rotation of shaft 25 and the rate at which liquid fractions 12 are fed through orifices 27 are such that the liquid is always sprayed upon a freshly rabbled portion of the surface of bed 14, which is not again rabbled until substantially all of those liquid fractions have been coked.

The vaporized fractions from flash pot 8 are

introduced into the bed 14 by means of conduit 34 and annular conduit 35 with which a series of inlets 36 communicate. Two of the inlets 36 are shown in the section which is illustrated in the drawing. Those inlets 36 are spaced above the combustion zone and well below the upper portion of bed 14 so that the vaporized hydrocarbons which are introduced into bed 14 through inlets 36 are caused to flow with the hot gases of combustion through a substantial portion of the incandescent bed and through the coking zone at the top of the bed. Any ash or excess coke which is formed may be discharged from chamber 15 to car 37 through valve 38.

The vapors are withdrawn from the top of chamber 15 through conduit 40 to fractionating column 41 where the higher boiling fractions may be condensed and then recycled through pump 42 and conduit 18 to the heater 7 where such condensate mixes with the charging stock. The vapors and fixed gases pass through the fractionating column 41 into a condenser 44 and thence into a separator 45 from which the low boiling hydrocarbons and fixed gases are exhausted through a line 46 to a conventional recovery system (not shown) for the separation and recovery of ethylene, butylene, butadiene, etc. The condensate 47 may be passed to storage by means of pump 48 and line 49 controlled by valve 50, or a portion of it may be returned to the fractionating column 41 through line 51.

In carrying out my method, I start operations by introducing a deep bed of granular coke into the chamber 15. By granular coke I mean loose, hard particles of carbonaceous material but I do not mean that the coke is necessarily very fine. I have found that granules ranging in size from ¼ inch to ¾ inch are very satisfactory. As the operations continue, new coke is formed and gradually descends, together with carbon formed during the cracking operation, into the combustion zone and the bed 14 remains open for the passage of gas and vapor.

Operations are conducted so that the temperature in the combustion zone ranges from 2800° to 3200° F.; the temperature at the upper portion of the bed ranges from between 1100° to 1400° F.; and the temperature at the portion of the bed where the vaporized hydrocarbons are admitted

ranges from 1400° to 1800° F. The higher temperatures are preferred. The vaporized hydrocarbons flow upwardly through a substantial portion of incandescent bed 14 with the hot gases of combustion which provide a non-oxidizing atmosphere. As a consequence, those hydrocarbons attain the elevated temperatures at which they are cracked to produce a high percentage of aromatics (benzene, toluol and styrene) and of unsaturates (ethylene, butylene and butadiene).

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What I claim is:

The method of cracking hydrocarbons in the vapor phase which comprises distilling from petroleum stock fractions which volatilize below the coking temperature of the stock, maintaining a deep incandescent bed of loose granular coke by burning coke at the bottom of the bed and coking the liquid residue of said stock at the top of the bed, and introducing the vaporized fractions of said stock into the incandescent bed at a point spaced below its top so that they are caused to flow through a substantial portion of said bed.

MALCOLM H. TUTTLE.

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