Sept. 20, 1949. A. H. SCHUTTE 2,482,140

METHOD FOR HYDROCARBON CONVERSION

Original Filed May 28, 1948

Fig. 1.

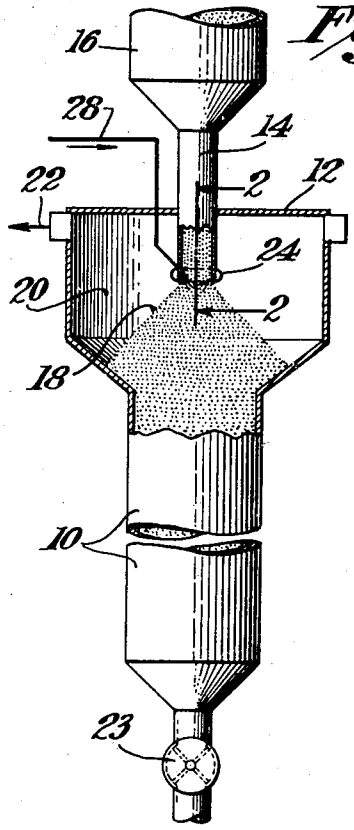
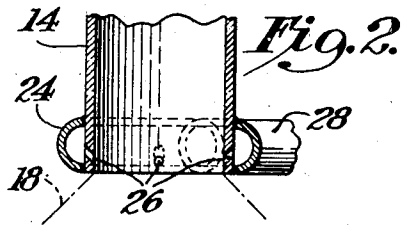


Fig. 2.



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METHOD FOR HYDROCARBON CONVERSION

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3 Claims. (Cl. 196—52)

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This invention relates to hydrocarbon conversion and in particular to the formation of coke concurrently with the vaporization and cracking of heavy hydrocarbons such as "bottoms" and hydrocarbon residuals wherein the coke formed in the aforesaid reaction is deposited on discrete particles of a free-flowing non-agglomerating bed moving continuously by gravity alone. It is a continuation-in-part of my copending application Serial No. 577,707, filed February 13, 1945, and entitled Improvements in converting hydrocarbons, and a division of my copending application Serial No. 29,751, filed May 28, 1948, and entitled Hydrocarbon conversion.

It is an object of this invention to make novel provision for the uniform distribution of liquids on the particles of the continuously moving gravity packed bed of contact material which moves downward through a sealed reaction chamber solely by gravity.

It is a further object of this invention to provide a new and improved method for securing the conversion of a hydrocarbon liquid in the presence of a continuously moving bed of contact material wherein the particles are uniformly coated with the non-vaporizable portion of the hydrocarbon.

Further objects and advantages of my invention will appear from the following description of preferred forms of embodiment thereof taken in connection with the attached drawings in which:

Fig. 1 is a schematic vertical section of a part of a reaction unit showing one form of liquid distributing means; and

Fig. 2 is a vertical cross section on the line 2—2 of Figure 1 on an enlarged scale.

In accordance with my above mentioned application and as pointed out in a copending application Serial No. 3,747, filed January 22, 1948, such application being a continuation-in-part of an earlier application Serial No. 510,119, filed November 13, 1943, and now abandoned, of which I am a coinventor, the disposition of heavy hydrocarbon by-products of cracking, distillation and like operations, comprising bottoms, tars and the like has represented a major operating problem in the petroleum industry. While it has been recognized that the conversion of a part of these by-products to coke along with the formation of useful and valuable conversion products would solve this problem, at least to a large degree, all former attempts have resulted in the use of expensive, complicated and cumbersome mechanisms difficult to service and of relatively low efficiency.

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The present invention is particularly adapted to the uniform distribution of these heavy hydrocarbon feeds in liquid or substantially liquid form into a compact, free-flowing gravity packed bed made up of discrete porous solid particles which move downward solely by gravity and in which the control of temperature and rate of feed of the charge and temperature and rate of feed of the bed, as well as the provision of a predetermined length of travel for bed particles, is so arranged as to avoid agglomeration. It has thus been found possible to obtain the continuous desired vaporization of the lighter portions of the charge and to form a coke coating on the discrete particles.

It is to be noted, however, that the uniform distribution of the charge is of substantial importance for if agglomeration occurs the bed stops moving and local low temperatures develop and the entire mass may tend to stop flowing.

I have found that it is desirable to avoid the introduction of any air or oxygen containing gas into the reaction chamber to prevent the formation of combustion products which would tend to dilute the vapors resulting from the hydrocarbon conversion. It is also not only unnecessary but undesirable to increase the temperature of the bed as it flows downward by gravity and preferably the hotter portion should be established at the top so that there is no tendency of the rising vapors to condense and coke on the surface of the reactor.

More particularly, referring to the drawings, Figure 1 represents a pilot plant size unit the main body 10 of which consists of a tube of nominal diameter surmounted by a hopper top generally indicated at 12 through which projects the contact material inlet pipe 14. The contact material in turn is contained in a hopper 16 and the contact material in passing through the inlet pipe 14 into the large chamber 10 will form a flowing pile of material the outline of which is shown at 18. The angle of this pile or mass is a function of the angle of repose of the material.

Between the top of the pile 18 and the dome of the hopper 12 is a vapor releasing space generally indicated at 20 from which the vapors may be removed through the line 22. It will, of course, be understood that the contact material moves downward by gravity out the bottom of the tube 10. Usually a control valve 23 is provided in the outlet pipe.

The feed spreader or distributor in the present

apparatus is generally indicated at 24 and as more particularly shown in Figure 2, it consists of a circular or annular ring which is mounted adjacent the end of the granular particle inlet 14. Conveniently this may be mounted directly on the end of the tube 14 and is preferably provided with a series of apertures 26. In the particular case there are four which are spaced substantially uniformly around the periphery of the tube 14. As shown in large cross section in Figure 2, the openings are on an angle so that the contact material which passes down through the conduit 14 and as it flows into the piles 18, will be completely coated with the charge. The hydrocarbon inlet is indicated at 28.

It will thus appear that the feed is applied to opposite sides of the stream of the discrete bed particles while said particles are confined in the inlet pipe 14 and when they are undergoing movement in the flowing piles from the material inlet to the reactor chamber 10. Uniformity of feed is assured; no liquid will be thrown against the wall and premature coking will be avoided. The construction is simple and effective and the feed openings are continuously kept clean by the movement of the particles across their surface.

The discrete particles of contact material may be either inert porous contact material such as "Kopper's" coke, petroleum coke, Alundum, Carborundum, or other materials or, alternatively, it may be of a catalytic type such as silica gel or other known catalyst depending upon the reaction desired. Preferably the bed particles are maintained in a range of from $\frac{1}{8}$ in. to $\frac{3}{4}$ in. major dimension and they may be in lump, pellet or extruded form. For the conversion of heavy hydrocarbons, it is sufficient if they are introduced in the inlet 14 at a temperature at from 800° F. to 1300° F. The hydrocarbons will, of course, be introduced at a suitable temperature in the usual range of 700° F. to 900° F. The vapors under such conditions will be of prime value for further cracking, usually having a gas oil composition with low carbon content so that they may be directly introduced into a conventional catalytic cracking unit for the production of high grade gasoline. If a cracking reaction is desired, the contact material being catalytic, and the temperatures and charge being adjusted accordingly, the vapors will of course be of high quality gasoline type.

Ordinarily the reaction is carried out at relatively low pressures which may range between 2 pounds p. s. i. g. and 60 pounds p. s. i. g. largely depending upon the pressure required to convey the product vapors to subsequent process equipment.

Upon spreading the feed upon the bed particles a part thereof is "flashed off" or evaporated upon contact with the hot bed particles and withdrawn as useful vapors which may be taken off, for further processing, to any suitable station. The remainder of the feed which does not "flash off" or evaporate is taken up or received by particles substantially entirely whereby formation of sticky films between the discrete bed particles sufficient in depth or thickness to destroy the free

flowing properties of the bed is totally obviated. As much as 50% of oil by weight to contact material may be applied without causing agglomeration depending upon the nature of the contact material. An entirely impervious material such as beach gravel will ordinarily receive about 10% by weight of hydrocarbon under my operating conditions.

As these loaded bed particles pass downwardly by gravity as a column of greater horizontal cross sectional area than the streams through the body of the reactor 10, sufficient residence time is provided for the coking reaction to proceed to completion or, in other words, for the liquid hydrocarbon load on the particles to be thermally converted or cracked into lighter hydrocarbon vapors which pass up through the bed to the vapor outlet 22, leaving a residue of dry coke deposit. The particles in this condition pass out of the reactor through the outlet 23. This residence time at the normal operating temperatures may range from 10 to 30 minutes. In such case a depth of bed below the feed point must be provided which is greater than the free flowing depth of the charge which at the temperatures under consideration has a viscosity of about one tenth that of water. A minimum depth of five feet and a preferred depth of thirty to fifty feet is the range for most effective dry coke formation.

While I have shown and described a preferred form of embodiment of my invention, I am aware that modifications may be made thereto and I therefore desire a broad interpretation of my invention within the scope and spirit of the description herein and of the claims appended hereinafter.

I claim:

1. In a process for conversion of a charge of high boiling liquid hydrocarbons in the presence of a substantially compact column of moving particle form solid contact mass material moving through an elongated conversion zone, the method for introduction of contact material and liquid hydrocarbon charge into said conversion zone which comprises: introducing particle form solid contact material into the upper end of said conversion zone in a confined, substantially compact stream of downwardly moving particles, said stream delivering said contact material to said column which is of substantially greater horizontal cross-sectional area than said stream, and injecting a stream of high boiling liquid hydrocarbon charge into said stream near the lower end thereof.

2. The process as defined in claim 1 in which a plurality of streams of high boiling liquid hydrocarbon charge are injected into said stream of contact material at peripherally spaced points near the lower end thereof.

3. The process as defined in claim 1 in which a plurality of streams of high boiling liquid hydrocarbon charge are injected into opposite sides of said stream of contact material at points above the lower end thereof.

AUGUST HENRY SCHUTTE.

No references cited.