STEAM CRACKING PROCESS

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3 Claims. (Cl. 196—63)

This invention relates to a process for converting hydrocarbons, particularly petroleum naphthas and gas oils. It is more particularly concerned with an improved steam cracking process wherein the cracked products are rapidly cooled in a fluidized solids cooling system of special design.

In brief compass, the present invention is directed to an improvement of a steam cracking process wherein an oil such as a gas oil is diluted with steam and subjected to cracking temperatures in the order of 1300° F. in a cracking coil to obtain chemicals and chemical intermediates. The improvement comprises introducing the high temperature effluent from the cracking coil into a transfer line quench zone which contains relatively cool particulate solids. The effluent is thereby quenched to a temperature in the range of about 800° to 1000° F. and a small amount of liquid residue or tar is deposited on the solids. Solids are separated from the cooled vapors in a cyclone. The vapors may then be further cooled by quenching with a relatively cool quench oil. The separated solids are passed to a cooling zone. The cooling zone contains a bed of fluidized solids and a coolant such as water is circulated in indirect heat transfer relationship with the bed to maintain the temperature of the bed at about 100° to 300° F. below the temperature in the transfer line quench zone. Cool solids are circulated from this fluid bed to the quench zone to cool further amounts of the cracking coil effluent.

The process of steam cracking of selected petroleum fractions is well known by the art. In this process a petroleum fraction having a boiling range within the limits of about 350° to 900° F. is vaporized, diluted with steam, and cracked in a coil at a temperature in a range of about 1200° to 1600° F. Residence times are relatively short being in the range of about 0.5 to 5.0 seconds. The products are immediately quenched to a temperature below about 700° F. to arrest further reactions and to prevent undue loss of the primary conversion products. This quenching is customarily accomplished by injecting water or a cooled oil such as a cycle stock into the high temperature cracked mixture.

Until now, there has not been a satisfactory method developed for quenching the effluent from the steam cracking coil without forming coke deposits in the lines containing the vapors. Coke deposits form at the point of quenching and beyond. Such coke deposits rapidly cause blockage and shut down of the equipment. To circumvent this difficulty, it is the current practice to use a transfer line dual liquid quench system which is alternately coked and cleaned. The coke is removed by shock cooling the quench point which causes the coke to break away from the pipe walls and then get carried into the bottom of the main fractionator handling the vapors. This system of quenching makes frequent turnarounds necessary because of coke accumulation in the bottom of the primary fractionation tower.

It is an object of this invention to devise an improved steam cracking process that overcomes these difficulties and others. A more particular object is to develop a fluidized solids quench system for cooling the high temperature effluent from a steam cracking coil.

The drawing attached to and forming a part of the specification serves to illustrate this invention. The drawing depicts one preferred embodiment of this invention and is presented by way of illustration only. For convenience, the pertinent operating conditions applicable to this drawing are summarized in Table I presented hereinafter.

Referring now to the drawing, an oil such as a light gas oil, which in this case has been previously vaporized, although this is not necessary, is admitted to the process by line 1 and is admixed with a substantial amount of steam supplied by line 2. The resulting mixture is passed through a cracking coil 3 and heated to a high temperature. The effluent therefrom in line 4 is immediately admitted to a transfer line quench zone 5 and contacts cool solids which quickly quench the mixture to temperatures below cracking temperatures.

Any convenient particulate solid may be used in the practice of this invention such as sand, finely divided mullite, pumice, kieselguhr, spent catalyst, coke and similar materials. The cool solids are supplied to the quench zone in amounts sufficient to absorb substantially all of the tar or heavy liquid residue in the cracked products. The amount of material condensed is small, amounting to about 1 to 5% on fresh feed. The amount of solids is sufficient to absorb these heavier materials while still remaining relatively free flowing.

The contents of the quench zone are discharged into a cyclonic separator 6 or an equivalent separator, e., g., a loop separator. The conversion vapors now substantially free from solids are downwardly withdrawn from a central portion of the cyclone by line 7. The vapors are further cooled at this point by injecting a cooled quench and wash oil supplied by line 8 into the vapors. The separated solids are transferred via dipleg 9 to a cooling zone 10.

A fluid bed of the solids is maintained in the cooling zone 10 in a manner known in the art. Fluidizing gas, e., g., steam is supplied to the base of zone 10 by line 11. This fluidizing gas may be used to extract some of the heat from the fluidized solids. Thus low temperature steam or wet steam may be injected into the vapor via line 11. In some cases water may be directly injected into the fluid bed to extract heat therefrom and to supply fluidizing gas thereto.

The vapors emerging from the fluid bed are passed through cyclone 12, which may be located interiorly within vessel 10 or exteriorly as shown. Entrained solids are removed in the cyclone and returned to the bed via dipleg 13. The spent gases are vented from the cyclone via line 14.

It is preferred to remove heat from the fluidized solids by maintaining a cooling coil 15 in the bed. A coolant such as water is circulated through this coil to remove heat from the bed. Alternatively, steam may be generated in this cooling coil or the oil feed to the process may conveniently be preheated or vaporized in this coil.

As coke deposits on the solid particles, it is necessary in most cases to provide means for burning off this coke or for removing it from the process. If a cheap material such as sand is used, a portion of the circulating solids can be discharged from the system and fresh feed particles added. It is preferred, however, to remove these coke deposits from the solids by burning. Thus a small portion of the circulating solids can be passed to an external burning vessel wherein the coke deposits are burnt off. Alternatively, air or a free oxygen containing gas may be supplied to vessel 10 via line 24 as shown, such that the burning and regeneration of the solids will take place in
the cooling zone. This air, is preferably, injected into the bed above the cooling coils, and vessel 10 has, preferably, a large length to diameter ratio such that a temperature gradient exists.

Cool solids are circulated from the cooling zone by line 16 to the quench zone in a manner well known in the art. An aerating gas such as steam is supplied to the base of the riser by line 17 to assist in the circulation of the solids. A vaporizable coolant, such as water, can be injected into line 16, as by line 23, to further cool the solids, if desired.

The conversion products are transferred by line 7 to a separation zone or fractionator 18. As shown, a relatively simple separation is made. A heavy tar is removed from the base of the fractionator by line 19 as product. An intermediate boiling range fraction which may boil from about 400°F. up to about 600°F. is removed from the fractionator by line 20. This material is cooled in heat exchanger 21 and is then passed to the cyclone separator 6 by line 8. Instead of using a recycle stream as a quench oil, either on other media such as water or catalytic cycle stocks can be used. Alternatively, a bottoms fraction alone can be separated in fractionator 18 and used as a quench medium.

The lighter products from the steam cracking operation boiling below about 430°F. are removed from the fractionator tower by line 22 and are subjected to further conventional processing. For example, the vapors may be compressed and an aromatic distillate separated therefrom. The vapors then may be scrubbed with caustic, dehydrated and then passed through a de-methanizer, de-ethanizer, de-propanizer system and a butane-pentane fractionator to recover the desired chemicals and chemical intermediates.

The following Table I summarizes the pertinent operating conditions applicable to the process depicted in the figure and presents a specific example.

| TABLE I |
| Operating conditions |
|----------------------|----------------|
| Feed-Bubbling Range, °F. | 350 to 700 light gas oil |
| *A.P.I. Steam Crack Oil | Example |
| Steam, Crack Oil | 35 |
| Outlet Pressure, p.s.i. | 12.0 |
| Outlet Temperature | 1,200 to 1,600 °F. |
| Conversion to C₆ and lighter, wt. percent | 30 to 50.0. |
| Mol percent steam, based on feed | 70 to 100. |
| Oil residence time, secs | 82. |
| Transverse Line Quench Zone | 3. |
| Outlet Temperature, °F | 1,000 to 1,600. |
| Outlet Pressure, p.s.i. | 100. |
| Superficial fluidizing gas velocity | 3. |
| Maximum | 30% on 45 mesh, 97% on 100 mesh |

What is claimed is:

1. In a now catalytic, steam cracking process wherein an oil is diluted with steam and subjected to cracking temperatures in the range of 1,200° to 1,600° F. in a cracking coil, the improvement which comprises introducing the high temperature effluent from said coil into a transfer line quench zone containing a dispersed suspension of flowing relatively cool particulate solids, the solids-feed ratio being in the range of 10 to 2, the density of the resultant mixture being in the range of 2 to 10 lbs./ft. and the average solids residence time in the transfer line quench zone being in the range of 1 to 7 seconds whereby said effluent is quench to a temperature in the range of 800° to 1,000° F. and liquid residue in an amount of from 1 to 5% on oil feed is deposited on said solids, separating solids and vapors from the effluent so quenched in a separation zone, further cooling said vapors by injecting a relatively cool quench oil, passing solids from said separation zone to a cooling zone containing a fluid bed of solids, circulating a coolant in indirect heat transfer relationship with said fluid bed to maintain the temperature thereof at least 100° F. below the temperature of said transfer line quench zone, and circulating cool solids from said fluid bed to said transfer line quench zone.

2. The process of claim 1 wherein the separated and further cooled vapors are separated to obtain a tar product, a cycle oil having a boiling point in the range of 400° to 600° F. and lighter fractions, and said cycle oil is cooled and used as said quench oil.

3. The process of claim 1 wherein a free oxygen containing gas is injected into said fluidbed to further dry and partially combust the solids therein.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,847,366 August 12, 1958
Worth William Boisture

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 12, for "now catalytic" read -- non-catalytic --; line 23, for "quench" read -- quenched --.

Signed and sealed this 18th day of November 1958.

(SEAL)

Attest:
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