

UNITED STATES PATENT OFFICE

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METHOD OF CRACKING HYDROCARBONS

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This invention relates to processes for cracking hydrocarbons and in particular to a process of shutting down oil cracking plants or similar apparatus used for cracking relatively heavy hydrocarbons, such as crude oil, reduced crude, fuel oil, petroleum residuums and other heavy petroleum oils.

It is necessary to shut down cracking plants at intervals in order to remove coke and carbonized residues which collect on the walls of the heating tubes and the reaction chamber. According to the practice heretofore followed in closing down such plants preparatory to cleaning the apparatus, the fires have been cut off and oil from the stock tank or from a mixing tank containing a mixture of recycle stock and a heavy petroleum oil such as above described is continued to be pumped through the system until the temperature has dropped considerably. The pump is then stopped and the oil remaining in the heating tubes and reaction chamber is permitted to vaporize and discharge by reducing the pressure on the same. Since during this discharging operation what amounts to a nearly complete distillation of the heavy charging stock takes place, gummy, tarry and carbonaceous residues are left in the apparatus, and these residues not only increase the amount of material to be removed but make it more difficult to remove the carbonized material previously adhering to the walls of the apparatus. The shutdown period is therefore unduly prolonged, and cleaning made more expensive. We have found that the time required for cleaning and the difficulties attending this operation may be considerably lessened by controlling the composition of the oil that is passed through the system during the shutting down period. In a preferred embodiment of our invention relatively clean distillate from the cracking operation is passed through the system during the period when the temperature is being reduced preparatory to shutting down.

Other objects and advantages of our invention will be apparent from the following description of the process taken in conjunction with the accompanying drawing.

The single figure of the drawing is a dia-

grammatic side elevation, partially in section, of an apparatus suitable for carrying out our process, although it will be understood that the process may be carried out in other apparatus.

Referring more particularly to the drawing, 10 indicates generally the furnace which contains a plurality of banks of tubes or heating coils 11 in which the oil is brought to a cracking temperature. The heating tubes or coils 11 are connected by a transfer line 12 to a forged steel reaction chamber 13. Cracking commences in the heating tubes and continues in the reaction chamber where the larger portion of the carbon produced is permitted to deposit. The reaction chamber 13 is heavily insulated to prevent loss of heat therefrom and is provided with manhole covers 14 at each end thereof, which may be taken off during the shutdowns to permit the removal of carbon from the chamber. Ordinarily means are also provided to permit of access to the heating tubes or at least to those portions in which carbon may be deposited. The reaction chamber is further provided with a valve controlled emergency outlet 15 for use in clearing the system of oil when it is shut down for cleaning.

During the normal operation, the products of conversion other than carbon are discharged from the reaction chamber 13 through the discharge line 16 controlled by a pressure reducing valve 17. The discharge line 16 discharges into an evaporator 18, the overhead products from which pass through a line 19 into a dephlegmator or bubble tower 20 in which the vapors are refluxed. The bottoms from the evaporator are drawn off through a pipe 21 controlled by a power operated valve 22 and pass first through a fuel oil cooler 23 and thence to storage through the pipe 24. The liquid level in the evaporator 18 is normally controlled by a level regulator 25 which may be of any well known type. The regulator 25 controls the admission of steam to the steam line 26 to open the power operated valve 22 when the level in the evaporator rises too high and shuts off the supply of steam and permits the valve 22 to close when the level drops below

the desired position. In normal operation there will be a nearly steady draw-off of the fuel oil through the pipe 21.

The overhead products from the dephlegmator 20 pass through a vapor line 27 to a condenser 28. Beyond the condenser 28 is arranged the usual valve-controlled gasoline distillate receiver 29 having the customary valved outlet 30 for permanent gases, which controls the pressure in the condenser and the fractionating apparatus.

The fresh feed to be treated is picked up from a stock tank 31 by the low pressure pump 32 and forced through line 33 to the pipe coils 34 and 35 located in the tops of the bubble tower 20 and the evaporator 18, respectively. The coils 34 and 35 are provided with valve controlled by-passes 36 and 37 respectively. The fresh feed passing through the coils 34 and 35 is preheated therein and serves to cool the vapors in the two towers, the amount of stock passing through the coils being regulated in accordance with the temperature conditions which it is desired to maintain in the towers. It will be understood that automatic temperature controlled valves may be utilized if desired in connection with the coils 34 and 35 and their by-passes to correctly proportion the amount of oil passing through the coils. The outlet of coil 35 is connected to a line 38 which discharges into the bubble tower 20, a power operated valve 39 in this line being controlled by the level regulator 40 which governs the liquid level in the bubble tower 20. The line 38 is also connected to a pipe 41 controlled by a power operated valve 42 and discharging into a return stock cooler 43. The level regulator 40 controls both the valve 39 and the valve 42, the connections being such that one valve is opened as the other is closed. The amount of fresh stock necessary to maintain the proper temperatures in the bubble tower 20 and the evaporator 18 is usually more than sufficient to maintain the proper level in the bubble tower 20, and therefore the excess oil is by-passed through the pipe 41 into the return stock cooler 43 and from there returned through the line 44 to the stock tank 31.

In the normal operation of the plant, the preheated fresh feed is introduced into the bubble tower through the line 38 and mixed with the reflux condensate or recycle stock collecting in the bottom of the bubble tower. By means of this arrangement the relative amounts of fresh feed and reflux condensate used to make up the charging stock are controlled, at the same time permitting the regulation of the temperatures of the evaporator and the bubble tower by circulating the necessary amount of fresh stock through the coils 34 and 35 as a cooling medium independently of the make-up requirements, since the excess stock is returned to the stock

tank. It will be obvious that the line 38 may discharge into the tower 20 near the bottom thereof as shown in the drawing or at some higher point if desired.

Where the bubble tower is operated under pressure, the control valve 39 may be replaced by a check valve preventing back flow from the bubble tower. In this case, when the level regulator 40 opens the valve 42 in the line 41 leading to the return stock cooler, the fact that the pressure in the cooler is less than that in the bubble tower will cause the excess oil to flow through the cooler.

An annular pan 45 is placed beneath the coil 35 to collect the hydrocarbons condensed in the upper part of the evaporator 18, and a run-back 46 conducts this condensate to the bubble tower 20.

A line 47 is connected to the bottom of the bubble tower 20 and to the suction side of a booster pump 48. The outlet from the booster pump 48 connects to the suction side of a high pressure hot oil pump 49, the discharge side of which, in turn, is connected by a line 50 to the first bank of the heating tubes 11. A by-pass line 51 is connected at one end to the line 52 connecting the two banks of heating tubes and at the other end connects with the line 47 at a point adjacent the pump 48. The valves 53 and 54 are located in the by-pass line and the line 52 respectively, to permit circulation of oil through the first bank of tubes while the second bank is cut out for cleaning.

The discharge side of the low pressure pump 32 is also connected to the bottom of the bubble tower 20 by a pipe 55 controlled by a power operated valve 56 governed by a regulator 57. The regulator 57 establishes a minimum level for the tower 20, and in the event of the level dropping down as far as the range of the regulator 57, the valve 56 is opened and stock passed directly into the bubble tower to obtain the necessary minimum level therein.

In carrying out our process in apparatus such as that above described it is necessary a short time before ceasing operations, say, approximately one-half hour, to build up a high level of the reflux condensate in the bubble tower 20 in order to provide a reservoir of clean overhead distillate. While the liquid level in the bubble tower is being built up, the valve 42 will be kept open and the valve 39 will be kept closed automatically by the level regulator 40, thus by-passing the fresh stock through the stock cooler 43. However, if desired, the regulator may be temporarily disconnected and the valves operated manually to insure that no fresh crude is introduced into the bubble tower and thence into the charging line during the shutting down period. This high reflux condensate level in tower 20 may be obtained for example by speeding up the pump 32 to increase the

flow of oil through the coils 34 and hence lower the temperature in the bubble tower 20, thus increasing the amount of condensate therein. It is preferable at the same time to slow down the pumps 48 and 49 in order to partially compensate for the shutting off of the supply of oil to the system. Another way of doing this would be to slow down only the pumps 48 and 49. This would result in a smaller amount of vapor being formed in tower 20; so that with the same amount of oil through the coil 34 a greater amount of reflux condensate will be formed. It is also obvious to those skilled in the art that by increasing the pressure in the tower 20 an increased quantity of reflux condensate can be built up. During the time the liquid level is being built up in the bubble tower 20 to the desired extent, the charging pumps 48 and 49 continue to withdraw oil from the bottom of the bubble tower so that in a short time the liquid contained therein will consist only of clean overhead distillate. This clean overhead distillate, unmixed with fresh feed then is led from the bubble tower and forced into the heating tubes and the reaction chamber until the overhead distillate—fresh feed mixture therein has been completely replaced by clean overhead distillate. At this time the fires are cut, the speed of the charging pumps is reduced and clean distillate is continued to be pumped into the heating tubes until the temperature of the oil under treatment is lowered approximately from 50° to 75° F. in the transfer line 12. The speed of the charging pumps then may be still further reduced, the valve 54 is closed and the valve 53 opened so as to permit circulation of oil through the first bank of tubes only. The valve in the outlet 15 is then opened and the oil in the second bank of tubes and the reaction chamber 13 is permitted to discharge under its own pressure through the outlet 15 to a sump. Steam from a steaming-out line through suitable connections not shown is then injected into the reaction chamber to remove all residual oil vapors. After which the manhole covers 14 may be removed and the reaction chamber cleaned in the customary manner. Similarly, access is had to the second bank of tubes through suitable openings not shown to permit cleaning after the steaming out operation is completed.

While the process has been described as carried out in a particular apparatus, it is to be understood that it is not confined thereto, but may be applied to other forms of apparatus. Further, it is to be understood that a clean distillate from another source than that indicated, namely, the overhead distillate from the fractionating apparatus of a cracking plant, may be used. In fact, the invention comprises the use as a medium for flushing out the system of any relatively light clean oil which will not deposit gummy, tarry

or other difficultly removable residual materials in the cracking apparatus while subjected to the distillation which takes place during the shutting down period.

Other changes and modifications will suggest themselves to those skilled in the art, and we therefore do not desire to be limited except by the scope of the appended claims.

What we claim is:

1. A process of shutting down an oil cracking plant in which the cracking system including a reaction chamber is normally supplied with heavy hydrocarbons which consists in displacing the heavy hydrocarbons by a relatively light hydrocarbon distillate, prior to reducing the temperature and pressure, and exhausting said light distillate from the system.

2. A process of shutting down an oil cracking plant in which the cracking system including a reaction chamber is normally supplied with a mixture of fresh stock and reflux condensate which consists in discontinuing supplying fresh stock to the reaction chamber and supplying only the comparatively clean reflux condensate until the system is filled with said condensate, reducing the temperature and pressure, and exhausting the reflux condensate remaining in the system.

3. A process of converting hydrocarbons which comprises continuously forcing a stream of heavy hydrocarbons under pressure through a cracking apparatus, supplying heat to said cracking apparatus to raise the oil therein to a cracking temperature, shutting off the supply of said heavy hydrocarbons when sufficient carbon has deposited in said apparatus to render it desirable to remove the same, displacing the heavy hydrocarbons in the cracking apparatus by a relatively light hydrocarbon distillate, and then shutting off the supply of heat to said cracking apparatus, and reducing the pressure on the hydrocarbons contained therein.

4. A process of converting hydrocarbons which comprises continuously forcing a mixture of fresh stock and reflux condensate through the reaction chamber of a cracking apparatus, shutting off the flow of stock to said chamber when sufficient carbon has deposited therein to render it desirable to remove the same, continuing to pass reflux condensate into such chamber to displace the heavy hydrocarbons contained therein and reducing the pressure on the hydrocarbons contained in said cracking apparatus.

5. A process of shutting down an oil cracking plant in which the cracking system including a reaction chamber and heating zone is normally supplied with hydrocarbons undergoing cracking which consists in displacing the aforesaid hydrocarbons by a relatively light hydrocarbon distillate, resistant to cracking prior to any substantial reduction

in temperature and exhausting the light distillate from the system.

6. A process of shutting down an oil cracking plant in which the cracking system including a reaction chamber is normally supplied with heated heavy hydrocarbons, which consists in stopping the supply of heavy hydrocarbons, displacing the aforesaid heavy hydrocarbons by a refractory hydrocarbon at substantially the same temperature, discontinuing heating of the refractory hydrocarbon, continuing to supply said refractory hydrocarbon to the reaction chamber until the temperature of the refractory hydrocarbon entering the reaction chamber has been reduced from 50 to 75° F., and then exhausting the hydrocarbon from the system.

In testimony whereof, we have signed our names to this specification.

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