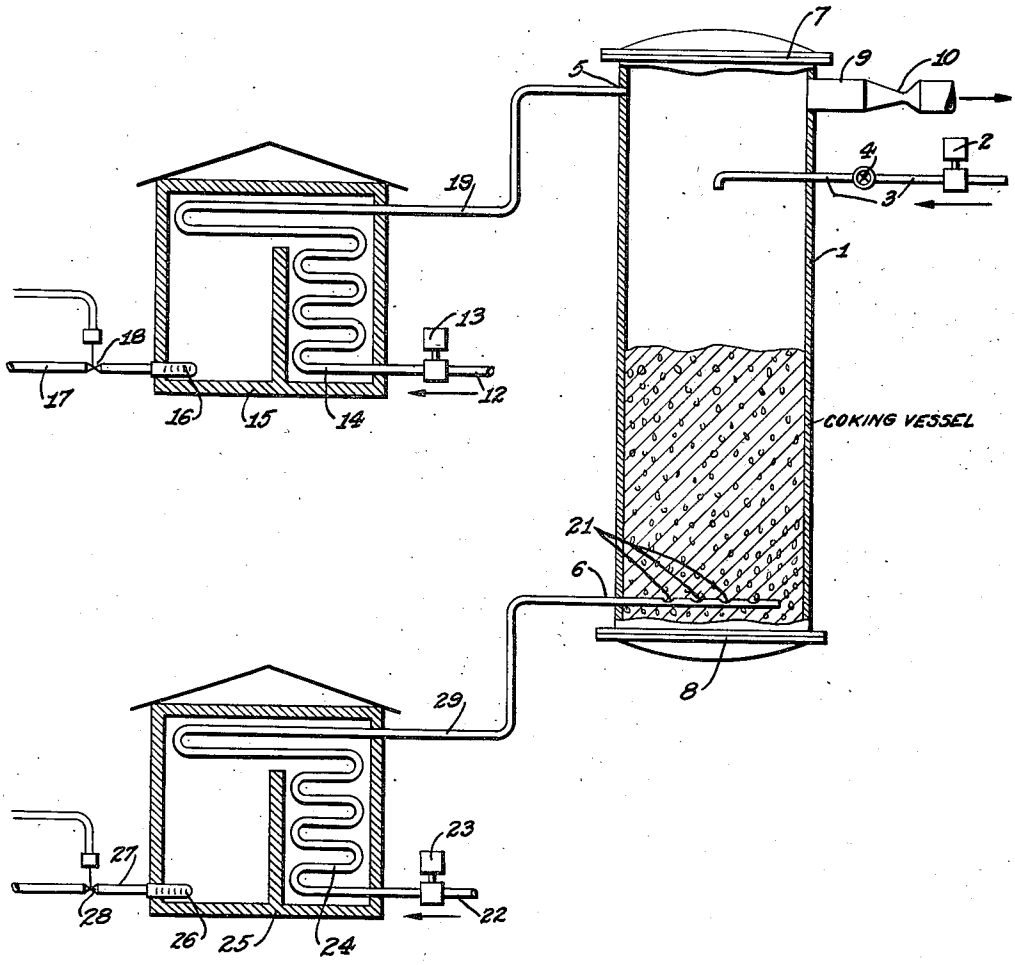
Nov. 24, 1936. H. V. ATWELL 2,062,254

METHOD OF COKING HYDROCARBON LIQUIDS

Filed June 10, 1933



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Patented Nov. 24, 1936 2,062,254

UNITED STATES PATENT OFFICE

2,062,254

METHOD OF COKING HYDROCARBON LIQUIDS

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Application June 10, 1933, Serial No. 675,147

2 Claims. (Cl. 202—15)

This invention relates to the art of coking hydrocarbon liquids, and has for an object the provision of a method whereby hydrocarbon liquid such as a reduced crude oil, a pressure tar or residuum resulting from a previous cracking operation, may be treated to produce a strong and dense coke.

My invention has for further objects such additional improvements in operative advantages and results as may hereinafter be found to obtain.

In its broad aspect, my invention contemplates coking hydrocarbon liquid under a fluctuating pressure, as well as, where desired, under a fluctuating temperature. By means of such changes in pressure or temperature or both during the coking operation, hydrocarbon liquid or vapors not yet coked are caused to penetrate into the intercellular structure of previously formed coke, thereby resulting in the building up of further coke within the cells of coke previously formed and in the ultimate production of an extremely dense mass of coke.

While the material being coked may be subjected to fluctuations of pressure or temperature or both during the coking operation in various manners, my invention further contemplates the provision of an improved method whereby such fluctuation of pressure and temperature may readily be achieved, as well as means for carrying out my improved method.

In this aspect, my invention contemplates delivering hydrocarbon liquid, preferably in a highly heated condition, to a coking retort having a restricted vapor outlet, and additionally supplying to the coking retort a stream of relatively light hydrocarbon fluid preheated to such temperature as will promote the reduction of residual portions of the relatively heavy hydrocarbon liquid to coke, and under a varying or fluctuating pressure. Thus, in a preferred instance, a stream of hydrocarbon oil such as gas oil or of hydrocarbon gas may be passed through a confined heating zone wherein it is heated to a relatively high temperature, for example 900° F., under a fluctuating pressure, the resultant highly heated products being discharged into the coking retort together with the hydrocarbon liquid to be coked. Preferably, the application of heat to the aforesaid confined heating zone is regulated automatically or otherwise in accordance with the pressure therein and the rate of flow therethrough to maintain a substantially constant outlet temperature.

The hydrocarbon liquid to be coked is initially brought to a pressure in excess of the pressure obtaining at any time in the inlet line for conducting the aforesaid relatively light heated hydrocarbon products into the retort, and if not already in a highly heated condition is preferably preheated and is then discharged through a restricted orifice into the coking retort. The extent of preheating may be varied over a wide range. Thus I may preheat the liquid to a temperature just short of one at which rapid coking is effected, or, preferably, I may preheat the liquid to be coked to a rapid coking temperature under a time of contact so short that no substantial coking occurs until the liquid is discharged into the coking zone.

Residual portions of the liquid thus discharged into the coking retort are maintained therein under the influence of the fluctuating pressure obtaining in the aforesaid confined heating zone until coked, while liberated vapors pass off through the restricted outlet from the coking retort.

In a modification of my invention, a further stream of relatively light hydrocarbon fluid such as light hydrocarbon oil, such as a cycle condensate produced in the process, or a suitable hydrocarbon gas may be supplied to the coking retort for the purpose of assisting in the coking operation. Such hydrocarbon fluid is preferably initially passed through a confined heating zone under a substantially constant elevated pressure and is discharged through a restricted orifice or a plurality of orifices into the interior of the coking retort and preferably directly into the mass of coke forming therein, in such manner that the introduction of the heated stream will vary in amount in accordance with the fluctuations in pressure effected as recited above. By thus varying the amount of the second stream of highly heated relatively light hydrocarbon fluid supplied to the interior of the coking retort, a temperature variation as well as a pressure variation may be effected therein, thus further promoting the formation of dense coke within the retort.

In order that my invention may be clearly set forth and understood, I now describe, with reference to the drawing accompanying and forming a part of this specification, various preferred forms and manners in which my invention may be practiced and embodied, but without limiting my invention to such illustrative exemplifications. In this drawing,

The single figure is a more or less diagrammatic elevational view of apparatus for effecting

the coking of hydrocarbon liquid in accordance with my present invention.

Referring now to the drawing, a hydrocarbon liquid to be coked, such, for example, as a reduced crude oil, a pressure tar or liquid residuum obtained from a previous cracking operation, is supplied to the interior of a coking vessel 1, preferably at a coking temperature or a temperature just short of one at which rapid coking is effected. In the instance illustrated, the introduction of liquid to be coked is accomplished by means of a pump 2 and a conduit 3 leading from a suitable source (not shown) and preferably provided with a restricted orifice or a pressure-reducing valve 4. It will be obvious that the pump 2 may be dispensed with where the hydrocarbon liquid to be coked is supplied from a source thereof under a suitably high pressure as, for example, the reaction chamber of a cracking unit. The pressure in the conduit 3 on the high-pressure side of the valve 4 should be of the order of 300 pounds per square inch, or more or less, depending upon the maximum pressure to be maintained in the coking vessel 1.

The coking vessel 1 is provided with inlets 5 and 6 for hydrocarbon liquid, vapor or gas, with removable heads 7 and 8 whereby coke may be removed from the interior of the vessel 1, and with a vapor outlet 9 having a restricted orifice 10. While various forms of orifices may be employed it is preferred to employ an orifice such as that illustrated at 10 in the drawing, which is of stream-line or venturi configuration, in order to minimize the formation of coke at this point.

In order to provide for varying the pressure within the coking vessel 1, a suitable hydrocarbon material, preferably of relatively light and clean character, for example, a clean gas oil, a naphtha or a hydrocarbon gas, is delivered from a source (not shown) through a conduit 12 by means of a pump 13 to heating coils 14 located within a suitable furnace 15. The pump 13 is operated in such manner as to provide a fluctuating pressure. Preferably this fluctuation of pressure is as severe and rapid as is possible to obtain. The pressure exerted by the pump 13 may, for example, vary from a pressure as low as from 10 to 20 pounds per square inch to as high as 200 to 280 pounds per square inch, plus whatever pressure is necessary to overcome the resistance or back pressure of the coils 14. It will be understood, however, that such specific pressures as have been recited, while representing a preferred range are nevertheless given largely by way of illustration, and may be varied in accordance with the nature of the materials handled and the nature of the results desired.

The furnace 15 is provided with a suitable burner or burners 16 to which suitable fuel is supplied through a line 17 having a regulating valve 18. By suitable automatic means, readily provided and not necessary to be described in detail herein, the supply of fuel to the burner or burners 16 is preferably automatically controlled in accordance with the flow of hydrocarbon material through the coils 14 to maintain a substantially constant outlet temperature. That is to say, as the pressure exerted by the pump 13 rises and the flow of hydrocarbon fluid through the coils 14 increases, the valve 18 automatically opens to admit more fuel to the burner or burners 16.

Preferably, the hydrocarbon oil or gas in passing through the coil 14 is heated to a temperature sufficient to promote coking of residual portions of the hydrocarbon liquid introduced into the coking vessel 1. While this temperature may vary considerably, a temperature of from 825 to 1050° F. or more and preferably about 900° F. is suitable under most conditions. The highly heated products from the coils 14 then pass through a transfer line 19 and the inlet 5 into the interior of the coking vessel 1.

By means of the fluctuation in pressure exerted by the pump 13, the operation of which is periodically varied as desired, and due also to the restriction provided by the orifice 10 in the vapor outlet 11 leading from the coking vessel 1, the pressure within the coking vessel 1 is caused to vary periodically, the fluctuation of pressure taking place at whatever rate may be desired. Due to this fluctuation in pressure within the coking vessel 1, the pores of the cellular coke being formed are caused to be filled with hydrocarbon liquid to be coked, thus resulting in building up and strengthening the cellular structure of the coke in process of formation and resulting, as aforesaid, in the ultimate formation of coke of very dense and strong character.

While it is not always necessary to introduce a further stream of heated hydrocarbon fluid to the interior of the coking vessel 1 through the inlet 6, nevertheless this is accomplished in a preferred instance. As illustrated in the drawing, the inlet 6 is located in the lower portion of the coking vessel 1, that is to say, in direct contact with the mass of coke forming within the lower portion of the vessel 1 and is provided with restricted orifices or openings 21. Relatively light hydrocarbon oil or gas is supplied from a suitable source thereof (not shown) through a conduit 22 having a pump 23 to heating coils 24 located within a suitable furnace 25. The furnace 25 is provided with a burner or burners 26 to which fuel is supplied through a line 27 having a preferably automatically operated control valve 28. Heated products from the coil 24 pass to the interior of the coking vessel 1 through a transfer line 29, the inlet 6 and the orifice or orifices 21.

In the preferred instance, the operation of the pump 23 is varied as required to maintain a substantially constant pressure in the inlet 6 which may be, for example, a pressure of the order of 300 pounds per square inch and the valve 28 is regulated automatically or otherwise to provide a substantially constant coil-outlet temperature of, for example, from 900° to 1000° F. or more, that is to say, a temperature sufficiently high to promote relatively rapid coking within the vessel 1 and preferably higher than the temperature within the vessel 1.

Due to the fact that the pressure within the inlet 6 is thus maintained substantially constant, whereas the pressure of the products introduced to the inlet 5 is periodically varying or fluctuating, the amount of vapors or gases which pass through the orifices 21 into the interior of the coking vessel 1 will vary in accordance with the fluctuating pressure within the vessel 1, and due to the temperature differential between the interior of the vessel 1 and the hydrocarbon material introduced to the inlet 6, a temperature variation within the vessel 1 is effected, which assists in the production of a dense coke for reasons set forth hereinabove.

While, as stated hereinabove, the periodic variation of pressure and/or temperature within the

coking vessel 1 may be accomplished at any desired rate, in the preferred form of my invention I prefer to limit the cycle of pressure or temperature variation to a relatively short time, for example, 30 minutes or less, the variation of pressure or temperature or both taking place within this period being limited simply by the strength of the available materials and the character of pumping equipment available. Within the cycle, the high-pressure or saturating periods and the low-pressure periods may be varied considerably, but it is ordinarily preferred to maintain relatively short saturating periods of, for example, from 1 to 10 minutes' duration, and relatively long low-pressure periods, of, for example, from 10 to 30 minutes or even longer. Where desired, the introduction of liquid to be coked may be suspended or considerably reduced during the low-pressure periods, the bulk or all of the liquid being charged into the retort 1 during the high-pressure or saturating periods.

My process may be employed to improve the density of coke previously made. Thus, I may initially charge the retort 1 with relatively porous coke produced elsewhere, for example in a combined cracking and coking unit of more or less conventional type, further liquid to be coked being introduced in the manner set forth hereinabove.

While I have set forth and described my invention hereinabove with respect to various illustrative instances thereof, my invention is not limited to such exemplification, but may variously be embodied and practiced within the scope of the claims hereinafter named.

I claim:

1. The method of reducing a hydrocarbon liquid to coke, which comprises introducing a hydrocarbon liquid to be coked into a coking zone, heating a stream of relatively light hydrocarbon fluid to a cracking temperature while in transit through a confined heating zone, discharging the heated products into the coking zone wherein separation of vapors and residual hydrocarbons takes place, and said residual hydrocarbons are retained and coked, periodically and rapidly varying the pressure within the range of from 10 to 280 pounds per square inch under which said relatively light hydrocarbon fluid is supplied to said confined heating zone, and restricting the flow of vapors from said coking zone to effect a resultant fluctuating pressure variation therein to thereby produce a dense coke.

2. The method of reducing a hydrocarbon liquid to coke, which comprises introducing a hydrocarbon liquid to be coked into a coking zone, heating a stream of relatively light hydrocarbon fluid to a cracking temperature while in transit through a confined heating zone, discharging the heated products into the coking zone wherein separation of vapors and residual hydrocarbons takes place, and said residual hydrocarbons are retained and coked, periodically and rapidly varying the pressure within the range of from 10 to 280 pounds per square inch under which said relatively light hydrocarbon fluid is supplied to said confined heating zone, supplying a further stream of highly heated hydrocarbon vapors to the coke mass forming within said coking zone, and restricting the flow of vapors from said coking zone to effect a resultant fluctuating pressure variation therein to thereby produce a dense coke.

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