

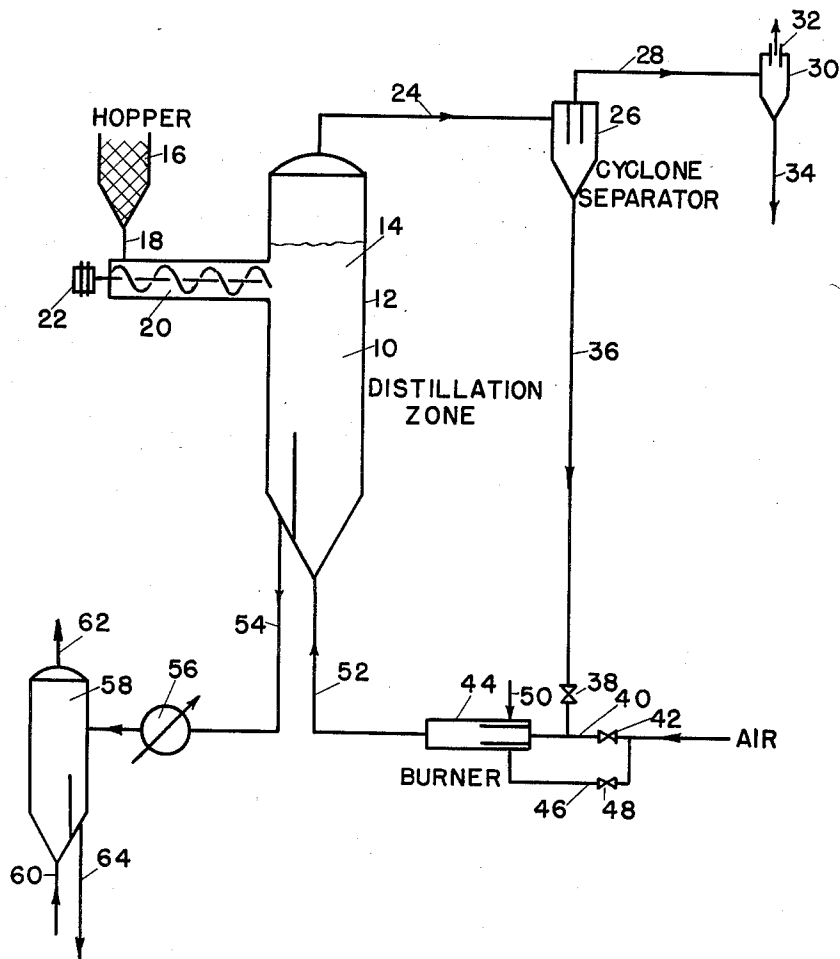
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DISTILLATION OF CARBONACEOUS SOLIDS

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DISTILLATION OF CARBONACEOUS SOLIDS

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This invention relates to the treatment of solids and more particularly to the distillation of carbonaceous solids such as coal, lignite, oil shale, and the like.

The primary object of my invention is to provide an improved method and apparatus for distilling carbonaceous solids.

Another object of the present invention is to provide an improved method and apparatus for the low temperature distillation of coal wherein hot distillation residue is utilized as a source of heat for effecting distillation of the coal.

A further object of the present invention is to provide a method of heating carbonaceous distillation residue for use in the distillation of carbonaceous solids which involves the combustion of the fixed carbon of the residue in preference to the volatile carbon.

I have provided a method and apparatus for distilling carbonaceous solids in which hot distillation residue is employed as a source of sensible heat for raising the temperature of the carbonaceous solids to the desired distillation temperature. The latter temperature, however, is not sufficiently high during the time of contact of carbonaceous solids and distillation residue to result in complete distillation of all of the volatile components of the carbonaceous solids. As a result, the distillation residue which is produced in the distillation zone contains volatile components of a carbonaceous character in addition to components having fixed carbon. In the case of coal, these include hydrogen and methane.

In accordance with my invention, solid distillation residue is removed from the distillation zone and conveyed to a heating zone where the temperature of the distillation residue is elevated sufficiently to volatilize a substantial portion of the volatile components remaining in the distillation residue. At the same time, the solids residue is raised to such a temperature that when mixed with the fresh feed in the distillation zone the average temperature is that required to effect distillation in the distillation zone. A small portion of the residue is then burned in a separate combustion zone to yield a hot flue gas as well as ash. The hot flue gas is circulated in heat exchange relation with the distillation residue from the distillation zone to bring about the previously mentioned heating of the residue and volatilization of the components. The flue gas may also be utilized to carry the finely divided distillation residue from a point adjacent the outlet of the distillation zone through the heating zone to an elevated position above that in

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the inlet to the distillation zone. The flue gas and volatile products produced in the heating zone are then conducted to any suitable storage space or to further treatment zones. It will thus be seen that the source of heat of the distillation residue is the fixed carbon components of a minor proportion of the distillation residue, little or none of the useful volatile components being consumed for this purpose.

Other objects and advantages of my invention will become apparent upon reference to the following description and drawing in which a preferred embodiment of an apparatus adapted to practice the invention is illustrated.

Referring to the drawing numeral 10 designates a carbonizing retort of the horizontal rotating type shown in detail in the copending application of Carl E. Leshner, Serial No. 11,964, filed February 28, 1948. A hopper 12 is provided for the carbonaceous solids and a conduit 14 connects the hopper with a screw feeder 16 driven by motor 18. The screw feeder communicates with the retort 10 as shown. At the opposite end of the retort, lifter members 20 are provided for lifting solids above a fixed level in the retort and dropping the solids into a hopper 22 which is associated with a screw feeder 24 driven by motor 26. A conduit 28 communicates with the screw feeder 24 and also with a separation zone 30.

The separation zone 30 communicates with a condensing zone 32 through a conduit 34. A conduit 35 conveys the non-condensable gas from the condensing zone while a conduit 38 conducts the condensed products away from the condensing zone. A pipe 39 is connected to the bottom of the separation zone 30 for conveying solid products therefrom under the control of a valve 40. Another pipe 42 also connects with the bottom of the separation zone 30 for conducting solid products under the control of a valve 44 to a conduit 46. The latter is connected to a second separation zone 48 which may be in the form of a cyclone. The bottom of this cyclone separator is connected by conduit 46 to the screw feeder 15. A valve 52 regulates the flow of solids through the conduit 46. A conduit 54 connects the top of the cyclone separator 48 with another cyclone separator 56 from which a conduit 58 leads for the purpose of carrying gas therefrom. Conduits 60 and 62 are connected to the bottoms of cyclone separators 56 and 48, respectively, and lead to conduit 64. Valves 66 and 68 in conduits 60 and 62, respectively, serve to regulate the flow of solids therethrough. A conduit 70 connected

to conduit 60 is provided for the purpose of diverting some of the solids from conduit 60. A valve 72 is provided for regulating the amount diverted. A conduit 74 connects with conduit 60 for the purpose of introducing oxygen-containing gas such as air into the system. Conduit 54 leads to a cyclone separator 76 from which ash is deposited through a conduit 78 and flue gas is conveyed through conduit 80 into conduit 46.

The operation of the apparatus shown in the drawing is as follows. For the purpose of better illustrating the invention, the application of the apparatus disclosed in the drawing to coal will be described. By coal I intend to include all ranks down to and including lignite. Finely divided coal is fed from the hopper 12 through conduit 14 into the carbonizing retort 10. Concurrently therewith hot previously distilled coal is introduced into the retort through conduit 16. The retort as previously stated, is of the horizontal rotating type in which the coal and distillation residue are thoroughly mixed by rotation of the retort. However, any of the known types of carbonizing retorts may be employed so far as the purposes of the present invention are concerned. I have found, however, that the use of the rotating horizontal retort results in the production of a high yield of high quality liquid tar as well as high B. t. u. gas. Furthermore, such a retort is adapted to continuous operation.

The amount of distillation residue as well as the temperature thereof are adjusted to produce an average temperature within the retort falling within the low temperature distillation range of the coal. In the case of high volatile bituminous coal this is of the order of 800° F. to 1400° F. The total circulation rate of the solids through the retort and the temperature are such that the distillation residue produced still contains volatile components after passing through the retort. This distillation residue as well as the volatile products are continuously removed from the retort in any suitable manner. As shown, lifter members attached to the retort pick up all solids above a certain level in the retort and dump these into hopper 22. Screw feeder 24 delivers the residue to conduit 28. At the same time the volatile products are led through the same outlet to the conduit 28.

The solid and vaporous products are separated in the separation zone 30 by a cyclone or any other suitable means, the vapors being conducted by conduit 34 to a condenser 32. The non-condensable gas is recovered through conduit 36 while the condensate in the form of liquid tar passes through conduit 37. The solid distillation residue deposited in the separation zone 30 is in part conducted to product storage through conduit 38 under the control of valve 40. The remaining solid product is conducted by conduit 42 under the control of valve 44 to conduit 46. At the same point hot flue gas is introduced into conduit 46. The production of this gas will be described below.

The hot flue gas and finely divided distillation residue pass through conduit 46 in heat exchange relation with each other. As a result, the distillation residue is raised to a temperature of the order of 1400° F. and higher. The remaining volatile components, or at least a substantial part thereof, are distilled from the residue. The mixture of flue gas, volatile products, and hot char or residue is conducted to the separator 48 where the flue gas and volatile products, largely hydrogen and methane, are conducted by

conduit 54 to a second cyclone separator 56. The major proportion of the hot char is then returned under the control of valve 52 to conduit 16 for delivery to the carbonizing retort 10 for repetition of the cycle.

A portion of the hot char deposit in the cyclone separator 48 is conducted by the conduit 62 under the control of valve 68 to a combustion zone which comprises the conduit 64. Also, if desired, any finely divided solids separated from the flue gas in the cyclone separator 56 are conveyed by conduit 60 under the control of a valve 66 to the same combustion zone by conduit 64. If it is not desired to utilize these extremely fine solids they may be conducted to storage through conduit 70 under the control of valve 72. In order to effect combustion of these solids in conduit 74, air is introduced through conduit 75. Substantially all, if not all, of the char is burned during its passage through conduit 64. The resulting volatile products and ash are separated in separator 76 with the ash being led away through conduit 78 and the hot flue gas being conducted through conduit 80 to the char heating conduit 46.

The amounts of char burned and char recirculated to the carbonizing retort are controlled so as to produce the desired average distillation temperature within the retort. The specific quantities required can readily be determined by calculations which form no part of the present invention.

In the event it is desired to obtain the volatile products produced as a result of heating the distillation residue in as pure a condition as possible, the flue gas from the combustion zone 65 can be circulated in any suitable manner in indirect heat exchange with the char from the carbonizer. In order to convey the char through the heating zone back to the carbonizer, only a portion of the flue gas may be employed or any readily removable gas, such as superheated steam or CO₂ may be used. In this manner only the amount of gas necessary to maintain solid flow is added to the volatile components evolved by the char, and is readily separated by condensation or other suitable means.

According to the provisions of the patent statutes, I have explained the principle, preferred construction, and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. The method which comprises contacting carbonaceous solids in a distillation zone with sufficient hot distillation residue from previously distilled carbonaceous solids, to raise the temperature of said zone to the point where distillation of said carbonaceous solids is effected to produce volatile products and solid distillation residue still retaining volatile components, passing at least a portion of said distillation residue through a heating zone which is maintained at a temperature above that of the distillation zone, whereby more volatile matter is evolved and the temperature of the residue is raised, returning only the heated distillation residue to the distillation zone, burning a portion of the distillation residue outside of the distillation zone to yield a hot flue gas, and circulating said hot flue

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gas in heat exchange relation with the distillation residue passing through said heating zone.

2. The method which comprises contacting coal in a distillation zone with sufficient hot distillation residue from previously distilled coal, to raise the temperature of said zone to the point where distillation of said coal is effected to produce volatile products and solid distillation residue still retaining volatile components, passing at least a portion of said distillation residue through a heating zone which is maintained at a temperature above that of the distillation zone, whereby more volatile matter is evolved and the temperature of the residue is raised, returning only the heated distillation residue to the distillation zone, burning a portion of the distillation residue outside of the distillation zone to yield a hot flue gas, and circulating said hot flue gas in heat exchange relation with the distillation residue passing through the heating zone.

3. The method which comprises contacting carbonaceous solids in a distillation zone with sufficient hot distillation residue from previously distilled carbonaceous solids, to raise the temperature of said zone to the point where distillation of said carbonaceous solids is effected to produce volatile products and solid distillation residue still retaining volatile components, passing at least a portion of said solid distillation residue through a heating zone which is maintained at a temperature above that of the distillation zone, whereby more volatile matter is evolved and the temperature of the residue is raised, separating a portion of the heated solid residue, returning only the remainder of the heated residue to the distillation zone, burning said separated portion to yield hot flue gas, and circulating said hot flue gas in heat exchange relation with the distillation residue passing through said heating zone.

4. The method which comprises contacting

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high volatile bituminous coal in a distillation zone with sufficient hot distillation residue from previously distilled coal to establish a temperature in said zone between 800° and 1400° F., whereby distillation of said coal is effected to produce volatile products and solid distillation residue still retaining volatile components, passing at least a portion of solid distillation residue through a heating zone which is maintained at a temperature above that of the distillation zone, whereby more volatile matter is evolved and the temperature of the residue is raised, separating a portion of the heated solid residue, returning only the remainder of the heated residue to the distillation zone, burning said separated portion to yield hot flue gas, and circulating said hot flue gas in heat exchange relation with the distillation residue passing through said heating zone.

GEORGE D. CREELMAN.

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