METHOD OF OPERATING RETORTS TO PRODUCE COKE, GAS AND OIL

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This invention relates broadly to operating methods for coking retorts for the purpose of producing high grade coke, low temperature oils and fuel gas from coking coals.

One of the important objects of this invention involves methods for producing and controlling the plastic gas resistant barrier which forms in coking retorts at the point of transition of the coal into coke.

A further object of this invention is the provision of methods for use in treatment of coking fuels in which an accurate control of the reaction is obtained for the continuous production of uniform coke, gas and oil.

Another object of this invention involves a method of maintaining a plastic barrier which forms when coal is coked so that the gases formed within the barrier may readily escape to the outside thereof.

A still further object of this invention is to form and control the size and position of the plastic barrier and maintain it vented in order to secure uniform products and uniform operation conditions.

Another object of this invention involves the control of the plastic barrier or film so as to keep the vapors formed on each side thereof separated until they are beyond the heating zone.

An additional object of this invention involves the formation of the plastic barrier in a column of coking fuel, the venting thereof, and the removal of the gases formed or introduced within the barrier from near the top of the column so that the fuel is preheated before it reaches the coking zone.

A still further object of this invention involves the control of the plastic barrier by control of the throughput of both coal and heating gases to secure production of high grade coke of relatively high volatile content while maintaining the production of gaseous products at a minimum.

These and many other objects as will appear from the following disclosure are secured by means of this invention.

This invention resides substantially in the steps and series of steps as will be apparent from the following description:

This application is a division of my co-pending application, Serial No. 571,332, filed, October 27, 1931.

Referred to in the drawing single feature is a vertical cross sectional view through the apparatus of this invention illustrated diagrammatically.

The apparatus and method of this invention relate to and involve the heat treatment of solid carbonaceous fuels, such as coal, lignite, oil shale and the like, and particularly coking coals for the purpose of producing therefrom high grade coke of uniform size, low temperature oils and gaseous fuels. The invention may be applied to continuous internally heated retorts, regardless of the source of heat, whether generated within the charge or externally. In coking retorts of this type it has been found that at the surface of transition of the coal into coke a plastic barrier or film forms which is more or less gas impervious. This film is composed of melted coal which is produced at a temperature of around 750 degrees F.

The film or barrier is in a plastic state and normally has a thickness of approximately one-quarter of an inch. This barrier of melted coal exists between the uncooked coal and the formed coke. It has been found that the formation of this film is the cause of the difficulties normally encountered in the production of coke at either high or low temperatures in continuous internally heated retorts. Because the film is gas impervious, the gaseous products formed within it are not easily removed and as a result a back pressure is built up within the retort. Furthermore, the formation of this film has been found to be the cause of the lack of uniformity in the operation of such retorts and the products produced thereby.

The prime object of this invention is to employ this very barrier or film for the purpose of producing uniform operation and uniform products.

In both externally and internally heated continuous retorts the plastic barrier occurs in the form of an inverted cone with the apex pointing downwardly. By means of this invention the position of the cone is reversed and its apex is vented to permit the escape of the gaseous products formed within it. Venting of the plastic cone is effected by feeding a central core of coke into the retort in such a manner as to maintain the top of the cone open so that the gaseous products formed within it may pass freely through the gas pervious coke core.

In ordinary internally heated continuous vertical retorts, especially when using fine sized coking coal, this plastic hollow, unventured cone tends to shift about in the retort varying both its size and position under different operating conditions so that it is impossible to produce uniform products and uniform operating conditions.

By means of this invention the position of the
plastic cone is relatively fixed and its size is controlled to aid in producing uniform products and operating conditions.

The retort which may be constructed in accordance with standard practice is shown in the figure and is preferably in the form of a truncated pyramid of increasing cross sectional area downwardly. Near the bottom of the retort the walls may be so formed that they converge downwardly to the point where the coke and other residue are discharged.

The lower end of the retort is provided with a suitable discharge apparatus such as is shown in the drawing comprising a casting 2 within which are mounted rotatable discharge gates 3. The top of the retort is provided with a cover 4 which is shown as provided with a depending skirt 4a and upwardly extending feed hoppers 4b provided with covers 4c. It is likewise apparent that the form of feeding mechanism employed may be of any of the well known types. The general object of the feed mechanism is merely that it shall be able to feed the coal continuously into the retort without substantially opening the retort to the atmosphere. There are many known types of continuous feed hoppers for such retorts. Extending centrally through the cover 4 is a tube 5 of any suitable cross section and provided with a cover 7. This tube is vertically slidable through the cover. The top of the retort is provided with gas take-off connections 8 of which only one is shown.

Extending around the base of the heating zone is a tuyère 10 provided with a series of discharge connections 9 opening directly into the retort. Just below the tuyère 8 is a second tuyère 10 likewise provided with space discharge connections 11 opening into the retort. At 12 is a connection into the retort provided with a nozzle by means of which steam, or any suitable neutral gas, may be discharged into the retort.

As indicated in the drawing the retort may be divided into three zones. The lower zone is termed the "cooling zone" in which the coke and other residue is gradually cooled. In the next zone, called the "heating zone", the fuel is heated either by the introduction of sensible heat through the tuyères or by direct combustion to a temperature sufficient to liberate the gases products thereof. The last zone is called the "pre-heating zone" and represents the volume where the fresh incoming fuel is heated by the gases ascending from the heating zone. In the pre-heating zone, for weakly coking coals, the higher boiling point volatiles may be made to condense on the relatively cold incoming fresh fuel. The heaviest condensation products flow back toward the heating zone where they are cracked down into simpler forms and revitalized, thereby augmenting the deficient cell.
In addition, the fuel column extends a considerable distance above the top of the vented cone and the gaseous products are taken off near or at the top of the column so that they must flow upwardly through the top of the column which is composed of fresh, incoming coal. The heated gases leaving the heating zone flow upwardly through the column and pre-heat it. This is a tremendously important feature of this invention because it enables the production of high grade coke at a maximum rate.

By venting the top of the cone and by introducing the heating gases at the base of the heating zone, at the proper temperature and volume, it is possible to pre-heat the coal to approximately 7000 degrees F. (near or at its melting temperature) before it reaches the heating zone. This requires that the heating gases enter the pre-heating zone at about 900 degrees F. and leave the retort at about 200 degrees F. with the fresh coal entering at about 60 degrees F., and with a proper volume of heating gases these results can be obtained. It is only by venting the top of the cone that it is now possible to increase the volume of the through-put to a value where these temperature relations at the top of the column are uniformly maintained.

It requires a large volume of gas per ton of coal to produce these results which amount can only be put through the retort when the top of the cone is vented. This would be roughly 50,000 cubic feet of gas per ton, having an entering temperature of the order of 1100 degrees F.

With this invention about 80% of the heat of carbonization of the coal is supplied thereto in the pre-heating zone and before melting starts, leaving approximately 20% to be added to the fuel in the heating zone. The pre-heating zone acts similar to a reflux condenser for all oils except the pitch fraction which alone undergoes destructive distillation as it descends into the heating zone. The result is, that the coal is uniformly saturated which is a necessary condition for the production of uniform coke structure.

Furthermore, this method of operation prevents swelling of the coal which is so disastrous to proper operation.

The method, when dealing with weakly coking coals where stronger coke structure is required, the temperature of the heating gases would be raised and the volume per ton reduced, thereby reducing the amount of pre-heat. The result would be the return of the heavier pitch residues to the coking zone to augment the coke forming constituents in the coal. Thus the coke quality would be improved at the expense of the oil yield. This is illustrative of the fact that the retort controls are varied to suit the coal as distinguished from the present practice where the coals are blended or otherwise treated to suit the retort.

It is important to note that the key to uniform strong coke formation is the absence of re- vaporization at the coking zone which is made possible by these conditions.

At this point it is interesting to note that a portion of the gaseous products after having the oils condensed therefrom and washed, may be delivered back into the retort through the tuyeres in the case where incomplete combustion is employed to effect further operation of the retort. They can likewise be burned in an outside combustion chamber and the hot products of combustion tempered with steam if desired, introduced into the retort to further its operation.

The height of the cone is determined by the coal throughput, the volume of the heated gases and the heat potential thereof; the lower the coal throughput, the greater the volume of the through-put heating gases, the shorter the cone, and the lower the potential of the heating gases, the shorter the cone. Conversely, the greater the coal throughput, the taller the cone; the less the volume of the heating gases the longer the cone, and the greater the potential, the longer the cone. In other words, the height of the cone is determined by the rate of through-put of the coal and heating gases and by the heat potential. The through-put of the heating gases can be maintained either by increased heat potential and less volume, or by larger volume at less heat potential. The plastic zone terminates at the point where the temperature of the coking fuels falls below 750 degrees F. The tube is made vertically adjustable so that the upper end of the cone has been maintained vented regardless of its vertical extent.

While coke is preferably fed through tube because it does not contaminate the finished product. It is apparent that some heating substance could be used for this purpose such as rock and the like. The center core of coke is fed downwardly continuously with the fresh incoming fuel to maintain a gas pervious center core of 30 and beyond the point where the coal begins to melt.

As the coke and other residue descends below the heating zone, it is cooled by discharging steam, or any neutral gas into it through pipe and its attached nozzle. By cooling the coke in a zone below the heating zone, by the introduction of a gas, the gas is super-heated as it rises through the heating zones and mixes with the hot products produced in the heating zone to thereby form a vehicle for suitably distributing heat in both the heating and pre-heating zones. The coked product is finally discharged after cooling from the retort through the discharge mechanism.

Another advantage of this method and apparatus which causes the formation of the plastic cone as shown is that the cone of coke within the plastic film is surrounded by a compacted cup of coal so that the coke is continuously subjected to pressure. As a result the coke cannot expand and deteriorate as in the case of previous apparatus where the cone is inverted so that the coke is in the form of an outside cup with a center core of coal.

In all continuous retorts the retorts are tapped to facilitate easy discharge. This invention allows any tap desired without disturbing the coke during formation. The loose coal is continuously taking up the extra space made by the tapped and does not allow the coke to swell; that is, does not make the coke too porous.

From the foregoing description it will be apparent that this invention resides in certain forms of apparatus and principles of operation which may be embodied by those skilled in the art in other ways without departure from the invention. I do not, therefore, desire to be strictly limited to the disclosure as given for purpose of illustration but rather to the scope of the appended claims.

What I seek to secure by United States Letters Patent is:

1. A method of coking coal in a continuous internally heated retort comprising feeding coal into the retort to form a column thereof, i.e.
niting the column at one end to form a combustion zone, forcing oxygen bearing gases into the combustion zone to maintain it and coke the coal, introducing coke into the central portion of the column above the combustion zone to form a core for the column, removing the gases generated in the column from the top thereof, said gases passing through coal column, and removing the residue from the bottom of the column, whereby an upstanding plastic film of conical shape of melted coal is formed and maintained vented at the apex of the coke core.

2. A method of coking coal in a continuous internally heated retort comprising feeding coking coal into the retort to form a column thereof, discharging coke into the retort to form a central core for the column of coal, introducing gases heated above the fusion temperature into the column to form a heating zone in the column, removing the gases generated in or introduced into the column from the top thereof and shielding the coke core to make it gas impervious to a point below the top of the column, whereby an upstanding plastic conical film of melted coal is formed vented at the apex by the coke core and gases generated or introduced within the film flow upwardly through the vented top of the film and through the unshielded part of core into and upwardly through the column to the point of gas removal from the column.

3. A method of destructively distilling coking coal in a continuous internally heated retort to control the compactness of the coke formed and uniformity of the oil yield comprising feeding coking coal into the retort to form a column thereof, maintaining a fusion zone at the base of the column with heated gases, feeding coke in a column into the coal column centrally thereof to form a gas pervious core therefor, removing the gases from the retort at the top of the coal column, shielding the coke core to vary the length of the gas pervious portion and controlling the amount of heated gas and the amount of shielding of the coke core, whereby a maximum amount of pre-heating of the coal column occurs before the coal reaches the fusion zone.

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