ABSTRACT OF THE DISCLOSURE

Disclosed is a non-recovery coke oven that not only gives off a minimum of smoke but also, for its size, gives enhanced production rates with a minimum of maintenance. Green coal and hot coke are coked in adjacent chambers, and smoky off-gas from the green coal is led to the hot-coke chamber, where it is burned and heated, and then to the bottom of the hot-coke chamber, speeding the finishing of the coking of the hot coke. Preferably, a silicon carbide bottom is used in each chamber to improve heat transfer and increase production.

As is known, there are two major methods for manufacturing coke, known as the non-recovery and the by-product or retort process. In the non-recovery process, air is admitted to the coking chamber in controlled amounts for the purpose of burning the volatile products of the coal to generate heat for further distillation, the smoke and other volatile products usually being discharged into the atmosphere. In the by-product method, on the other hand, air is excluded from the coking chamber; and all of the volatile products liberated during coking are recovered as gas and coal chemicals, making it an essentially smoke-free process. Part of the recovered gas in the by-product process is burned to provide the necessary heat for distillation externally of the coking chamber itself.

While the non-recovery process was originally the leading method for the manufacture of coke, it was subsequently almost entirely replaced by the by-product process, which, in addition to coke, produced valuable coal chemicals. In recent years, however, the by-product process has lost favor among producers. This is due, among other reasons, to the fact that the by-product process is much more costly, a typical by-product plant being as much as ten times the cost of a non-recovery installation for the same amount of coke production. Furthermore, producers have had difficulty disposing of the recovered coal chemicals on a profitable basis, particularly since many of the same or equivalent chemicals are recovered in the refining of petroleum products.

For these reasons, the non-recovery process has again become an important factor in the coke industry; and while it has many advantages, it also has one serious disadvantage, namely, the excessive smoke and atmospheric contamination which it produces. This, of course, is a particularly serious problem in urban areas.

As an overall object, the present invention seeks to provide a method and apparatus for producing coke in non-recovery ovens without producing excessive amounts of smoke and atmospheric contamination, and without requiring an external source of heat other than that produced in the ovens themselves.

Another object of the invention is to provide new and improved non-recovery coke oven apparatus in which at least part of the necessary heat for distillation is supplied from external combustion of some of the gases recovered from the coking process.

Another object of the invention is to provide improved non-recovery coke oven apparatus wherein the floor of the coking chamber is heated by combustion of the gas recovered from a plurality of oven chambers, preferably adjacent oven chambers. In this manner, coking proceeds from the bottom of the coal upwardly, as well as from the top of the coal downwardly, with the result that the coking time is materially reduced.

In accordance with the invention, at least one pair of oven chambers are arranged in generally side-by-side relationship and are provided with a stack for conducting the products of combustion to the atmosphere. Means are also provided for conducting partially burned products of combustion from green coal in one of the chambers through the other chamber containing hot coke and thence to the stack. In this manner, the partially burned products of combustion (i.e., smoke) from the green coal will be substantially completely burned in passing through the other chamber before passing to the stack whereby the issuance of smoke from the stack will be materially reduced, if not completely eliminated.

In accordance with another aspect of the invention, the hot gases from both of two adjacent coke ovens, one containing green coal and the other containing partially coked material, are passed underneath the oven containing green coal before passing out through the stack. In this manner, the underside of the green coal within one of the chambers is heated as well as the upper portion portion, coking proceeds from both the top and bottom portions to materially increase the speed of the coking process.

The above and other objects and features of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings which form a part of this specification, and in which:

FIGURE 1 is a vertical cross-sectional view of one embodiment of the invention wherein separate stacks are provided for adjacent coke ovens;

FIG. 2 is a cross-sectional view taken substantially along line II—II of FIG. 1;

FIG. 3 is a vertical cross-sectional view of another embodiment of the invention wherein a single stack is employed for two adjacent coking ovens;

FIG. 4 is a vertical cross-sectional view of still another embodiment of the invention wherein the bottom of the coke is not heated; and

FIG. 5 is a cross-sectional view taken substantially along line V—V of FIG. 4.

With reference now to the drawings, and particularly to FIGS. 1 and 2, two adjacent coking ovens A and B are shown. Each oven comprises a standing side walls 10 and 12 of refractory brick or the like and having an arched roof 14, also formed from refractory brick or other suitable material such as castable or plastic refractories. Formed in the roof 14 is an opening 16 through which green coal to be coked is charged into the oven A or B. At all times except when the oven is charged, the opening 16 is covered by means of plate 18.

The bottoms 20 of the oven chambers comprise silicon carbide or some other similar refractory material of high heat conductivity. The floors or bottoms 20 rest on beds 22 of castable refractory material overlying arches 24 supported on columns or baffles 26 which are staggered to cause the products of combustion to take a circuitous path in passing beneath the floor. The spaces 25 formed beneath the floors 20 by the arches 24 and columns 26 communicate through arched openings 28 with vertical flue passageways 30 and 32, respectively, extending upwardly along the sides of the chambers A and B. These same spaces 25 formed beneath the floors 20 communicate through arched openings 34 (best shown in FIG. 2) with vertical flue passageways 36 and 38 for chambers A and B, respectively. The vertical flue passageway 36 communicates with a stack 42 while passageway 38 com-
municates with stack 40. Each of the stacks 40 and 42 is provided with a removable damper 44 or 46. As will hereinafter be explained, one of the dampers 44 or 46 will be open while the other is closed and vice versa. The oven chamber A communicates with vertical passageway 30 through opening 48; while oven chamber B communicates with vertical passageway 52 through opening 50. Both of the oven chambers A and B are interconnected by means of flues 51 extending through walls 12 and passageways 36 and 38.

In operation, the oven chambers A and B are charged as soon as practicable after drawing coke therefrom, in order that stored-up heat from the previous charge will be sufficient to start the coking process. With the oven in readiness for charging, the cover 18 is removed from opening 16 and the charge of green coal is dropped through the opening, leaving the coal in a cone-shaped pile in the oven. In order to secure uniform coking of the coal, this pile must be leveled so that the coal will lie in a bed of uniform length over the entire bottom of the oven, usually having a thickness of about twenty-four inches. Thereafter, the forward door 52 shown in FIG. 2 is opened sufficiently to permit a leveling machine to level out the coal to a layer of uniform thickness. At the completion of the coking operation, both doors 52 and 54 (FIG. 2) are opened and the coke pushed out of the rear door 54.

In conventional prior art coking ovens, the coking process begins soon after leveling is completed, since the ovens retain enough heat in the brick of the walls to start liberation of the volatile matter of the coal. As more heat is absorbed by the coal charge, the temperature of the oven soon reaches the ignition point of volatile gases which, in the presence of air admitted to the oven, ignite and then continue to burn quietly in the crown of the ovens, or as small candellike flames at the surface of the coking mass, thus supplying heat to continue the process. It will be appreciated, therefore, that in prior art coking ovens, coking proceeds from the top of the coal downwardly, meaning that the coking time depends mainly upon the depth of the coal. As a rule of thumb, it can be said that the coking process proceeds from the top downwardly at the rate of about one-half inch per hour. Assuming, therefore, that the depth of the coal within the oven is two feet, the entire coking process takes forty-eight hours or two days.

In accordance with the present invention, however, the hot gases of combustion are passed beneath the silicon carbide floor 20 of the oven before passing to the stack 40 or 42. The silicon carbide, being of high heat conduction, readily conduct the heat from the hot gases passing through arch openings 28 and 34 to the bottom of the mass of coal. Accordingly, in the present invention, coking proceeds from the bottom of the coal upwardly as well as from the top downwardly, thereby materially increasing the speed of the process.

Further, in accordance with the invention, the smoke and other partially combusted materials from the green coal in oven A, for example, are passed through flues 51 and oven chamber B before passing to the stack 42. Thus, when oven chamber A contains green coal and chamber B contains hot coke as shown, the damper 46 is closed and damper 44 is opened. Consequently, the smoke and other gases of combustion from the green coal will pass through flues 51 along the path of the arrows, thence through oven chamber B, thence through passageway 52 and thence through arched opening 25 beneath the floor 20. Finally, the gases pass upwardly through passageway 38 and the stack 42 to the atmosphere.

Green coal is charged into oven chamber A, for example, after the coking process in chamber B is approximately one-half completed. Under these circumstances, the temperature above the hot coke bed in chamber B will be about 2500° F. It has been found by experimentation that when the smoke from green coal is passed through a chamber having a temperature above 2200° F., the partially combusted products are completely burned, whereupon the smoke from oven chamber A is not removed. It can be seen therefore, that passing the smoke from oven chamber A through chamber B has the effect of eliminating visible smoke from the products of combustion before they pass upwardly through the stack into the atmosphere.

After coking has been completed in oven chamber B under the conditions assumed, doors 52 and 54 are opened, the hot coke is removed, and green coal again charged through opening 16 of oven chamber B. By this time, however, coking of the coal within oven chamber A will be approximately one-half completed. Accordingly, the damper 44 is now closed and damper 46 opened, whereupon the smoke from the green coal in oven chamber B will pass across the partially coked material in oven chamber A before passing through passageway 30 and space 25 underneath the bottom 20 of chamber A to stack 40. The result, of course, is the same as before with the partially combusted products of combustion from the green coal being completely burned in passing over the hot, partially-coked coal in oven chamber A to substantially completely eliminate smoke passing into the atmosphere.

In FIG. 3, another embodiment of the invention is shown, wherein four furnace chambers 80, 82, 84, and 86 are illustrated in side-by-side relationship. Elements of FIG. 3 corresponding to those shown in FIGS. 1 and 2 are identified by like, primed reference numerals. In this case, however, only a single stack 60 is employed for every two adjacent furnace chambers, as, for example, chambers B' and C' in FIG. 3. This, of course, eliminates the triple wall construction between adjacent chambers shown in FIG. 1. In the case of FIG. 3, openings 48' and 50' are provided with dampers, schematically illustrated at 62 and 64, respectively, it being understood that dampers for an actual furnace installation may be of a different form. Similarly, arch openings 28' beneath the chambers are provided with dampers, schematically illustrated at 66 and 68. In the operation of the system, dampers 64 and 66 will be opened while dampers 62 and 68 are closed. Under these circumstances, smoke from green coal within oven chamber B', for example, will pass through flues 51 and oven chamber C' where the products of combustion are completely burned. Therefore, it will pass through opening 60' having open damper 64 therein, vertical passageway 32', opening 28' having open damper 68 therein, and vertical passageway 70 between chambers B' and C' to the stack 60.

When the condition of the two ovens is reversed and oven chamber C' contains green coal while chamber B' contains hot coke, dampers 64 and 68 will be closed while dampers 62 and 66 are opened to permit the products of combustion to flow from chamber C' to chamber B', thence through opening 48' having open damper 62 therein, passageway 30', and through arch openings 28' and 34' beneath chamber B' to passageway 70 and the stack 60.

Coke ovens of the type shown herein are normally built in long rows; and it can be appreciated that with the arrangement shown in FIG. 3 the passageways 30' and 32' are continually used, either by one set of adjacent coke chambers, or the next adjacent set.

With reference now to FIGS. 4 and 5, a simplified form of the invention is shown as applied to conventional non-recovery coke ovens wherein the floor or sole of the oven is not heated. In this case, two oven chambers A" and B" are again shown, the chamber A" containing hot coke and the chamber B" containing green coal. Each chamber includes a floor 70 and upstanding side walls 72, 74 or 76 provided with arched roofs 78 as in the previous embodiment. The arched roofs 78 are again provided with openings 80, 82, 84 and 86, each structure 84 or 86 is normally covered with a plate 88 at all times except...
when green coal is charged into its associated oven chamber.

A single stack 90 is provided for both of the oven chambers; and this stack communicates through passages 92 and 94 with the openings 80 and 82, respectively. As best shown in FIG. 5, the stack 90 is displaced rearwardly with respect to the cylindrical structures 84 and 86; however the particular positioning of the stack is unimportant inasmuch as the green coal preferably will be fed into the openings 80 and 82 on conveyor belts or the like.

At opposite ends of the common wall 74 between oven chambers, as best shown in FIG. 5, are openings 96 and 98. Dampers 100 and 102 are provided to selectively close off the opening 80 or 82. In the operation of the system, the damper for the oven chamber containing hot coke—in this case damper 100—will be opened while the other damper 102 for the oven chamber containing green coal will be closed. Under these circumstances, the smoke from the green coal in oven chamber B" will flow through the openings 96 and 98 at the ends of wall 74 and thence through opening 80 and passageway 92 to the stack 90. The openings 96 and 98 are disposed at opposite ends of the wall 74 in order to afford a longer path of travel for the smoke over the hot coke in oven chamber A". That is, if the smoke were passed through an opening in wall 98 which was immediately below the opening 80, its path of travel through the hot oven chamber A" would be relatively short. However, by forcing the smoke to flow into oven chamber A" at the opposite ends thereof, it will be caused to pass over a longer length of the hot coke to insure that the unburned products comprising the smoke will be substantially completely burned before passing to the stack 90. This feature, of course, is not absolutely necessary in the embodiments of FIGS. 1-3 for the reason that the smoke must pass along the hot sides and underneath the oven chambers where combustion of the unburned products can be achieved.

Although the invention has been shown in connection with certain specific embodiments, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

I claim as my invention:

1. Coke producing apparatus comprising a pair of oven chambers arranged in generally side-by-side relationship, a stack for conducting products of combustion to the atmosphere, and means for conducting partially burned products of combustion from green coal in one of said chambers through the other chamber containing hot coke and thence to said stack whereby the products of combustion from the green coal will be substantially completely burned in passing through said other chamber before passing to the stack, the means for conducting products of combustion to the stack including a passageway beneath said other chamber containing hot coke, whereby the floor of said other chamber will be heated by the products of combustion passing to the stack and coking will proceed from the bottom of the charge within said other chamber upwardly as well as from the top downwardly.

2. The coke producing apparatus of claim 1 wherein the bottoms of said oven chambers are formed from refractory material of high heat conductivity.

3. The coke producing apparatus of claim 1 wherein the bottoms of said oven chambers are formed from silicon carbide.

4. Coke producing apparatus comprising a pair of oven chambers arranged in generally side-by-side relationship, a pair of stacks for conducting products of combustion to the atmosphere, passage means for conducting partially burned products of combustion from green coal in a first of said chambers through the second chamber containing hot coke and thence to a first of said stacks, passage means for conducting partially burned products of combustion from green coal in the second chamber through the first chamber containing hot coke and then to the second of said stacks, damper means in said first stack which is closed when the first chamber contains green coal, and damper means in the second of said stacks which is closed when the said second chamber contains green coal, the passage means for conducting products of combustion to said first and second stacks further including passageways extending beneath said first and second chambers, respectively, said passageways being in heat-conducting contact with the bottoms of said chambers.

5. The coke producing apparatus of claim 4 wherein the passage means for conducting products of combustion to said first and second stacks includes passageways extending beneath said second and first chambers, respectively, and refractory material of high heat conductivity at the bottoms of said chambers for conducting heat from said passageways to the bottoms of charges of coal placed within the said chambers.

6. In the method for producing coke in a pair of coke oven chambers arranged in generally side-by-side relationship, the steps of conducting partially burned products of combustion from green coal in a first of said chambers through the second of said chambers containing hot coke, conducting said products of combustion beneath the floor of the second of said chambers and thence to the atmosphere whereby the floor of said second chamber will be heated to cause coking to proceed from the bottom of the chamber upwardly as well as from the top of the chamber downwardly, conducting to coke coal in both of said chambers, removing coked coal from the second of said chambers after coking has been completed therein and charging it with green coal, thereafter conducting partially burned products of combustion from the green coal then in the second of said chambers through the first chamber which then contains hot coke, conducting said latter-mentioned products of combustion beneath the floor of said first chamber and thence to the atmosphere whereby the floor of the first chamber will now be heated to cause coking to proceed from the bottom of the first chamber upwardly as well as from the top downwardly, the products of combustion from the green coal being substantially completely burned in passing through the chamber containing hot coke before passing to the atmosphere.

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