

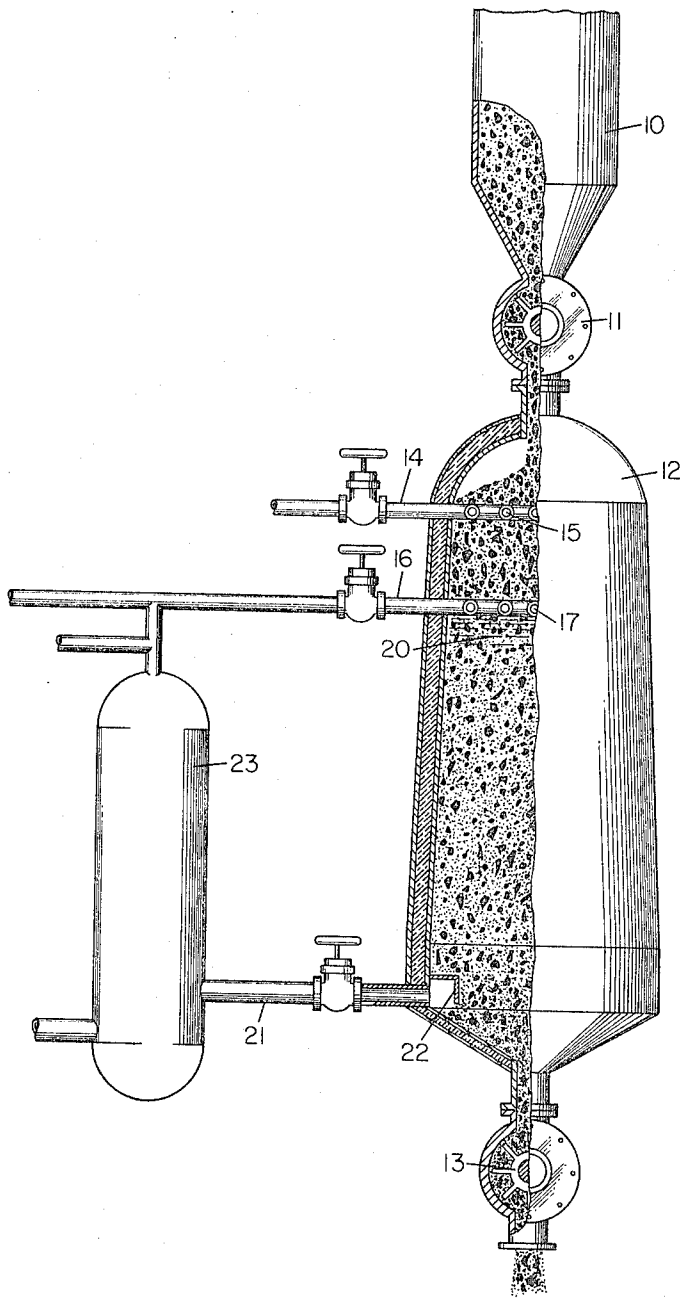
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PROCESS OF CALCINING COKE

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PROCESS OF CALCINING COKE

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The portion of the term of the patent subsequent to July 21, 1981, has been disclaimed
16 Claims. (Cl. 201-20)

My invention relates to calcined coke and to a process for its preparation. More particularly the invention relates to a process wherein coke is calcined by passing an oxidant and coke through a retort in a cocurrent direction.

Nearly everyone is acquainted with coal furnaces or with coal fires in a home grate. In both these devices the flow of air is generally countercurrent to the flow of coal or coke; and substantially all of the combustible matter is burned, the burning rate depending on the air throughput.

I have now discovered that, contrary to what would be expected, only minor amounts of coke are consumed in a furnace or retort when the air flow is reversed, i.e., the coke and oxidant flow are cocurrent and are both countercurrent to the movement of the combustion zone. Furthermore, calcined cokes of unique properties; for example, varying but generally low density, porous structure, and volatile combustible matter content; can be produced readily in simple coking furnaces. These results probably arise from the temperature profile within the retort.

In the usual furnace the temperature rises to a peak as the combustion zone is approached and falls rapidly behind the combustion zone. In the process of the instant invention, the temperature remains low, rises abruptly within the combustion zone and remains high after the combustion zone is passed.

A study of gas flow in the two types of combustion explains this phenomenon. In the case where air flow is countercurrent to coke flow, cool air passes through the burned materials and is heated as it approaches the combustion zone. It is further heated in the combustion zone and loses its heat as it passes through the unburned matter preceding the combustion zone. In the case of cocurrent air flow, the air remains cool until it contacts the combustion zone, is rapidly heated and remains hot as it flows along with materials which have passed through the combustion zone.

I have no completely satisfactory explanation for the fact that all of the combustible matter burns in the usual situation and little burns in the process of this invention. It may be that, as the relatively cool coke contacts the combustion zone, volatiles near the surface of the coke escape into the gas stream and burn, thereby exhausting the available oxygen so that no further burning can take place. In such a situation, the combustion would be substantially in the gas phase and would move ahead with relative rapidity leaving calcined coke rather than ash.

Conversely, in the usual process where the flow of oxidant is countercurrent to the flow of combustible matter, the volatiles are distilled off and exhausted by hot flue gases and only solids are left to burn. The combustion zone, therefore, moves more slowly through the solid phase and converts it completely to ash.

It might also be that in the usual process all of the solid combustible matter is burned because it is heated to combustion temperatures by the time it reaches the combustion zone, while in the process of this invention the combustible matter is relatively cool until it enters the combustion zone. This fact may also explain the unique properties of calcined coke made by my new process.

A better understanding of my invention can be obtained by reference to the drawing, which is a front elevation of a retort and associated equipment suitable for the process of this invention. The retort is partly broken to show internal equipment and material movement.

Typically, sized coke is fed from hopper 10 through valve 11, here shown as a star feeder, into retort 12. The valve prevents any substantial pressure leak. Retort 12 is bell-shaped and terminates in the conical bottom portion. Valve 13 discharges calcined coke from the retort without substantial loss of pressure.

After coke enters retort 12 through valve 11, it piles and moves downwardly through the retort by gravity flow. Where desired, the incoming coke is preheated by hot inert gas, usually flue gas, introduced through preheater gas input pipe 14 and nozzle header 15. An oxidant is distributed throughout the width of the coke via oxidant input pipe 16 and header 17.

The unignited coke passes downwardly into the combustion zone 20, indicated by the dashed lines just below header 17. The combustion zone tends to rise in the retort but is substantially fixed by controlling the volume of coke and oxygen-containing gas.

Substantially all of the available oxidant is consumed at the face of the combustion zone thereby limiting the combustion zone depth to a few inches, a small volume when compared to the total treatment zone.

The area below the combustion zone contains coke which is above its spontaneous ignition temperature but which, due to a lack of oxidant, does not burn. It is in this area that calcination takes place. The calcination time is controlled by varying retort depth and the rate of coke and oxidant throughput. Preheating aids in temperature control and in combustible gas and liquid recovery from the furnace.

Combustion gases are exhausted through pipe 21, protected by flange 22, and are separated from the condensable hydrocarbons by known means such as by partial condensation in condenser 23. If desired, a portion of the noncondensable gases can be recycled for preheating purposes into retort 12 through inlet 14. Insulation in retort 12 prevents substantial heat loss.

The process of this invention is useful for calcining any coked material but is particularly useful in calcining petroleum cokes. The process is especially useful in calcining the so-called "fluid" and "delayed" petroleum cokes and is preferably used for this purpose. Volatile combustibles can be economically recovered where the coke contains in excess of about 15 percent by weight volatiles.

The oxidant used in the instant process can be oxidant gases such as fluorine, chlorine, nitrogen dioxide, and the like but is preferably oxygen or mixtures thereof with inert gases. Examples of such mixtures include air or oxygen-superheated steam mixtures. The oxidant can be preheated to any desired temperature prior to use in the process.

The amount of oxidant required in a particular process would depend on the oxidant used, the coke to be calcined, the desired combustion zone temperature, and the desired volatile combustible matter content of the final product. The amount of oxidant required can be determined for a particular process through the use of routine techniques. Generally, however, the oxidant introduced into a reactor will be that amount required to completely oxidize only about 2-25 percent, by weight, of the coke being calcined. Preferably, sufficient oxidant is utilized to completely burn from about 5 to about 10 percent, by weight of coke, of the total charge.

The preheating temperature, and coke and oxidant throughput should be regulated to maintain a temperature of about 540 to about 1400° C. and preferably from about

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815 to about 1360° C. at and just below the combustion zone. The highest temperatures are obtained at the forward face of the combustion zone where most of the oxygen is consumed. There is a continuing slow temperature drop as the calcined coke passes away from the combustion front.

The following example further illustrates my invention; and it is not intended that my process be limited to operation in the furnace shown, disclosed coke, reaction temperatures, etc. Rather it is intended that all equivalents obvious to those skilled in the art be included within the scope of my invention as claimed.

Example

In a series of experiments, fluidized coke, sized to pass through a 20-mesh screen, was used to fill an insulated tube furnace 3 in. I.D. x 4 ft. long. The fluidized coke had a bulk density of about 1.59 and volatile combustible (VCM) content of 5.40 percent, by weight. Air was flowed into the top of the sealed tube and the exit of gases from the tube was controlled to maintain a 10-lb. pressure at the top of the tube. The pressure drop across the tube was normally about 6 lbs. The coke was ignited at the bottom of the tube with an electric heater. As the combustion front passed up the tube, heat was added to the system at the combustion zone area by use of external resistance coils. Normally the temperature of the resistance coils ranged between about 200 and 375° C.

The following table sets out various operating conditions and results. The yield includes only the residual coke. Volatile hydrocarbon products are not included.

Run No.	Final percent VCM	Percent Yield	Air Flux (s.c.f.h./ft. ²)	Velocity of Burning Front (ft./hr.)	Temperature of Burning Front (°C.)
1.-----	1.94	85.7	800	1.5	749
2.-----	3.01	91.5	408	1.0	704
3.-----	4.81	97.8	137	0.5	538

As shown in the above example, the combustion zone heat can be augmented. Thus noncondensable or condensable fuels in the flue gases can be recycled into the combustion zone in the preheating step. Alternately, the coke to be fired can be wetted with a noncoking hydrocarbon fuel prior to being passed into the furnace. Thus, for example, the particles could be wetted with kerosene or naphtha and fed into the furnace.

Now having described my invention, what I claim is:

1. A continuous process for calcining coke comprising in combination the steps of passing coke particles as a moving bed cocurrently into a combustion zone with an amount of oxidant stoichiometrically insufficient to cause complete combustion of the coke under conditions such that only a minor portion of the coke is oxidized, the remaining coke being calcined, without substantial oxidation, by heat imparted from the combustion; and thereafter passing both the solid and gaseous products from said combustion zone through a zone containing insufficient oxidant to support combustion.

2. The process of claim 1 wherein a supplementary fuel is also introduced into the combustion zone cocurrently with the coke and the oxidant and wherein the combustion zone temperature is maintained at from about 540 to about 1,400° C.

3. The process of claim 2 wherein the supplementary fuel is selected from the group consisting of liquid and gaseous hydrocarbon fuels.

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4. The process of claim 1 wherein the oxidant is sufficient to oxidize from about 2 to about 25% by weight of the coke.

5. The process of claim 1 wherein the combustion zone is restricted and the amount of oxidant is limited to that amount required to maintain a temperature of from about 540 to about 1,400° C. in the combustion zone.

6. The process of claim 5 wherein the combustion zone temperature is maintained at from about 815 to about 1,360° C.

7. The process of claim 5 wherein from about 5 to about 10% by weight of the coke passed into the combustion zone is burned.

8. The process of claim 1 wherein the coke and the oxidant are preheated prior to passing into the combustion zone and wherein the combustion zone is maintained at a temperature of from about 540 to about 1,400° C., and wherein the calcined coke is thereafter recovered downstream from the combustion zone.

9. The process of claim 8 wherein the combustion zone temperature is maintained within the range of from about 815 to about 1,360° C.

10. The process for the preparation of the calcined petroleum coke comprising passing cocurrently into a combustion zone having a temperature of at least about 540° C. coke as a moving bed, and a stoichiometrically limited amount of oxidant insufficient to cause complete combustion of the coke, wherein combustion of the oxidant and a minor portion of coke occurs within a restricted combustion zone to form calcined coke, thereafter maintaining the coke at an elevated temperature for a predetermined period and passing both the solid and gaseous products from said combustion zone through a zone containing insufficient oxidant to support combustion and thereafter recovering calcined coke.

11. The process of claim 10 wherein a supplementary fuel is also passed cocurrently into the combustion zone and is burned in the combustion zone with the oxidant to maintain a reaction zone temperature of from about 815 to 1,360° C.

12. The process of claim 11 wherein from about 2 to about 25% by weight of coke is oxidized in the combustion zone.

13. The process of claim 11 wherein from about 5 to about 10% by weight of the coke is oxidized in the combustion zone.

14. The process of claim 11 wherein the supplementary fuel is selected from the group consisting of liquid and gaseous hydrocarbon fuels.

15. The process of claim 11 wherein the oxidant is selected from the group consisting of oxygen and mixtures of oxygen with an inert gas.

16. The process of claim 11 wherein the oxidant is selected from the group consisting of the halogens, nitrogen dioxide, and oxygen-containing gases.

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