

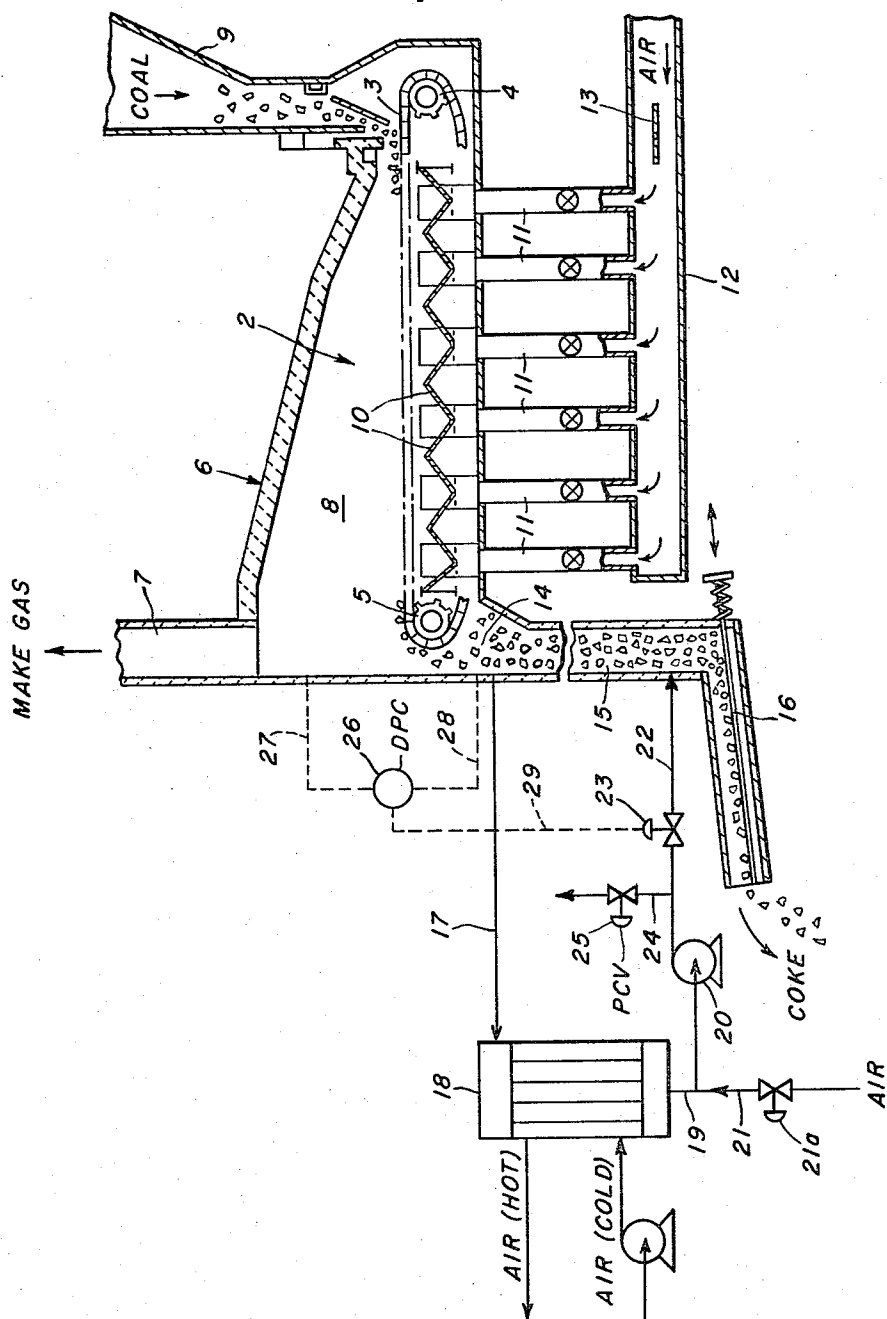
Jan. 10, 1967

L. W. ALBERTS

3,297,550

METHOD OF AND APPARATUS FOR THE MANUFACTURE OF COKE

Filed Sept. 23, 1963



INVENTOR.

LEONARD W. ALBERTS

By

Christy, Parmelee & Strickland
Attorneys

1

3,297,550

METHOD OF AND APPARATUS FOR THE
MANUFACTURE OF COKE

Leonard W. Alberts, Bethel Borough, Pa., assignor to
Blaw-Knox Company, Pittsburgh, Pa., a corporation
of Delaware

Filed Sept. 23, 1963, Ser. No. 310,586

8 Claims. (Cl. 201-27)

This invention is for the manufacture of coke by the use of a coking stoker and relates particularly to a method and means whereby gases generated from coking of coal on the coking stoker, referred to in the industry as "make-gas," are for all practical purposes free of oxygen.

Coking stokers are well known in the industry. In general they comprise a traveling grate such as an endless belt type of grate that moves through an enclosure from a receiving end where coal is loaded onto the grate to a discharge end where the coal is discharged as finished coke. During its travel through the closed environment, air is introduced to the fuel through the grate. When the stoker is in operation this air is utilized to burn volatiles released from the coal. The heat of combustion, either directly or by radiation from the walls of the enclosure, heats the incoming coal to coking temperature, the temperature of the coal increasing toward the discharge end of the grate. In most operations the volatiles are completely burned and supply heat for some external purpose, as for example the firing of a kiln or the generation of steam.

In recent years, however, the use of coking stokers for the production of chemical coke has become increasingly prevalent. Such coke is used in the chemical industry as a reducing agent, or for other purposes. In this operation the amount of volatiles released is much greater than that required to supply the heat needed for operation of the coking stoker. It has therefore been proposed to utilize the gases from the coking stoker as raw material for the manufacture of other chemicals. By way of illustration, and not by way of limitation, one process contemplates the use of these gases for the production of methanol, pure hydrogen and pure CO or mixtures thereof.

One obstacle to the use of the gases from the coking stoker in this way has arisen from the difficulty of excluding significant amounts of oxygen from the gases, with the result that somewhere along the line of processing these gases explosive mixtures may result, or the oxygen be otherwise either detrimental or dangerous to such use of them.

The present invention has for its principal object to provide a method and means whereby the make-gas from a coking stoker may be free, or for all practical purposes free, of oxygen.

A further object of the invention is to provide a novel method and apparatus wherein the coking of the coal is incompletely finished on the coking stoker, and thereafter completed in a finishing section into which the incandescent, but still incompletely coked fuel is discharged, there being supplied to the coking stoker only sufficient combustion air for the operation of the stoker while additional air is supplied in the finishing section to complete the coking operation.

A further object of the invention is to provide for the regulation of gas pressure in the coking stoker and finishing section such that gas flow from the finishing section to the stoker is prevented, whereby the oxygen-free gases from the stoker cannot be contaminated by oxygen-containing gas from the finishing section, the apparatus providing what may be termed a "pressure barrier" that al-

2

lows continuous passage of the incompletely finished coke from the coking stoker to the finishing section, but which prevents a flow of gas in the reverse direction.

In general the invention provides a coking stoker of usual construction within an enclosure and with provision for supplying air through the traveling grate in the usual manner. The air supply is regulated so as to furnish within the enclosure of the stoker all of the combustion air needed to continuously effect the coking operation, but insufficient to burn all of the combustible gases that are released from the coal. Under these conditions all of the oxygen will be utilized, and the gases from the stoker will be free, or substantially free, or uncombined oxygen. The operation of the stoker is carried out in such fashion that while most of the volatiles have been driven out of the coal on the stoker, the coking is not entirely complete when the coal is discharged from the stoker. The unfinished coke so discharged moves continuously into a finishing section or enclosure. The finishing section is provided with a duct near the end where the coke is received, through which gases may be withdrawn and recycled, preferably after being cooled, to this finishing section at a place remote from the place from which the gases are withdrawn, and preferably close to the coke discharge end of the finishing section. The recycling of the gas is effected by the use of a blower, and provision is made for introducing air into the stream of recycled gases in a controlled amount. The recycled gases along with air circulate through the body of coke in the finishing section, initially effect a cooling of the coke, but further along in the travel of these recycle gases through the finishing section the oxygen-containing gas reaches an ignition temperature and the heat then generated is used to drive off the remaining volatile matter in the coke, thus producing the desired qualities in the final product.

A differential pressure regulator operatively connected on one side with the interior of the enclosure forming part of the coking stoker, and on the other side with the finishing section near the point where the stoker discharges into said section, regulates the recycling of the gases in such manner that the pressure at this point in the finishing section will never exceed, and perhaps be slightly lower than the pressure in the enclosure above the coking stoker. Consequently there can never be any flow of gases from the finishing section into the space above the stoker, and if there is any transfer of gases, the flow will be always out of the stoker enclosure into the finishing section. Consequently oxygen which is used in the finishing section, or which may enter the finishing section as coke is discharged, can never mingle with or adulterate the make-gas from the stoker. On the other hand adequate air can be circulated through the finishing section to assure the desired quality of coke.

Due to the resistance of the coke in the finishing section to the passage of the recycled gases and inducted air from their point of introduction to the place of withdrawal of the recycle gas from the finishing section, there will be a considerable pressure drop between the point where the gases enter the finishing section and the point from which they are removed. A pressure controlled valve is adjusted to vent or "bleed off" some of the recycle gases, whereby the pressure at which the recycle gases enter the finishing section may be kept at a predetermined maximum. Once operation has been established, the apparatus thus becomes substantially self-regulating. Since the gases from the stoker section are practically free of oxygen, they may be withdrawn for use as raw gas in subsequent processes, particularly the manufacture of ammonia and processes known to the petro-chemical industry. Since it is desirable to recover

3

as much make-gas as possible from the stoker, coking is carried as completely as is safely possible on the coking stoker so as to avoid unnecessary loss of volatiles or gases in the vent from the recycle gases in the finishing section.

The invention may be more fully understood by reference to the accompanying drawing showing a schematic diagram of an apparatus embodying my invention for the practice of the process.

In the drawing, a coking stoker is designated generally as 2. It has an endless traveling gate 3 passing around a drive sprocket 4 at its charging end and around a guide sprocket 5 at its discharge end. The grate is within an enclosure 6, the top and sides of which are refractory-lined, and the roof slopes upwardly toward a "make-gas" outlet 7 over the discharge end of the grate. The space 8 thus enclosed above the grate provides a plenum chamber for both combustion gases and volatiles from the coal.

At the charging end of the grate there is a feed hopper 9 for delivering coal to the top of the grate. Air is supplied through a series of transverse wind boxes 10 between the two horizontal reaches of the conveyor. Each wind box has an air duct 11 leading from a manifold 12 connected with a blower (not shown). Regulating dampers are not indicated in each duct 11, and means are provided for controlling the overall flow through the manifold, as schematically indicated by damper 13.

At the discharge end of the grate is a chute or throat 14 forming a passage into a finishing section 15, which may be of many different forms, but which, for simplicity of construction and illustration of the invention, is simply a vertical column or enclosure into which the material from the stoker falls, and which provides a relatively large holding section for the final treatment and cooling of the coke. It is here shown as having a vibrating discharge conveyor 16 extending laterally from the bottom.

As here shown there is a duct 17 leading from near the top of the finishing section through a heat exchanger 18. There is an outlet duct 19 leading from the heat exchanger to the intake of a blower 20, and a connection 21 in the line 19 admits air. The blower 20 discharges into a duct 22 opening into the lower part of the column or finishing section 15, and in this duct there is a valve 23. Between the blower 20 and the valve 23 there is a vent pipe 24 in which is a pressure-controlled valve 25.

The valve 23 is regulated by a differential pressure controller 26 which responds to pressure in the plenum chamber 8 and the upper portion of the column 15, as indicated by the dotted lines 27 and 28. Dotted line 29 indicates the communication between the differential control and the valve 22 which it regulates, and the adjustment is such that the introduction of recycled gases and air is so controlled that the differential pressure between lines 27 and 28 will be as close to zero as possible, but with any differential always being lower in the upper part or receiving end of the finishing column than in the plenum 8. Air flow through air inlet pipe 21 is controlled through a valve 21a.

In the operation of this equipment coal is fed to the coking stoker and moved continuously through the closed environment to the discharge end. Assuming the process to be in operation, air is passed upwardly through the grates in an amount sufficient to burn enough of the volatiles to maintain a coking temperature within the chamber so that the fuel becomes progressively hotter as it approaches the discharge end of the stoker. The air so admitted is insufficient to support combustion of all of the volatiles, so that the make-gas discharged at 7 is oxygen-free, at least for all practical purposes.

In order that the make-gas may be oxygen-free, complete removal of the volatiles and finishing of the coke cannot be completed on the coking stoker. The fuel is therefore discharged from the stoker before coking has been completed, and it is continuously discharged from the stoking grate into the chute 14 and into the receiving

4

end, or as here shown, the top, of the finishing section. Here the still unfinished coke progresses through the finishing section.

Gases from the receiving end of the finishing section are withdrawn through conduit 17, cooled by the heat exchanger 18, and circulated by pump 20 back to the finishing section, preferably near its lower or discharge end. With the cooled recycle gases, sufficient air is inducted through pipe 21 and valve 21a to supply adequate oxygen to burn out the residual volatiles from the coke.

The differential pressure controller 26, which is a well-known type of instrument, regulates the valve 23 so that the pressure at the entering end of the finishing section never exceeds the pressure in plenum chamber 8 within the coking stoker enclosure. An ideal regulation would be a zero differential in pressure so that there would be no interchange of gases between the chamber 8 and the receiving end of the finishing section. However, for practical reasons the pressure in the entering end of the finishing section is slightly lower than the pressure in the chamber 8, assuring that any flow of gas will be from the chamber 8 into the finishing section. This can be regulated to a very inconsiderable flow, so as to avoid waste of the make-gas from the coking stoker. The controller 26 opens the valve 23 if there is too great a differential pressure, allowing more gas to flow into the finishing section, and it restricts the flow through valve 23 if the pressure at the entering end of the finishing section tends to increase above a level of equilibrium with the pressure in chamber 8. Thus, the operation as pointed out above, provides a pressure barrier to the flow of gases from the finishing chamber to the chamber 8 but in no way impedes the continuous flow of incompletely coked fuel to the finishing chamber. The body of coke in the finishing section between the receiving end and the level where pipe 22 supplies the recycle gas and air causes a pressure drop between the discharge from pipe or duct 22 and the level of the pipe or duct 17. The increase in volume of the recycle gases due to the introduction of air, the burning of volatiles and flow from chamber 8 into the finishing section is relieved by vent 24 and pressure-controlled valve 25, this valve opening in accordance with a build-up of pressure between pump 20 and valve 23. The vent gases may be disposed of as may be feasible, either being wasted entirely, or used as a fuel in a boiler, or otherwise.

The cooling of the recycle gases is desirable because the purpose of these gases is to cool the coke in the lower portion of the finishing section so that when the coke is discharged through outlet 16 it will not burn or require quenching. Air alone could not be used since it would burn the coke, and the recycle gases used for this purpose are inert with respect to the coke. Only sufficient air is used to assure the removal of the small amount of residual volatiles in the coke in the finishing section with minimum combustion of the carbon in the coke itself.

While I have shown one specific embodiment of an apparatus embodying this invention, it will be apparent to those skilled in the art that the invention may be embodied in and practised with apparatus otherwise constructed.

Also, while the air in the finishing section may desirably be mixed with the recycle gases, it may be separately introduced at a different or higher level, or through the discharge 16, so long as it has an opportunity to eventually flow through the incandescent coke in the receiving end of the finishing section sufficiently to remove the small amount of residual volatiles.

I claim:

1. The process of preparing coke from coal which comprises moving it continuously through a closed environment, admitting air to said environment and burning only a part of the volatiles in the environment to sustain the coking operation while consuming all of the oxygen from the air so admitted, transferring incompletely coked fuel

5

from said closed environment to a finishing section having a receiving end and a discharge end, withdrawing make-gas from said closed environment, recycling gas from the receiving end of the finishing section and returning it only to the finishing section at a location remote from the receiving end for cooling the coke, introducing air into the recycled gases in an amount to complete the coking of the fuel but insufficient to substantially burn the coke, and regulating the flow of recycled gases and air so that the pressure in the receiving end of the finishing section is slightly negative with respect to the pressure in said closed environment to provide a pressure barrier against flow of gases from the finishing section into said closed environment.

2. The process of coking coal as defined in claim 1 wherein all of the recycle gases are cooled after they are withdrawn from the finishing section and before they are again introduced to said section.

3. The process of preparing coke from coal which comprises:

- (a) moving the coal continuously through a first closed environment,
- (b) incompletely coking the coal in said environment to release most of the volatiles therefrom by burning with air only such portion of the volatiles as is necessary to sustain the partial coking operation and consume all of the oxygen in the air so supplied,
- (c) withdrawing oxygen-free gases from said closed environment,
- (d) continuously discharging incompletely coked coal from said environment into a communicating second environment having a receiving end and a discharge end in which the coking operation is completed and wherein the coal moves from the receiving end to the discharge end,
- (e) continuously removing gases from the second environment through a withdrawal duct adjacent the receiving end, cooling it and recycling it into said second environment near the discharge end,
- (f) continuously introducing air required to complete the coking operation with the recycled gas,
- (g) continuously venting a portion of the gases being recycled before re-entering said second environment, and
- (h) regulating the pressure of the air and recycled gases in the second environment at a level where gases at the inlet end thereof will be removed entirely through said withdrawal duct and thereby prevented from flowing into the first environment.

4. The process defined in claim 3 wherein the coal is carried through said first environment on a stoker and is removed from said stoker at the end of its travel in the first environment and moves vertically in a column by gravity through said second environment with the gas withdrawal duct being near the upper end of said column and the air and recycled gases are introduced near the bottom of said second environment.

5. Apparatus for coking coal comprising:

- (a) a coking stoker having a traveling grate and an enclosure through which the grate travels,
- (b) means for supplying coal to one end of the grate,

6

(c) means for supplying a controlled supply of combustion air to the stoker,

(d) a finishing section into which the stoker discharges coke, said section having a receiving end and a discharge end,

(e) means for introducing air into the finishing section at a point remote from the receiving end,

(f) means for withdrawing gases from the receiving end of the finishing section, and

(g) means for maintaining a regulated pressure barrier between the stoker enclosure and the receiving end of the finishing section by the withdrawal of gases from said receiving end at a rate sufficient to prevent the flow of gases from the finishing section into the stoker enclosure.

6. Apparatus for coking coal comprising:

(a) a coking stoker having a traveling grate and an enclosure through which the grate travels,

(b) means for supplying coal to one end of the grate,

(c) means for supplying a controlled supply of combustion air to the stoker,

(d) a finishing section into which the stoker discharges coke, said section having a receiving end and a discharge end,

(e) means for introducing air into the finishing section at a point remote from the receiving end,

(f) means for withdrawing gases from the receiving end of the finishing section,

(g) means for cooling and recycling the gases so withdrawn to the finishing section near its discharge end,

(h) a differential pressure controller responsive to pressures in the enclosure for the grate and the receiving end of the finishing section,

(i) a valve regulated by the differential pressure controller for regulating the flow of recycled gases into the finishing section for preventing the pressure at the receiving end of the finishing section exceeding the pressure in the stoker enclosure, and

(j) means for venting surplus gas not needed for recycling to the finishing section.

7. Apparatus for coking coal as defined in claim 6 wherein the means for introducing air is arranged to mix the air with the recycle gas.

8. Apparatus for coking coal as defined in claim 6 wherein the means for recycling the cooled gases includes a blower interposed between the cooling means and the finishing section, said valve which is regulated by the differential pressure controller being operatively interposed between the blower and the finishing section, the means for venting surplus gas not needed for recycling comprising a pressure regulating vent valve operatively interposed between the blower and the first-named valve.

References Cited by the Examiner

UNITED STATES PATENTS

2,406,810	9/1946	Day	202—15
3,013,951	12/1961	Mansfield	202—117 X
3,167,487	1/1965	Mansfield	202—22

MORRIS O. WOLK, *Primary Examiner*.

J. H. TAYMAN, Jr., *Assistant Examiner*.