

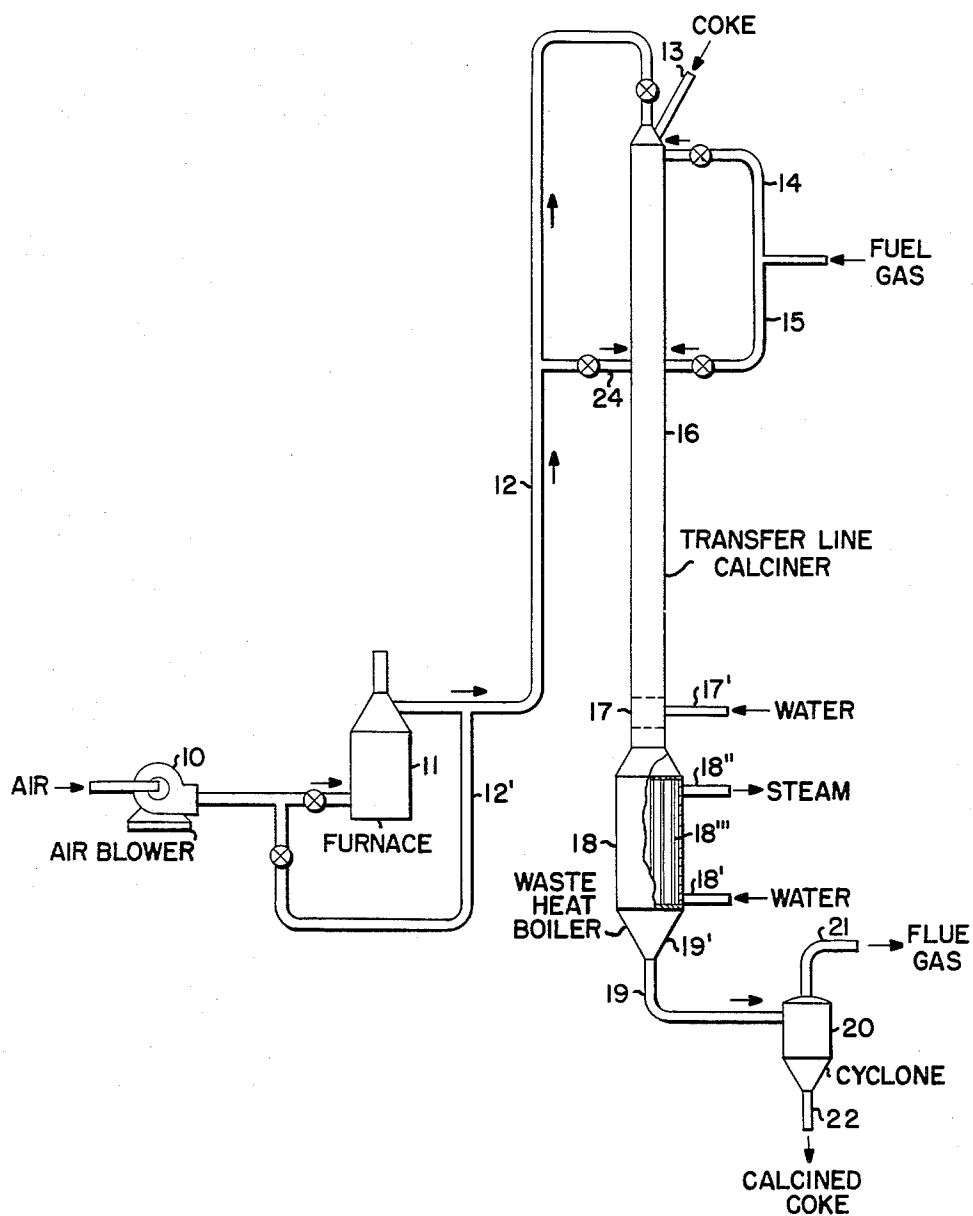
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TRANSFER LINE COKE CALCINER

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## TRANSFER LINE COKE CALCINER

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5 Claims. (Cl. 201-17)

This invention relates to a process and apparatus for the calcination of coke particles made in a fluid coking process. More particularly, the invention relates to a single-stage calcination process and apparatus wherein fluid coke particles are suspended in a gaseous medium, rapidly heated to a calcination temperature, and the gaseous suspension of coke particles is then cooled or quenched before the coke is separated from the suspending gaseous medium.

Fluid coke is produced as one product in the fluid coking process for the conversion of residual petroleum oils and the like to lower boiling hydrocarbons, such as gas oil. The fluid coking process is described in Pfeiffer et al., U.S. Patent 2,881,130, granted April 7, 1959. Various uses have been suggested for the fluid coke particles which have a particle size between about 150 and 250 microns on the average. To improve the quality of the fluid coke particles, it is necessary to calcine the coke particles, i.e., they are heated to a temperature between about 1600° F. and 3000° F. to remove volatile materials from the coke particles, the heating being relatively prolonged if the coke particles contain a high percentage of sulfur. Calcination increases the density of the coke particles and lowers their electrical resistivity. The combustible volatile material released during calcination is burned in preference to the coke product and so helps in supplying heat to fluid coke particles in the calcination vessel.

Various methods for the calcination of coke from the fluid coking process have been devised. One type of process involves the use of a transfer line burner wherein the fluid coke in a gas suspension is rapidly heated to a temperature up to about 2500° F., the purpose of this being to devolatilize the coke. The hot mixture of coke and gases is then passed to a cyclone separator where the hot fluid coke particles are separated from the gases. Following this, the separated hot coke particles may be conveyed to a heat soaker where they are retained for a period of time at a high temperature to complete the devolatilization process. A great disadvantage of this process resides in the fact that since, the coke leaves the transfer line at a temperature of about 2500° F., the cyclone separator to which it is conveyed must be built of extremely expensive heat-resistant materials. Furthermore, the cyclone must be very large since at 2500° F., the volume of the gases leaving the transfer line is very great.

It is proposed in this invention to cool or quench the calcined coke particles before they pass from the transfer line to the cyclone separator or other separating means. This will reduce the temperature and volume of the solid-gas suspension so that a smaller, conventionally-constructed cyclone of much lower cost may be used. Although it would be impossible to heat soak this cooled coke, it has been found that heat soaking is unnecessary to produce coke of high density and low electrical resistivity if the coke has a low sulfur content.

It is an object of this invention to calcine fluid coke in a single-stage process by heating it rapidly in a high velocity transfer line heater.

It is a further object of this invention to minimize the combustion of coke in the transfer line by adding extraneous fuel thereto.

Another object of this invention is to permit the use

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of a conventionally-constructed cyclone separator or the like in the calcination process by cooling or quenching the coke as it leaves the transfer line and before it is introduced into the cyclone separator.

Other objects and advantages of the invention will become apparent during the course of the following description and discussion of the accompanying drawing.

Referring now to the drawing, coke, which may be cold or at a temperature of about 1000° F. as it comes from a fluid coke burner, is introduced into the upper portion of transfer line burner or heater 16 through line 13. While the transfer line burner is shown as vertically arranged, it can be inclined at any angle or even horizontally arranged. The embodiment of the invention indicated in the drawing indicates a downflow; however, it is possible alternatively to arrange the apparatus so that the gaseous-solid suspension flows upwardly, or flows at any angle to the horizontal, including horizontal flow itself.

Transfer line burner 16 may be between 20 and 100 feet long, preferably between about 30 and 80 feet long. In the specific example, it is 60 feet long. Its inside diameter may be any size within practical limits of construction and depends on coke feed rate. Any coke feed rate is possible, although this example predicates a feed rate of about 200 tons per day, and an inside diameter of burner 16 of about 3½ feet. Between about 3500 and 4000 s.c.f.m of air leaves blower 10 and after its temperature is raised to about 1000° F. to 1300° F. in furnace 11, the heated air is introduced into the upper portion of the transfer line burner through line 12. If desired, the air need not be preheated and may be utilized at room temperature by being passed around furnace 11 through line 12'. Between about 150 and 300 s.c.f.m. of a gaseous fuel such as methane, natural gas, or the like enters the upper portion of transfer line burner 16 through one or more branched, vertically spaced lines 14 and 15. Line 14 discharges into the upper portion of burner 16 and line 15 discharges lower down and into an intermediate portion of burner 16. The mixture of coke and gases forms a dispersed or dilute suspension which is heated to between about 1600° F. and 3000° F. by the combustion of the extraneously added gaseous fuel and the volatile products evolved from the coke particles as the suspension passes down through transfer line burner 16.

The velocity of the gas in the transfer line burner may be between about 10 and 100 feet per second; in the specific example, it is about 20 feet per second. The velocity of the coke in said transfer line is between about 10 and 150 feet per second and while the coke residence time may vary in the range of 0.1 to 5 seconds, in the specific example it is about 2 seconds. To maintain proper air concentration within transfer line burner 16, air may be secondarily injected into the burner through line 24 which taps line 12 and connects line 12 with an intermediate portion of burner 16, substantially in the region where line 15 injects fuel gas into burner 16.

The concentrations of the solids-gas suspension passing down through transfer line burner 16 at the selected gas velocity of about 20 feet per second is about 0.9 lb. per lb. of gas, or the density is about 0.02 lb. of coke per cubic foot of gas at 2600° F. and 2 atmospheres pressure.

The coke and gas suspension may be cooled by passing it through a preliminary quenching or cooling zone 17 in the lower portion of burner 16 which may be of a simple water spray type where water is introduced through line 17'. The partly cooled coke suspension then passes down through a further cooling or quenching vessel 18 arranged at the bottom portion of burner vessel 16. Various methods of cooling are possible, such as the use of a

water tube boiler or the introduction of cold coke. However, in the embodiment shown in the drawing, a waste heat tubular boiler having a bottom water inlet 18' and a top steam outlet 18'' is utilized. The coke/gas mixture flows down through the tubes 18''', transferring heat by indirect heat exchange to water on the outside of the tubes. If desired, a waste heat boiler can be used where the coke/gas mixture is on the outside of the tubes and the water to be heated and vaporized is on the inside of the tubes.

The coke/gas mixture remains in quenching or cooling zone 17 for about 0.5 to 1.0 second and is cooled to a temperature between about 400° F. and 1600° F., preferably about 400° F. to 500° F. Approximately 28 gallons per minute of water enter line 18' and about 14,000 lbs. per hour of steam are taken off through the line 18''. The coke/gas mixture or suspension then passes down from boiler 18 through conical bottom 19', and then through line 19 into cyclone separator 20 where the cooled coke solids are separated from the entraining gases. Combustion gases are withdrawn overhead through line 21 and the product calcined coke is withdrawn through dipleg 22. This coke can be further cooled by indirect heat exchange in a waste heat boiler, by water quenching, or by any other conventional means.

The diagrammatic showing omits many features which those skilled in the art would recognize as desirable or essential in actual plant operation. These omissions are made in order to simplify the presentation of the invention and to avoid encumbering it with well understood engineering details.

This invention eliminates the conventional heat soaking stage found in processes of a similar type. It has been found that this heat soaking step is of very little value if desulfurization is not required. Such is the case if the coke is made from a low sulfur residual stock so that it contains less than about 2 wt. percent sulfur.

The data presented below show how quickly the volatile material is removed from the coke and how quickly the density is increased. The data also show how little the properties of such fluid coke particles may be improved by heat soaking after calcination in a transfer line burner.

In the examples shown, coke from the fluid coking process having a particle size between about 150 and 250 microns on the average was mixed with methane and air, and the suspension was passed through a 10 foot long horizontal transfer line wherein it was heated to a temperature of about 2400° F. for about 0.5 to 2.0 seconds. A portion of this coke was separated from the gases with which it was mixed by the use of a cyclone separator and was then passed to a heat soaker, while a separate portion was rapidly cooled to a temperature of about 400° F. after being separated from the gases with which it was mixed by means of a cyclone separator. Both portions of coke were tested to indicate the volatile content, density, and electrical resistivity of the coke particles. The heading "Coke Temperature, ° F." refers to the temperature of the coke at the exit of the transfer line; V=volatile content, wt. percent; D=density, gms./cc.; R=electrical resistivity, ohm-inch $\times 10^3$  at 500 p.s.i.

## RUN NUMBER 1

Coke rate, 8.8 lbs./min.  
Air rate, 27.7 lbs./min.  
Gas rate, 0.39 lb./min.  
Coke temperature, ° F., 2,220.

| Coke properties.....          | V    | D    | R        |
|-------------------------------|------|------|----------|
| Raw coke.....                 | 5.60 | 1.56 | $\infty$ |
| At exit of transfer line..... | 0.40 | 1.75 | 38       |
| After 60 min. soak.....       | 0.39 | 1.84 | 33       |
| After 120 min. soak.....      | 0.40 | 1.88 | 31       |

## RUN NUMBER 2

Coke rate, 8.0 lbs./min.  
Air rate, 29.0 lbs./min.  
Gas rate, 0.87 lb./min.  
Coke temperature, ° F., 2,470.

| Coke properties.....          | V    | D    | R        |
|-------------------------------|------|------|----------|
| Raw coke.....                 | 4.30 | 1.51 | $\infty$ |
| At exit of transfer line..... | 0.60 | 1.76 | 31       |
| After 60 min. soak.....       | 0.60 | 1.80 | 27       |
| After 120 min. soak.....      | 0.50 | 1.77 | 25       |

## RUN NUMBER 3

Coke rate, 6.8 lbs./min.  
Air rate, 29.5 lbs./min.  
Gas rate, 0.9 lb./min.  
Coke temperature, ° F., 2,610.

| Coke properties.....          | V    | D    | R        |
|-------------------------------|------|------|----------|
| Raw coke.....                 | 5.50 | 1.55 | $\infty$ |
| At exit of transfer line..... | 0.34 | 1.71 | 36       |
| After 60 min. soak.....       | 0.64 | 1.79 | 34       |
| After 120 min. soak.....      | 0.37 | 1.81 | 32       |

By the time the coke reached the end of the transfer line, it had attained, for all practical purposes, its final physical form. Heat soaking changed the properties very little. Therefore, it may be seen from the data that a short-time, single-stage, high-temperature calcination process utilizing a transfer line burner as described can be used to produce coke with satisfactory properties despite the elimination of the heat soaking step.

This invention has been described with certain specific embodiments; however, it should be understood that these are by way of example rather than by way of limitation and it is not intended that the invention be restricted thereby, but only by the scope of the appended claims.

What is claimed is:

1. A process for calcining coke particles made in a fluid coke process to rapidly remove volatile matter and to rapidly increase the density of the coke solid particles which comprises the steps of rapidly heating the coke particles containing less than about 2 weight percent of sulfur and while in the form of a high velocity dispersed gaseous suspension passing through a transfer line heating zone to a temperature in the range of about 1600° F. to 3000° F. in about 0.1 to 5.0 seconds by the combustion initially of an added gaseous extraneous fuel with an oxygen-containing gas, then immediately and rapidly cooling said dispersion of coke particles adjacent the exit of said transfer line heating zone in a cooling or quenching zone to a temperature in the range of about 400° F. to 500° F., then separating the cooled coke particles from the suspending flue gas, and then withdrawing the cooled and calcined coke particles from the separating step.

2. A process according to claim 1 wherein the dispersed suspension of coke particles contains about 0.2 to 2.0 lbs. of coke per pound of gas.

3. A process for calcining fluid coke solid particles to rapidly remove volatile matter and to rapidly increase the density of the coke solid particles which includes introducing said coke solids containing less than about 2 weight percent of sulfur into one end of a high velocity transfer line burning zone, adding gaseous fuel to said burning zone, injecting air into said burning zone to burn said fuel and form a hot gaseous suspension of said coke solids while moving it through said burning zone, burning said gaseous fuel in said zone to heat said moving coke solids suspension to a temperature between about 1600° F. and 3000° F. in about 0.1 to 5.0 seconds, then immediately discharging the heated gaseous suspension of coke solids from the other end of said burning zone and rapidly cooling said coke solids suspension adjacent

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the other end of said burning zone to a temperature between about 400° F. and 500° F., and then passing said cooled coke solids gaseous suspension to a solids separating zone to remove cooled calcined coke solids from the suspending gases.

4. A process according to claim 3 wherein the temperature in said transfer line burning zone is about 2400° F., the residence time of said suspension in said burning zone is about 2.0 seconds and the suspension of said coke solids is rapidly cooled to about 400° F.

5. A process according to claim 3 wherein the gaseous suspension of coke solids contains about 0.2 to 2.0 lbs. of coke per pound of gas and the time of quenching is about 1 second.

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