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GASIFICATION OF CARBONACEOUS MATERIAL

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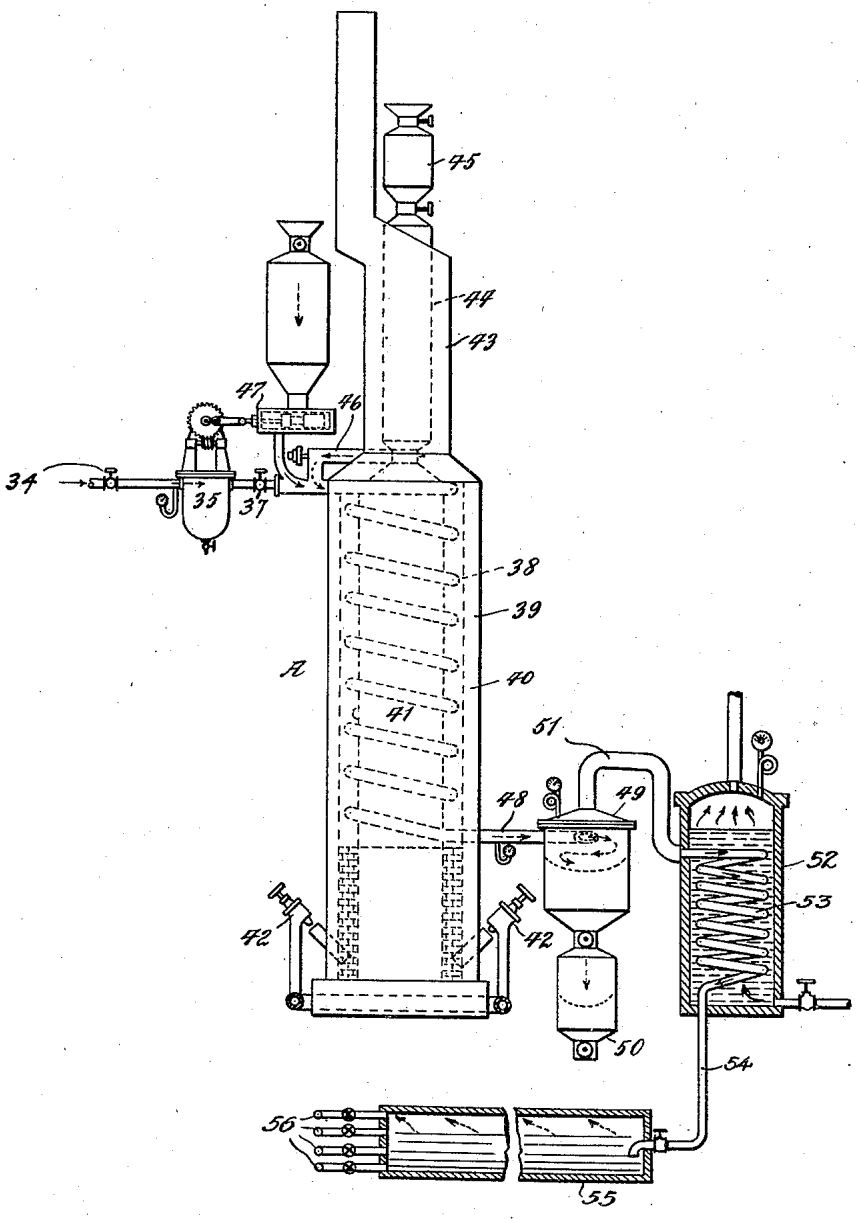

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GASIFICATION OF CARBONACEOUS MATERIAL

Original application filed October 29, 1926, Serial No. 144,947. Divided and this application filed December 20, 1927. Serial No. 241,287.

This invention relates to a process for the production of gas and other products from coal and other carbonaceous material. It is a division of my application Serial No. 144,947, filed October 29, 1926. The solid raw material is reduced to a granular or pulverized condition, such as will permit it to be conveyed through a heated tube by a current of steam acting as a carrier for the material, and as a suitable medium in which to heat it so as to distill any volatiles and to gasify part or all of the solid carbon or coke to water gas. The solid raw material is preferably coke or coal but other carbonaceous materials may be used for submission to the gasifying reaction with steam. All combustible matter in the solid raw material may be converted to a gaseous form with no residues except ash and some small amounts of condensible volatiles of poor quality. This invention also applies to the gasification of carbonaceous materials wherein large quantities of enriched water-gas are formed with a minimum amount of tars and coke residue. The process may be operated so as to vary the yield and character or heating value of the gas formed from any given carbonaceous substance, and the gas may be generated under high pressure.

Advantages are obtained in this invention by the means provided for operating under high pressures, whereby the volatile products are formed under high pressure and the resulting gas may be transmitted under pressure to very distant points without the use of compressors. Also by virtue of the pressures used throughout the system, the volatiles may be cooled and condensed in relatively small heat exchangers and be caused to give up their contained heat to generate the process steam for operating other units simultaneously at lower pressures.

According to the present invention prior operating difficulties in the carbonizing and gasifying of coals, due to their fusibility, low rate of heat conduction, and low reactivity, are overcome to such extent that the coal can be distilled and gasified rapidly regardless of its fusing property or slagging tendency, or of its fineness, or of the percentage of mineral matter or ash therein.

It is well known that carbon will react with steam when the temperature is high enough and when heat is supplied at the needed temperature in sufficient amounts to produce water gas. According to my process, coal or coke in granular but preferably in pulverized form is introduced into a heated tube through which steam is flowing so that the coal or coke is carried through the tube, by the steam, being heated in contact with the steam as it moves through the tube until little or no solid matter is left except ash. When the raw material is coke the resulting gas is that known as blue water gas and this is separated from any excess steam in a cooler or condenser, after having previously been separated from the ash. It is however possible to wash the hot solid material discharged from the heated tube and so to separate solid ash and residual carbon, steam, or other vapors, from the blue water gas in a single step.

When coal is gasified, the temperature of the steam may be raised above 1200° F. so as to remove all the volatiles and form some water gas. My process when using coke, is a continuous water gas process, producing blue water gas in which the heat required is absorbed by the steam and coke through the tube walls and at temperature high enough and sustained long enough by the heating conditions of the tube. When using coal, the volatiles of the coal are added with some decomposition, to the blue water gas formed from the carbon, and the resulting gas is carburetted water gas, the amount of carburation depending on the ratio or hydrocarbon volatile to fixed carbon in the coal and to some extent on its chemical nature, and on the amount of water gas formed to volatiles contained therein.

When using coal as the raw material, the coal may be first distilled and its coke separated in one apparatus, and then the coke introduced into a second similar apparatus operated at higher temperatures, or the two steps of distillation and carbon gasification may be carried out in a single apparatus as seems most expedient.

For coals that have a tendency to become sticky on heating the sticking together of the particles may be prevented by a pretreatment in the presence of oxygen or carbon dioxide alone or mixed with the steam, or by introducing the coal into steam so highly superheated as to rapidly coat each particle with a shell of coke before the main mass of the lump becomes hot enough to soften. The latter treatment prevents neutral dilution of the final gas. In all cases whether coal or coke is used an initial heating of the solid material or a superheating of the steam or both is provided so that there will be no condensation of steam as a result of contact. If complete gasification is desired, the final temperatures to which the carbon, coke, and steam, are heated is always high enough and maintained long enough to gasify all or substantially all of the solid combustible, leaving no solid but ash.

I have used final temperatures from 1350° F. to 1950° F., and have obtained gas of calorific values between 250 and 1050 B. t. u. per cubic foot from Utah coal, and 275 and 525 B. t. u. per cubic foot from its coke. I have used steam velocities to carry the solid raw material through the tube from 100 to 600 feet per second, and steam pressures from about 100 lbs. per square inch downward preferably with turbulence. The gas is thereby generated at pressures sufficiently high for economical long distance transmission of the same.

The hot products from the gasifier tubes may be caused to give up their heat so as to boil water to make steam at a lower temperature and pressure and such steam may be used to supply a second or a series of similar gasifiers working at lower pressures.

The accompanying drawing is a side view with parts in section of an illustrative form of apparatus for carrying out my process: Steam from a source such as a turbine exhaust, an accumulator, or from another coal-treating unit (not shown), is carried by a valved heat-insulated main 34 through a steam separator 35 and past a valve 37 and into the gasifier tube 38 in which the granular or pulverized carbonaceous material is introduced.

Steam from any convenient source enters through the valved pipe 37 into the coil 38 which occupies the annular space between the heat-insulating outer wall 40 and core 41 of a furnace setting. The coil 38 is conveniently heated by products of combustion from burners 42 at the base of the furnace. The hot combustion gases pass up around the tubes of the coil, heating the lower part to the highest temperature, and pass off through a stack 43 which surrounds a feed-bin 44, fed by a valved magazine 45.

A feeding device 46 controls the rate at which the raw fuel is fed into the tube. A device 47 is provided for intermittent delivery of scouring materials into the gasifier to remove accumulations of scale from the inner tube surfaces when necessary.

The exit end 48 of the coil passes into a separator, here shown as a cyclone heat-insulated dust collector 49 which removes the ash from the gas stream. There is provided a double-valved bottom bin 50 for removing the accumulated ash from dust collector 49. A well insulated gas outlet 51 is provided by which the gases and vapors may be transferred to a condenser or other cooling element 52 forming part of the heat exchange device which also serves as an evaporator. The pressure and therefore the temperature of the gases and vapors in the conduit 51 will be so high, while condensing, that the water in the device 52 yields steam, at lower pressure, which may be used in a second coal treating unit. The condensed vapors, water, etc., together with uncondensed gases flow out of the coil 53 by a valved pipe 54 into a separator 55, without material reduction in pressure. The uncondensed gases and any condensates that may collect in the separator 55 may be withdrawn by means of valved outlet pipes 56. The valves in the pipes 56 also serve to regulate or control the pressure throughout the system and to provide for delivering gas at high pressure. Instead of connecting the conduit 51 directly to the heat exchange device 52, it may be connected to a lump coal carbonizer so that the hot gases will carbonize the coal and become partially cooled before they pass to the device 52. This is shown in detail in the parent application Serial Number 144,947.

Coal, coke or other solid carbonaceous fuel in the raw state, or after a previous treatment, is fed through magazine 45 into bin 44 where preheating to any desired temperature is accomplished. The fuel is then fed by device 46, at a predetermined rate as required, into gasifier tube 38 in contact with a stream of steam that is admitted through valve 37, which carries it along and reacts therewith. The suspended or rolling solid particles then move at a high velocity through the tube counter flow to the movement of the combustion gases and into zones of increasing temperature.

I claim:

1. A continuous process for producing water gas from material such as coal, coke and the like which comprises preheating granular particles of said material in a chamber, periodically delivering material from the preheated chamber into a second heating chamber which is maintained under pressure, and thereafter continuously discharging said material from the second chamber and passing the same at high pressure by means of steam in a generally downward direction through an externally heated tube of extend-

ed length and of restricted cross section at a temperature and period of time sufficient to effect substantially gasification of the carbon constituent of the material, the material while being heated in the pre-heating chamber being maintained under the working pressure of the second chamber by the medium maintaining pressure therein.

2. A continuous process for producing water gas from material such as coal, coke and the like which comprises preheating granular particles of said material in a chamber, periodically delivering material from the preheated chamber into a second heating chamber which is maintained under pressure and thereafter continuously discharging said material from the second chamber and passing the same at a pressure of the order of one hundred pounds per square inch in a generally downward direction through an externally heated tube of extended length and of restricted cross section at a temperature and period of time sufficient to effect substantially gasification of the carbon constituent of the material, the material while being heated in the pre-heating chamber being maintained under the working pressure of the second chamber by the medium maintaining pressure therein.

3. A continuous process for producing water gas from material such as coal, coke and the like which comprises preheating granular particles of said material in a chamber, periodically delivering material from the pre-heated chamber into a second heating chamber which is maintained under pressure, thereafter continuously discharging said material from the second chamber and passing the same at high pressure by means of steam in a generally downward direction through an externally heated tube of extended length and of restricted cross section at a temperature and period of time sufficient to effect substantially gasification of the carbon constituent of the material, and introducing a scouring material and effecting its passage through said tube.

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