

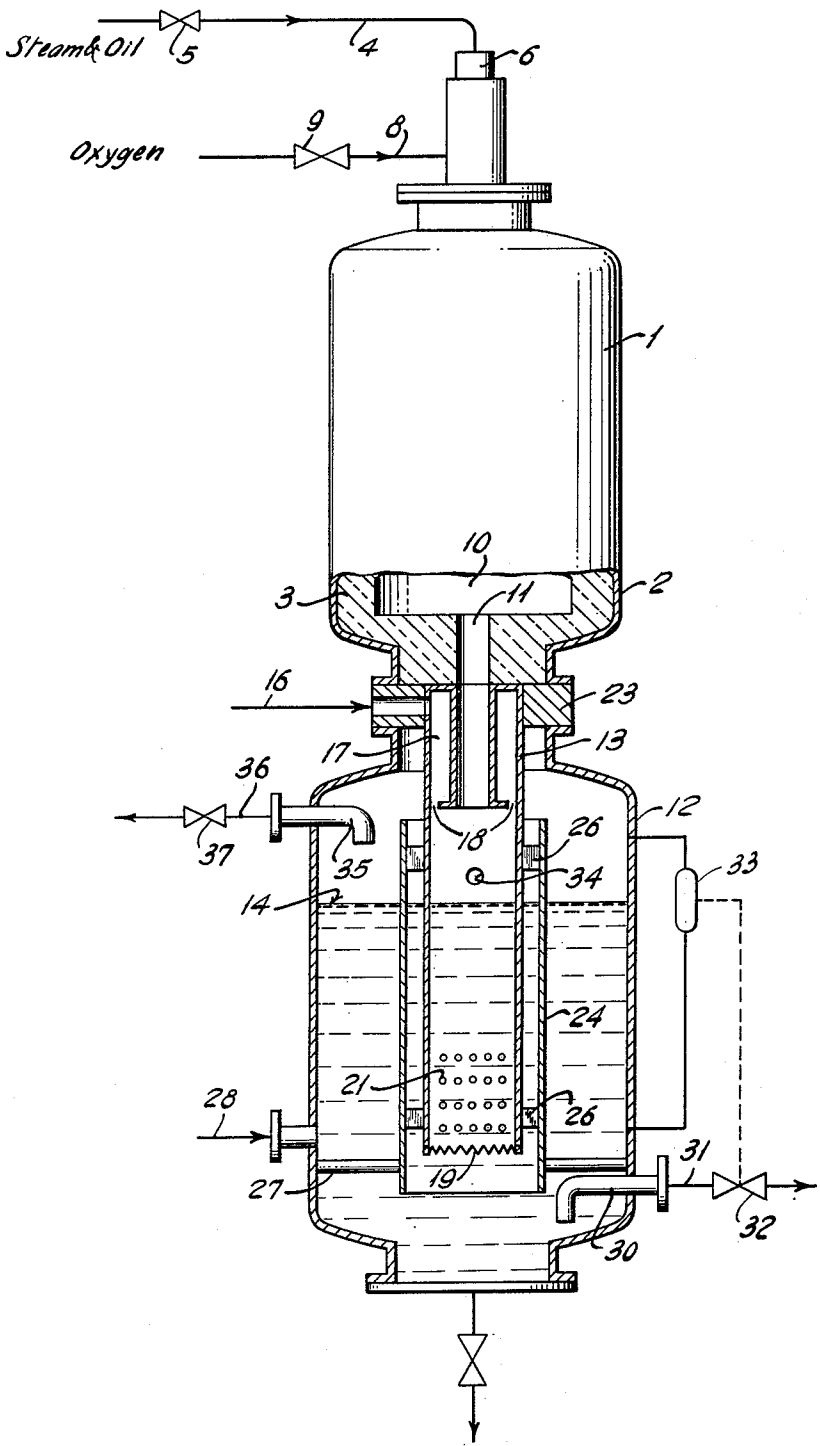
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METHOD OF SHUTTING DOWN THE GAS GENERATOR

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METHOD OF SHUTTING DOWN THE GAS GENERATOR

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6 Claims. (Cl. 48—196)

This invention relates to the production of high temperature gases at elevated pressure and more particularly to quench cooling or scrubbing high temperature gases at elevated pressure. In one of its more specific aspects the invention relates to the production of carbon monoxide and hydrogen, or synthesis gas, wherein a carbonaceous fuel is subjected to reaction with an oxidizing gas comprising free oxygen at an elevated temperature and at superatmospheric pressure and wherein the hot resulting products of reaction are cooled by direct contact with liquid water in an amount in excess of the amount which may be vaporized in cooling the gas stream.

Carbonaceous fuels, including gaseous and liquid hydrocarbons and solid fuels, such as coal, coke and lignite, may be converted to carbon monoxide and hydrogen by reaction with an oxidizing gas comprising free oxygen. Air, oxygen-enriched air, or substantially pure oxygen may be employed as the source of free oxygen. Generally, substantially pure oxygen is preferred. With the heavier carbonaceous fuels, i. e. liquid and solid fuels, it is generally desirable to react the fuel with a mixture of free oxygen and steam, whereas in the case of gaseous fuels, the presence of steam, although optional, is usually not desirable. Recently a process has been developed for non-catalytic reaction of carbonaceous fuels with free oxygen in a flow-type reaction zone. (See, for example, 2,701,756, Eastman et al., and 2,655,443, Moore.) The generation of synthesis gas may be carried out at elevated pressures which may range as high as 800 to 1000 p. s. i. g., preferably 100 to 500 p. s. i. g., and at temperatures in the range of 2000 to 3500° F. Partial oxidation of the carbonaceous fuel under these conditions may effect substantially complete conversion of the fuel to carbon monoxide and hydrogen. Small amounts of carbon dioxide, light hydrocarbons and free carbon are generally contained in the raw product gas.

In the generation of synthesis gas, i. e. carbon monoxide and hydrogen, by partial oxidation, it is desirable to quench the hot gas leaving the reaction chamber from the reaction temperature which is above 2000° F. to a temperature below about 600° F. in a very short period of time. Quenching the hot gases freezes the composition of the product gas and substantially prevents degradation reactions which take place on slow cooling. The degradation reactions generally result in the formation of free carbon and hydrocarbons. It is preferable to quench the product gas from the gas generator by direct contact at substantially generator pressure with liquid water maintained in a suitable reservoir into which the hot gases are conducted and discharged at a point below the surface of the liquid.

This method of quenching, while entirely satisfactory, presents a problem when the generator is shut down to prevent the entry of liquid water from the quench vessel into the reaction chamber. The danger of permitting liquid water to come into contact with the refractory

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lining of the synthesis gas generator, which is generally at a temperature considerably in excess of 2000° F. when the generator is shut down, is obvious. The temperature maintained in the quench vessel is not above about 550° F., and generally, less than 500° F. In any case, the quench water temperature is not above the temperature corresponding to the boiling point of water at the pressure existing in the quench zone, which is substantially equal to the pressure in the gas generator.

If the flow of reactants to the gas generation zone is interrupted while continuing withdrawal of reaction products therefrom so that the pressure in the gas generation zone and associated water quench cooling zone is permitted to decline, the point is soon reached at which the pressure in the gas generation zone and water quench cooling zone is below the vapor pressure of the water in the cooling zone. When the pressure falls below the boiling point of water in the cooling zone, steam flashes from the water and may be forced up into the hot generator. This is a very dangerous condition which may very easily lead to destruction of the hot refractory insulation within the gas generator. The condition may be avoided by depressuring the generator and quench system while continuing to feed reactants so that the steam flashed off from the water in the quench zone is carried away with product gases. This method has two disadvantages. First, the product gas must generally be vented, since under normal operations the gas is delivered at a pressure of several hundred pounds per square inch and compressors and other equipment are designed to handle gas only at elevated pressure. Second, it may be imperative that the gas generator be shut down quickly due to failure of gas or oxygen supply or dangerous condition of equipment.

We have found that the gas generator may be shut down immediately while avoiding the danger of introducing water or steam into the hot generator. This is accomplished by discontinuing the introduction of reactants to the gas generation zone and simultaneously discontinuing the withdrawal of reaction products therefrom and from the associated pressurized quench zone. The generator and quench zone are thus "bottled up" so that there is no substantial reduction in pressure in either the gas generator or the quench zone. At the same time cooling water is continuously supplied to and withdrawn from the cooling zone, or quench zone, at a temperature below the temperature corresponding to the boiling point of the water at the existing pressure. (Often hot water is supplied to the gas cooling and quench zone during normal operation.) The pressure is then gradually reduced in the reaction zone and cooling zone by withdrawal of gas therefrom at a rate such that the pressure in the reaction zone is maintained at all times in excess of the vapor pressure of the water in the cooling zone. Generally, in shutting down the gas generators it is desirable to bring the pressure of the generator and associated quench system down to atmospheric pressure. This is accomplished by introduction of cool water, i. e. water at a temperature below 212° F., into the cooling zone, and withdrawal of water therefrom, until the temperature of the water in the cooling zone is reduced below the atmospheric boiling point or below about 212° F. Pressure reduction in the gas generator and quench system is accomplished by venting gas therefrom, preferably from the water quench vessel, until the pressure is reduced to the desired pressure, generally atmospheric pressure.

The invention will be more readily understood by reference to the accompanying drawing.

The figure is an elevational view in cross section of an illustrative gas generator and associated cooling or quench vessel. Although the apparatus illustrated is particularly

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adapted for the generation of synthesis gas from liquid hydrocarbons, the principles of operation described in connection therewith apply generally to similar operations in which a high temperature gas is generated at elevated pressure and is brought into intimate contact with a volatile cooling liquid, e. g. water or oil. Apparatus for the generation and quench cooling of gases comprising carbon monoxide from gaseous or solid fuels are generally similar to the illustrated apparatus. In case of solid fuel having a fusible ash, provision may be made for separately collecting and cooling the slag, not, per se, a part of the present invention.

With reference to the figure, the gas generator 1 comprises a pressure vessel 2 provided with a suitable refractory and heat insulating lining 3 enclosing a compact, unpacked reaction chamber 10. A dispersion of oil in steam is passed through line 4, controlled by valve 5 into a suitable mixer-burner 6. Oxygen from line 3, controlled by valve 9, is separately admitted into burner 6. Steam, oil and oxygen are introduced through burner 6 into the reaction zone into intimate admixture with one another. Partial combustion takes place within the reaction zone at high temperature and elevated pressure producing carbon monoxide and hydrogen.

Products of reaction are discharged from the reaction chamber 10 through gas outlet 11 into a quench vessel 12 containing water and operated at substantially the generator pressure. The hot product gases leaving the generator through outlet 11 are conducted through pipe 13 to a point below the surface 14 of water contained in the quench vessel. Water is continuously introduced through line 16 to a cooling ring 17 provided with an annular outlet 18 adjacent the inner wall of pipe 13. Water introduced through the annular opening in the cooling ring helps cool the gases and prevents overheating of pipe 13.

The lower end of pipe 13 is provided with serrations 19. A section of pipe 13 between serrations 19 and liquid level 14 is provided with perforations 21. The combination of perforations and the serrations serve to intimately contact the hot gases with water in the quench vessel thereby providing almost instantaneous quench cooling of the gases.

Pipe 13 is supported from flange 23. A cylindrical shield 24 surrounds quench pipe 13 extending from a point below the bottom of pipe 13 to a point near the upper end of vessel 12. Shield 24 is supported from pipe 18 by lugs 26. Spacer bars 27 extend from the lower part of the shield to the wall of the vessel to maintain the quench pipe and shield in spaced relationship with the wall of the vessel.

Part of the quench water is introduced into the quench vessel through line 16 as previously described. Additional quench water is supplied to the vessel through line 28. Water is drawn from the quench vessel as required to maintain the desired liquid level through nozzle 30 and line 31 controlled by valve 32 in response to liquid level controller 33.

Vent 34 in pipe 13 above the liquid level of the water in the quench vessel permits gases to enter pipe 13 when the flow of reactants is discontinued in reaction zone 10 so that water cannot be sucked from the quench vessel into the hot reaction chamber.

Quenched product gases pass through nozzle 35 into a product gas line 36 controlled by valve 37. Nozzle 35 is disposed below the upper end of shield 24 to prevent entrainment of water in the product gas stream withdrawn through line 36.

In operation, steam and oil are introduced through line 4 and oxygen through line 8. The reactants are thoroughly mixed at the point of discharge into the reaction zone 10 by the burner 6. The reactants are proportioned, as controlled by valves 5 and 9, so that partial combustion takes place within the reaction chamber 10 at elevated temperature and pressure producing synthesis gas consisting essentially of carbon monoxide and

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hydrogen which is discharged through outlet 11. Pipe 13 conducts the hot synthesis gas from the reaction chamber into quench vessel 12 where the gas is discharged into intimate contact with water contained in the quench vessel through perforations 21, and, if needed, through serrations 19. The cooled gas, at approximately the temperature corresponding to the boiling point of the water at the pressure existing in the generator and quench vessel, is discharged through nozzle 35 and line 36, normally at uniform high pressure. Valve 37 is normally open.

To shut down the gas generator when it is desired to terminate the run, the flows of reactants to the generator are interrupted by closing valves 5 and 9 and, at the same time, the withdrawal of reaction products from the quench vessel is discontinued by closing valve 37. Since the water in the quench vessel is normally at or near its boiling point at the elevated pressure at which the generator is operated, it is evident that if the pressure in the system is lowered, for example by withdrawal of gases from line 37, water in the quench vessel flashes to steam. As the generator cools, this steam is drawn through outlet 11 into the hot generator. By closing the reactant inlets and the product gas outlet and bottling up the generator and quench vessel, this is prevented. Meanwhile, introduction of cooling water, optionally at a reduced flow rate, into the quench vessel is continued. Excess water is withdrawn through line 31. As the temperature of the water within the quench vessel drops, it is permissible to withdraw gases through line 36, as controlled by valve 37, to depressure the system. The rate of pressure reduction must be controlled so that the pressure within the gas generator is maintained in excess of the vapor pressure of the water in the quench vessel. To permit reduction of the pressure in the gas generation system to atmospheric pressure, it is necessary that the water in the quench vessel be cooled below about 212° F., the atmospheric boiling point of water.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. In a process wherein high temperature gases are produced by introducing reactants into a reaction zone maintained at elevated pressure and effecting reaction in said zone, and product gases are contacted in a cooling zone maintained at substantially said elevated pressure with a volatile cooling liquid having a boiling point below the temperature at which said gases are produced, the method of shutting down the gas generation system which comprises discontinuing the introduction of reactants to said reaction zone without substantial reduction in pressure therein, continuously supplying said cooling liquid to said cooling zone associated with said reaction zone at a temperature below the temperature corresponding to the boiling point of said liquid at the existing pressure, and reducing the pressure in said gas generation system by withdrawal of gas therefrom at a rate such that the pressure in said reaction zone is maintained in excess of the vapor pressure of the cooling liquid in said cooling zone.

2. A process as defined in claim 1 wherein said cooling liquid is water.

3. A process as defined in claim 1 wherein said high temperature gases comprise carbon monoxide.

4. In a process for the production of carbon monoxide and hydrogen by reaction of a carbonaceous fuel with an oxygen-containing gas at superatmospheric pressure in a compact reaction zone at an autogenously maintained temperature in the range of 1800 to 3500° F. wherein products of reaction are contacted with water in a cooling zone maintained at substantially the pressure of said reaction zone in an amount in excess of the amount required for saturation of the product gas at operating pressure and

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at a temperature not above about 500° F., the improvement in shutting down the gas generation system which comprises discontinuing the introduction of reactants to said reaction zone without substantial reduction in pressure therein, continuously supplying water to said cooling zone associated with said reaction zone at a temperature below the temperature corresponding to the boiling point of the water at the existing pressure, and reducing the pressure in said gas generation system by withdrawal of gas therefrom at a rate such that the pressure in said 10

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reaction zone is maintained in excess of the vapor pressure of the water in said cooling zone.

5. A process as defined in claim 4 in which the temperature of the water in said cooling zone is reduced to a temperature below 212° F. and the pressure in said reaction zone is subsequently reduced to atmospheric pressure.

6. A process as defined in claim 4 in which said carbonaceous fuel is a liquid hydrocarbon.

No references cited.