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(12) **Patent:** (11) **CA 873257**

(54) SYNTHESIS GAS GENERATION

(54)

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SYNTHESIS GAS GENERATION
(D#44,123-F)

The present invention relates generally to a synthesis gas generation process, and specifically to a process for the reaction of a liquid hydrocarbon with an oxidant gas stream (e.g. air, oxygen-enriched gas, or substantially pure oxygen with or without steam) to produce a mixture of gaseous products comprising carbon monoxide and hydrogen, useful as a synthesis gas, fuel gas, or as a source of hydrogen for various purposes.

The partial oxidation of liquid hydrocarbons to form carbon monoxide and hydrogen, together with more or less carbon dioxide, water vapor, light hydrocarbons and free carbon is known in the art. The hydrocarbons are converted to carbon monoxide and hydrogen by reaction with steam alone or with a mixture of oxygen and steam, at an elevated reaction temperature sufficient to convert the hydrocarbon substantially completely to fixed gases comprising mainly carbon monoxide and hydrogen.

In the Texaco Synthesis Gas Generation Process for generating gases from heavy oils, the oils are atomized by mixing with superheated steam in highly turbulent flow through a preheat system. The resulting fuel-steam mixture is then mixed with an oxidizing gas (air and/or oxygen) in the form of jets injecting from a burner tip into a generator wherein the reaction zone temperature is maintained within the range of about 1800° to about 3500°F. at a level where the reaction goes nearly to completion rapidly.

Satisfactory atomization of the fuel and flow of the mixture through the feed system have been maintained with steam-oil ratios as low as 0.25. Lower steam-oil ratios are of interest where low water content synthesis gas is to be used as a supplementary feed to a blast furnace.

In accordance with the present invention, the reactants

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are brought together in a novel manner which has been found to produce superior results in the gasification of liquid hydrocarbons.

In the process of this invention, the hydrocarbon is injected at a burner tip into an annular stream of an oxidizing gas, such as enriched air or even oxygen alone or mixed with steam. Hereafter, this mixture will be referred to as the "oxygen-steam" mixture. (Equivalent oxidizing gases can be used in the process, also.) The ensuing shearing action by the oxygen-steam mixture disperses the oil uniformly in this mixture to form a substantially homogeneous dispersion having the appearance of a mist as it leaves the burner tip and immediately enters the reaction zone in the generator.

It is an object of this invention to provide carbonaceous liquid subdivided into droplets of sufficient minuteness to permit optimum intimacy of contact with the other reactants in a synthesis gas generation process.

This and other objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawing wherein:

Fig. 1 is a general illustration of a burner assembly in position; and

Fig. 2 is a diagrammatic longitudinal cross section through the burner tip showing the burner face cooling chamber.

The process of the present invention contemplates the solution to the problem of the thermal or pyrolitic decomposition and/or polymerization of hydrocarbon liquids prior to the chemical interaction with other reactants in a synthesis gas generation process.

Referring to the figures in the drawings, in Fig. 1, the burner assembly is indicated generally at A, with the burner tip at B, an expansion joint assembly at C, the mounting flange at D, the oxygen-steam mixture inlet at E, and the hydrocarbon fuel inlet at F. One of the coolant connections is disclosed at G, the other being located diametrically opposite.

In Fig. 2, the burner tip at B, included in coassigned U.S. Patent No. 2,928,460, is shown in cross section, with the inner conduit, indicated at 10, providing the hydrocarbon fuel, and having an outlet therefor at 11, and with diametrically spaced locking lugs indicated at 12, 12. An outer conduit 13, ending in an orifice 14, is locked in spaced relationship with the inner conduit 10 to define an annular passage, indicated at 15, which leads to the orifice at 14. The annular passage 15 converges inwardly in the shape of a hollow, right cone to accelerate the oxygen-steam mixture discharged therefrom, with the conical angle indicated at X and being in the range of 30° to 45°. The orifice 14 is surrounded by a face cooling chamber indicated at 16, to which an appropriate coolant is provided by coolant tubes. The outer conduit 13 carries complementary locking lugs indicated at 17, 17 and 18, 18, which coact with locking lugs 12, 12 to restrain extensive longitudinal movement of the inner conduit. All the locking lugs may be integral with their respective conduits or welded thereto. Radial spacers may be used alternatively so long as the conduits are restrained from excessive differential movement along the longitudinal axis.

The outer conduit 13 also carries a plurality of spacer pins 19, indicated as four in number in the drawings, which serve to locate the inner conduit in spaced relationship to the outer conduit. These spacer pins also may be integral with the outer conduit or affixed thereto in some other suitable manner, as by press fitting into bore holes and then plug welded, as disclosed herein.

The disclosed apparatus is subjected to severe temperature operating conditions, not only being disposed adjacent the reaction zone where the synthesis gas generation proceeds desirably at above 2000°F., and frequently as high as 3500°F., but also conveying reactants which are preheated to relatively high temperatures, e.g. above 900°F., prior to their discharge into the reaction zone. Consequently, structural provision, disclosed at C, FIG. 1, is made for the high differential expansion and contraction of the several elements of the burner, arising not only from exposure of the burner to radiation from the high temperature reaction zone but also from the flow of preheated gases.

Preferably, the steam is superheated to about 900° - 1000°F. prior to intermixing with the oxidizing gas, which also may be heated (e.g. about 300°F.) to result in a mixture at an intermediate temperature, perhaps 500°F. so that there is substantially no condensation of the steam. The hydrocarbon fuel, i.e. oil, may be preheated so as to be pumpable, or remain at ambient temperature, when injected into the annular oxygen-steam stream.

It is known that liquid streams are dispersed into fine droplets of controlled size with an average diameter in the range of 25 microns by the shearing action of relatively high velocity gas jets or streams. The dispersion results from the relatively great difference in the delivery speeds between the gas and liquid. The shearing action of the high velocity gas stream on the relatively low speed liquid stream draws out fine streamers of liquid from the main stream of the liquid. Eventually, the streamers collapse into individual droplets under the force of surface tension. The oxygen-steam mixture flows at speeds up to 400 feet per second, while the liquid hydrocarbon fuel is furnished at speeds of flow as low as 5 to 10 feet per second.

The hydrocarbon fuel, in the form of liquid oil is fed to the burner in a steady single-phase flow, independent of the amount of steam fed with oxygen. By using the oxygen to assist in the atomization of the fuel, the quantity of steam required is reduced so that a low water content synthesis gas is produced. The liquid fuel should be injected near the location of the highest flow velocity of the stream of the oxygen-steam mixture, either axially, radially or tangentially so as to subject it to the action of a gas stream with a relative velocity greater than 200 feet/second, although higher speeds are desirable. Although the oxygen-steam stream is disclosed as a hollow right cone, the area of impact of the liquid and gas streams should be where the greatest relative velocity occurs, and so the shape of the passages should be selected to achieve this result.

Thus, there has been shown and described a novel synthesis gas generation process wherein a dispersion of fuel, oxidizing gas and steam is provided to a reaction zone of a generator having a temperature in the range of about 1800° to about 3500°F. the dispersion occurring when a liquid hydrocarbon is injected at relatively low speed into a relatively high speed, converging annular gas stream, with droplets of the liquid of controlled size being disposed uniformly downstream and having an average diameter in the range of 25 microns.

Other 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.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a process for reacting a hydrocarbon fuel with an oxidizing gas in predetermined proportions to produce a mixture of gaseous products by partial oxidation of said fuel, the improvement which comprises introducing said fuel in liquid form into a stream of an oxidizing gas, introducing said dispersion immediately thereafter into a reaction zone, and effecting said partial oxidation therein at a temperature within the range of from about 1800° to about 3500°F, said oxidizing gas being discharged through an annular conduit as an annular stream converging into the shape of a hollow right cone having an apex angle in the range of 30° to 45° as said oxidizing gas comes into contact with said fuel.

2. A process as defined in Claim 1, wherein said dispersion is formed by providing said oxidizing gas at a relative velocity in excess of 200 feet per second with respect to the velocity of said fuel.

3. A process as defined in Claim 1, wherein said oxidizing gas includes steam.

4. A process as defined in Claim 1, in which said oxidizing gas is subjected to preheating, and above the temperature required to maintain the steam substantially in vapor phase at the existing pressure.

5. A process as defined in Claim 1, wherein said fuel is disposed uniformly throughout said dispersion with droplets thereof having a controlled average diameter in the range of 25 microns.

6. A process as defined in Claim 3, wherein the amount of steam is controlled to produce a low water content synthesis gas as said mixture of gaseous products from said partial oxidation.

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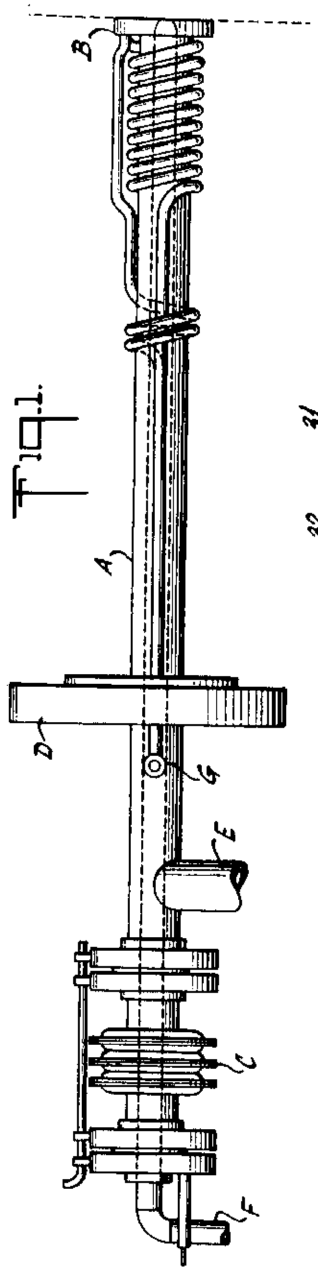

Fig.1.

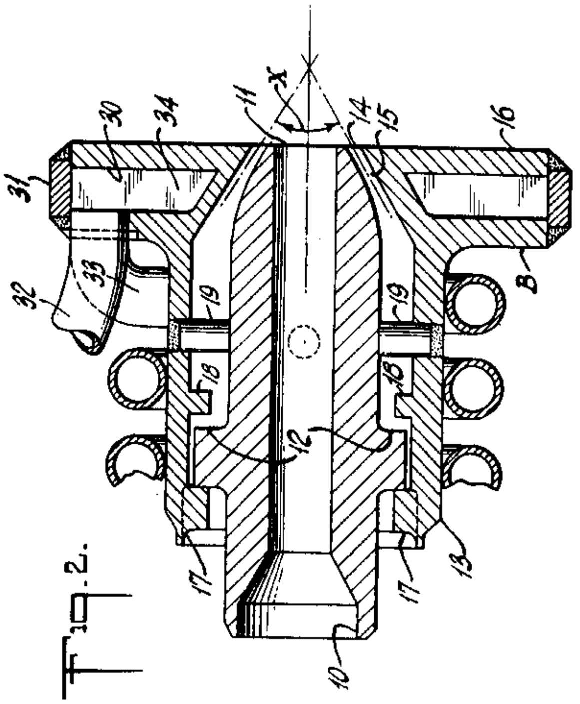

Fig.2.

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