

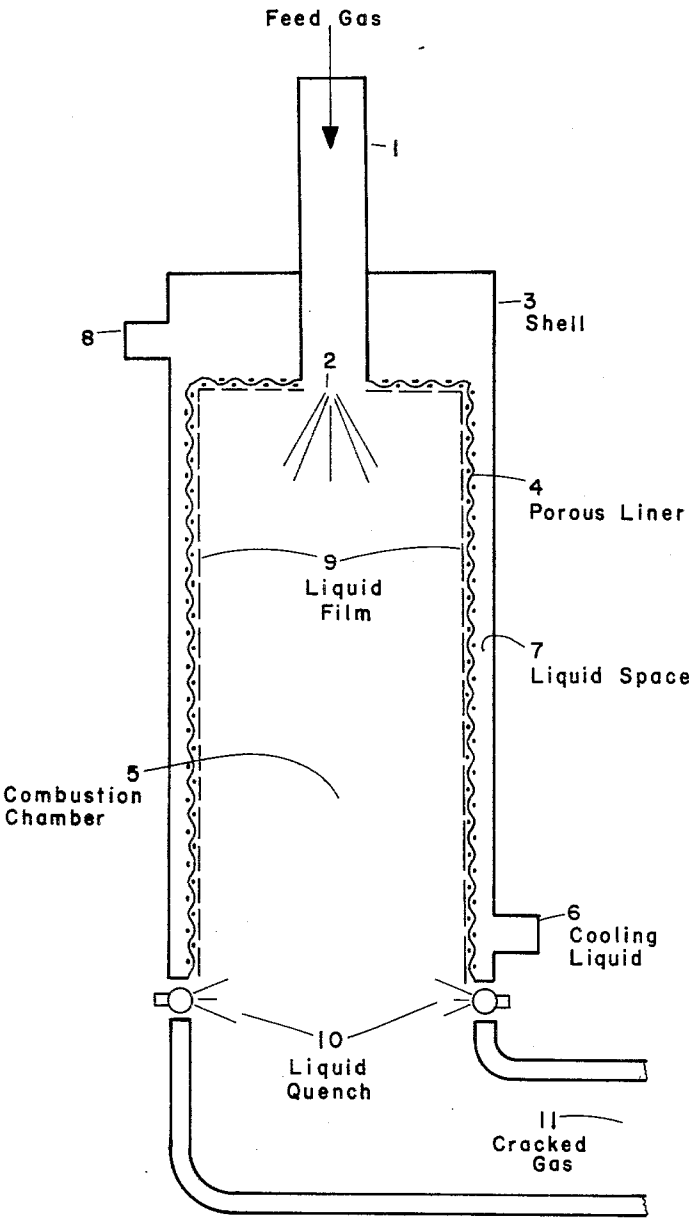
Feb. 8, 1966

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3,234,300

PRODUCTION OF ACETYLENE BY THE PARTIAL COMBUSTION PROCESS

Filed Nov. 19, 1962



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PRODUCTION OF ACETYLENE BY THE PARTIAL COMBUSTION PROCESS

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Filed Nov. 19, 1962, Ser. No. 238,616
4 Claims. (Cl. 260-679)

The present invention relates to an improved method for the partial combustion of hydrocarbons to produce acetylene. More particularly, it relates to a process for the production of acetylene by a partial combustion of methane or natural gas whereby carbon deposits in the converter are eliminated without causing any appreciable quenching of the flame gases in the converter.

To produce acetylene from hydrocarbons, energy must be supplied in large amounts at high temperatures. The heating must be done quickly and it must be followed by a rapid quench to prevent the decomposition of the hydrocarbon products to carbon and hydrogen. The partial combustion of methane to produce acetylene is sometimes described as the one-stage burner process. There are two steps to this method, that is, the combustion step and the cracking step which occur almost simultaneously. In the combustion step, part of the natural gas or methane is burned with a quantity of oxygen, insufficient for complete combustion, to furnish heat at a temperature in the range from 1,200° C. to 1,800° C. Since the combustion is incomplete, there remains a portion of the methane which is the reaction component for the cracking operation. Most of the remaining methane is then cracked in this second step to acetylene by utilizing the heat available from the combustion step. After the formation of the acetylene in the cracking step, the acetylene-bearing gas stream is rapidly cooled to prevent any further reaction or decomposition. The cracked gas from this one-stage burner process is the processed in a purification system to recover acetylene as the final product.

Unlike other processes such as the two-stage burner where acetylene is produced from hydrocarbons by complete combustion of a fuel gas to furnish heat and a separate hydrocarbon feed is cracked to acetylene, the partial combustion process must use the same component for fuel and cracking stock. This creates several problems. With the necessary operating conditions of flame temperature and methane-oxygen ratio, the products of the partial combustion of methane do not consist of the most desirable products. Instead of a complete combustion of methane and oxygen to form by-products consisting primarily of carbon dioxide and water, the partial combustion forms by-products consisting principally of carbon monoxide, hydrogen, water and carbon. The principal bad effect of this operation, besides the problem of securing construction materials to withstand the high temperatures, is that a considerable amount of carbon is produced as a hard deposit on the walls of the burner, requiring special provision for removal causing shutdown for cleaning and rehabilitation of the burner.

It has now been discovered that the deposition of carbon in an acetylene converter can be prevented by maintaining a film of liquid on the inner surface of the walls of said converter.

It is an object, therefore, of the present invention to provide an improved method for the partial combustion of hydrocarbons to produce acetylene. Another object of the invention is to provide an improved process for the partial combustion of methane to produce acetylene whereby carbon deposits in the burner are eliminated. A further object of this invention is to provide an acetylene burner for the partial combustion of methane which

will easily withstand the high combustion temperature inherent in the process and will not collect carbon deposits during operation. Another object of this invention is to provide a method and apparatus of maintaining a liquid film along the inner wall of an acetylene burner without quenching the combustion. These and other objects of the invention will become apparent from the following description, drawing and appended claims.

According to the present invention, acetylene is produced by the partial combustion of hydrocarbons in an acetylene converter without deposition of carbon on the inner wall of said converter by passing a liquid through said inner wall constructed of a porous material to form a protective film thereon without quenching the combustion therein. Also, according to this invention, an apparatus for the partial combustion of hydrocarbons to produce acetylene is provided which has a combustion chamber having walls of a porous structure through which a liquid can be passed to form a productive film on the inner wall of said combustion and thereby eliminate the deposition of carbon on the inner wall thereof.

The drawing is a diagrammatic illustration of the acetylene converter of this invention.

Referring to the drawing, burner feed gas consisting of oxygen and natural gas or methane enters an acetylene converter through line 1 and the flame chamber 5 through nozzle 2. The acetylene converter comprises a cylindrical metallic shell 3 and porous wall 4 which encloses flame chamber 5. Porous wall 4 is separated from metallic shell 3 by annular space 7. The cooling liquid enters the acetylene converter via line 6, fills the annular space 7, and leaves through line 8. A small amount of the cooling liquid is forced through porous wall 4 and forms liquid film 9 on the inside of flame chamber 5. The acetylene-bearing gas stream is quenched by water nozzles 10 at the bottom of flame chamber 5. The cooled gas stream leaves the converter via line 11 for subsequent cooling and is then purified to recover the acetylene.

The following examples are given to illustrate the invention but are not to be construed as limiting it in any manner whatsoever.

Example 1

In a conventional one-stage acetylene converter similar to that shown in the drawing, the flame chamber wall or tube was constructed of a porous metal known as Rigmesh. This material consists of 29% iron, 21% chromium, 20% nickel, 20% cobalt, 3% molybdenum, 3% tungsten, 1% columbium, 1.5% manganese and 1.5% silicon on a weight basis. It is produced by compressing woven wire cloth into multiple layers and is formable, weldable and machineable. Approximately 68 lbs./hr. of mixed feed gas consisting of 56 weight percent oxygen and 44 weight percent natural gas was introduced downwardly into the acetylene converter and incompletely burned to generate a temperature of about 1,500° C. at which temperature the remaining natural gas feed is cracked to form acetylene. Sanitary water was fed into the space between the shell and porous wall of the acetylene converter at a rate of about 2 gallons/minute and approximately 1/2 gallons/minute passed through the porous metal wall creating a thin film of water enclosing the entire flame chamber. The pressure differential across the porous metal wall was about 10 p.s.i.g. and the water rose in temperature from about 33° C. to 64° C. inside the flame chamber of the acetylene converter. After a run of approximately 3 hours, the converter was shutdown and the walls of the flame chamber were inspected. No carbon deposits appeared on the walls of the flame chamber. Acetylene was recovered from the quenched cracked gas and was essentially identical in

composition and quantity to that produced without the water flow through the wall of the flame chamber.

Example II

In the identical acetylene converter as used in Example I, the flame chamber wall was constructed of stainless steel sheet. Approximately 68 lbs./hr. of mixed feed gas consisting of 56 weight percent oxygen and 44 weight percent natural gas was introduced downward into the acetylene converter and incompletely burned to generate a temperature of about 1,500° C. at which temperature the remaining natural gas feed is cracked to form acetylene. Sanitary water was fed into the space between the shell and the stainless steel wall of the acetylene converter at a rate of about 2 gallons/minute to maintain the wall of the flame chamber at a reduced temperature. After a run of approximately 3 hours, the converter was shut down and the walls of the flame chamber were inspected. It was found that carbon in the form of a hard coke was deposited over the entire inside surface of the flame chamber from about ¼-inch in thickness to ½-inch in some areas.

These examples show that the simple expedient of using a porous material as the flame chamber wall in a one-stage acetylene converter, with a liquid forced through the porous wall to form a liquid film, will eliminate the carbon deposits produced inside the flame chamber.

The temperature of the reaction is quite important. The combustion reaction must develop temperatures in the range of about 1,200° C. to about 1,800° C. to furnish sufficient heat to crack the remaining methane or natural gas feed. Although it is possible to carry out the combustion and cracking reactions at temperatures higher than 1,800° C., it is not possible to achieve the optimum acetylene content in the cracked gas and increased quantities of carbon are also produced. Preferably, the cracking reaction is carried out below 1,800° C. For instance, from about 1,400° C. to about 1,600° C. has proved to be very desirable.

Pressure is not critical in the partial combustion of methane to produce acetylene. The burner operates at essentially atmospheric pressure under normal conditions but also operates satisfactorily at as high as 40 p.s.i.a. and as low as 5 p.s.i.a.

The quantity of water or cooling fluid forced through the porous tube of the flame chamber must be sufficient to form a continuous film of liquid on the inside walls of the flame chamber. This is necessary to eliminate the formation of carbon on the walls. As least one pound per minute of liquid passing through 1 square foot of the porous wall is necessary to maintain this continuous film and not more than about 100 pounds per minute per square foot of wall is practical, although any quantity up to about 500 pounds per minute per square foot can be used. The pressure of the liquid depends upon the nature of the porous material from which the porous tube is constructed and is not important as long as it is sufficient to force the liquid through the porous tube into the flame chamber. Normally, from about 5 to about 100 p.s.i.g. is sufficient to accomplish this although pressures from about 1 p.s.i.g. to about 500 p.s.i.g. can be used.

Although water is the preferred liquid to employ as the cooling fluid on the inside walls of the flame chamber because of its cost and low tendency to react with the hydrocarbon gas stream, it is possible to use other liquids as well. Any liquid which will not react with the hydrocarbon feed or the oxygen or the burner products is suitable to use as a cooling fluid on the inside walls of the flame chamber as long as the viscosity is

not so high that it would be impractical to force through the porous tube. Examples of some such liquids are nonflammable liquids such as halogenated hydrocarbons and silicone fluids.

One of the most important factors in this invention is the construction of the porous tube. It is necessary that the material be sufficiently porous that reasonable pressures can be employed to force the liquid through the tube. Yet, it is also important that the tube material have sufficient strength so that there is no tendency to collapse from strain and so that it can be handled and installed with relative ease. Examples of desirable materials are porous shapes of aluminum, steel, stainless steel, chromium, nickel, cobalt, alloys of the same and other metals which can be formed in a porous state and still have sufficient strength for the purpose intended. It is preferred that all alloys containing copper not be used since it is possible that the acetylene produced could react with the copper to form potentially dangerous compounds. One extremely desirable material is that exemplified by the example and is known to the trade as Rigimesh. The Rigimesh alloy is described in Example I and is constructed of compressed woven wire cloth of multiple layers. Any metal or alloy other than one containing copper which could be constructed in the same manner as Rigimesh would be highly desirable. It is also possible to use porous ceramic materials for the flame chamber wall but because the strength of ceramic materials is somewhat less than the metals noted above, it would be preferred principally in cases where the reactivity of certain of the above metals is detrimental to the product and the temperature limitations of the metals are of concern.

The process of this invention is applicable to any hydrocarbon conversion process where there is by-product carbon produced which may deposit on the inside of the converter. The partial combustion of hydrocarbons to produce acetylene has been exemplified in the example but it is apparent that the partial combustion of hydrocarbons to produce a synthesis gas consisting primarily of carbon monoxide and oxygen would also be applicable. Generally speaking, any process where gaseous hydrocarbons are partially burned can employ this invention to great advantage.

What is claimed is:

1. A method for preventing the deposition of carbon particles on the walls of an enclosed combustion zone during the production of acetylene by the partial combustion of hydrocarbons prior to the quenching step of said partial combustion process, said method comprising forming a layer of a protective liquid on the inner surface of said walls of said combustion zone by diffusing said protective liquid through the pores of said walls at a rate of from one pound per minute per square foot of porous wall to about 100 pounds per minute per square foot of porous wall.

2. The process of claim 1 wherein the said protective liquid is water.

3. The process of claim 1 wherein the hydrocarbon is methane and the partial combustion is carried out with oxygen.

4. The process of claim 1 wherein the reaction is carried out at from about 1,200° C. to about 1,800° C.

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