This invention relates to a process for manufacturing acetylene directly from a hydrocarbon, and more particularly to a process wherein a gaseous hydrocarbon such as methane is heated with a molten metal such as iron at a temperature of 3000° to 3500° F. for about 5 to about 100 milliseconds, then rapidly quenched to below 200° F., and acetylene recovered therefrom.

Acetylene is a very important chemical, and large amounts are made by the so-called calcium carbide method. This method is indirect, and requires a large and expensive plant installation.

Suggestions have been made heretofore for producing acetylene directly from hydrocarbon material; e.g. by contacting an ethylenic hydrocarbon with stainless steel at a temperature of the order of about 1600° to 2500° F., then quenching the gas to below about 500° F., and recovering acetylene therefrom. So far as is known, such a process has not achieved commercial success, and one drawback thereof is the requirement of the rather valuable ethylenic hydrocarbon starting material. The art is confronted with the problem of providing a method for producing acetylene from the most abundant and lowest cost hydrocarbon material in a convenient and economic manner.

It has been found in accordance with the invention that a hydrocarbon vapor may be converted to acetylene by heating to a temperature in the range of about 3000° to 3500° F. for a time in the range of about 5 to 100 milliseconds, and then rapidly quenching the vapor to below about 200° F. The acetylene may be recovered therefrom in a convenient manner.

The invention will be described in connection with the accompanying drawing which illustrates a suitable form of apparatus, partially diagrammatically, partially in perspective, and partially in section.

The objects achieved in accordance with the invention as described herein include the provision of a method for converting hydrocarbon vapor directly to acetylene; the provision of suitable apparatus for carrying out such a process; and other objects which will be apparent as details or embodiments of the invention are set forth hereinafter.

In order to facilitate a clear understanding of the invention, the following preferred specific embodiments are described in detail:

Referring to the drawing, the apparatus consists of a hydrocarbon vapor reactor 1, a metal bath regenerating reactor 2, molten metal conducting lines 3 and 3′ connecting these two reactors, molten metal such as iron 4 in each of these reactors, a submerged feed inlet for hydrocarbon vapor 5 and a surface feed inlet for hydrocarbon vapor 8, vapor feed jets 6 from inlet 5, acetylene vapor outlet 7 (connected to acetylene recovery system, not shown), quench material inlet 9 and quench material spray nozzle 10, air feed inlet 11 (with jet analogous to those of 6), combustion gas outlet 12 (to stack) and thermal insulation 13. The inlet 5 may be situated near the bottom of reactor 1, or at any higher point so long as the jets 6 are below the surface of the molten metal therein.

A hydrocarbon vapor, preferably natural gas or methane, is introduced through inlet 5 (or alternately through inlet 6 or a combination of both 5 and 6) so that it contacts the molten metal 4 which is at a temperature in the range of 3000° to 3500° F., for a time in the range of 5 to 100 milliseconds, and a water spray or mist is introduced through inlet 9 and spray nozzle 10 so as to reduce rapidly the exit hydrocarbon temperature to below about 200° F. The depth of metal and the hydrocarbon vapor flow rate are such that the hydrocarbon is maintained at a temperature in the range of 3000 to 3500° F. for the time in the range of 5 to 100 milliseconds.

The effluent from outlet 5 is passed to an acetylene recovery system of known type. Such a system may be based upon selective solvent absorption of the acetylene using a hydrocarbon oil as the solvent, regeneration or low temperature fractional distillation of the gases, scrubbing the gases with a selective solvent, azotropic distillation of the gases, extraction distillation of the gases, selective adsorption of the acetylene from the gases with activated charcoal or silica gel in a fixed bed or a continuous moving bed system, chemical separation or purification of the gases, or the like. Any unconverted hydrocarbon vapor in the exit gases may be recycled to the molten metal bath.

Hydrogen may also be recovered from the hydrocarbon gas mixture.

In the operation of this process, a part of the hydrocarbon may be converted to carbon which remains in the metal. The molten metal is circulated from reactor 1 through duct 3 to reactor 2 where the carbon is burned out by means of air introduced through inlet 11, thus supplying heat to maintain the temperature of the bath. Exit gases from this reactor pass through outlet 12 to the stack. Decarbonized or regenerated molten metal is passed from reactor 2 through duct 3′ back to reactor 1, and this process is relatively continuous, the movement being aided by the arrangement of the jets 6 and in the corresponding inlet 11 to facilitate this flow.

The apparatus may be provided with auxiliary heating means, such as electrical heating means, oil-fired heating means, or the like (not shown) in order to initially heat the metal. Such means may also be used to supply heat, especially if the process is conducted in a manner such that the amount of carbon formation in the molten metal in reactor 1 is insufficient to provide the heat required in the system, when burned out in reactor 2.

Iron is preferred for the molten metal bath. The apparatus may be constructed of suitable materials for handling molten iron, as known in the metallurgical art.

In order to test the suitability of any particular metal for this process, a stream or line of the molten metal may be passed downwardly through a vertical sillimanite column of about ¾ inch inner diameter, surrounded by a jacketed heating space for heating or insulating with flue gases. An inlet for hydrocarbon vapor is provided near the lower end thereof, and an exit for acetylene gases is provided near the upper end thereof, below the liquid metal inlet nozzle; and hydrocarbon vapor is passed upwardly in the column. About 11 inches is a convenient distance between the hydrocarbon vapor inlet and the acetylene gas outlet tubes. The outlet pipe is connected to a water quench and liquid separating system, and the vapors therefrom are passed into a gas analysis system for determining the acetylene content thereof.

Using such a system, and providing the molten iron by means of a thermite charge in a crucible set at the top of the tube, with a methane feed of about 50 cubic feet (ordinary temperature and pressure conditions) per hour,
with the molten metal at a temperature in the range of 3000° to 3500° F., in test runs the exit gases contained about 1 to 2% by volume acetylene; clearly showing the suitability of molten iron for this process.

In view of the foregoing disclosures, variations and modifications of the invention will be apparent to one skilled in the art, and it is intended to include within the invention all such variations and modifications except as do not come within the scope of the appended claims.

We claim:

1. A process for the preparation of acetylene, which comprises passing a gas, consisting of hydrocarbon gas, selected from the group consisting of natural gas and methane, through a heating zone, and, immediately thereafter, through a quenching zone, maintaining a molten iron bath in said heating zone and contacting said gas with said bath to thereby heat said gas, regulating the temperature of said bath and the rate of flow of said gas through said heating zone and into said quenching zone to thereby heat said gas to a temperature in the range of 3,000 to 3,500° F. and maintain the same at such temperature for from 5 to 100 milli-seconds, and, immediately thereafter, rapidly quenching said gas in said quenching zone to a temperature below 200° F.; and, thereafter, recovering the thus produced acetylene.

2. A process of claim 1 wherein the quenching is with aqueous mist.

3. A process of claim 2 wherein the hydrocarbon is passed through the bath.

4. A process of claim 2 wherein the hydrocarbon is passed over the bath.

5. A process of claim 2 wherein the hydrocarbon is methane.

6. A process of claim 2 wherein a portion of the bath is continuously removed and a corresponding amount of refined bath material is continuously added thereto.

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