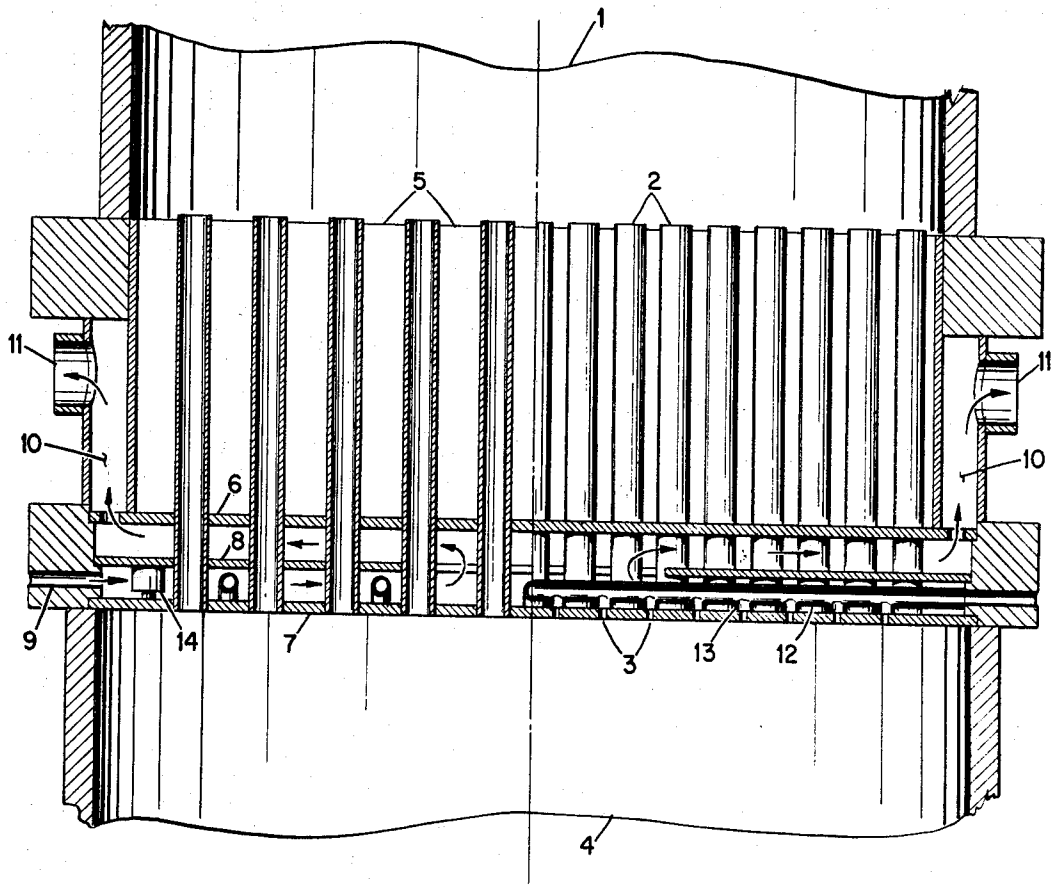
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CORROSION RESISTANT FLAME REACTOR

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CORROSION RESISTANT FLAME REACTOR

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1 Claim. (Cl. 23—277)

ABSTRACT OF THE DISCLOSURE

In producing acetylene by incomplete oxidation of saturated hydrocarbons, where a portion of a gas distributor issues streams of premixed oxygen plus hydrocarbon feedstock into a reaction zone, and other portions of the distributor feed streams of auxiliary oxygen into the reaction zone, it has also been disclosed to provide the lower portion of the distributor adjacent the reaction zone with a liquid-cooled heat exchanger. This exchanger passes cooling fluid around the lower portion of the means feeding the gaseous streams into the reaction zone and as a result the exchanger has a lower tube sheet exposed on one side to the reaction chamber and on the other to the cooling fluid. The sheet thus encounters an extreme heat flux while at the same time is exposed to the deleterious atmosphere of the reaction zone. To withstand this atmosphere and to cope with the extreme heat flux, the lower tube sheet is made from low-carbon steel having a thin chromium diffusion layer of chromium diffused into the surface of the sheet exposed to the reaction chamber.

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of copending U.S. application Ser. No. 424,418, filed Jan. 8, 1965, and now abandoned.

BACKGROUND OF THE INVENTION

In a typical method for the production of acetylene, a lower aliphatic hydrocarbon such as methane or natural gas is mixed with oxygen in a mixing chamber, the amount of oxygen being less than that required for complete combustion of the hydrocarbon. The mixture of gases is passed to a flame chamber wherein a portion of it is ignited. The high temperature thus produced causes thermal cracking of the unignited gases, resulting in the formation of acetylene and numerous by-products, including higher molecular weight acetylenes, tars, aromatics such as naphthalene, indene and analogous compounds, and a substantial amount of soot. This mixture is immediately quenched with water to arrest the cracking reaction and is then passed to a number of quenching and purification steps wherein the acetylene is recovered and the impurities are removed.

To promote proper combustion of the gas mixture and for other purposes, there is interposed between the mixing chamber and the flame chamber a gas distributor unit. This apparatus ordinarily comprises a cylindrical burner block or the like containing regularly spaced tubular channels passing from the mixing chamber into the flame chamber. The gas passes through these channels at a speed in excess of the flame propagation speed of the hydrocarbon-oxygen mixture. Thus, the distributor section functions also as a flame arrestor by preventing the backup of ignited gases from the flame chamber into the mixing chamber.

A major problem encountered in the use of the above-described apparatus is the maintenance of a stable and

permanently positioned flame in the flame chamber. For consistent operation, it is necessary that the flame be maintained in the same region of the flame chamber and of roughly the same size and temperature. This stabilization of the flame can be accomplished by the introduction of auxiliary streams of oxygen through ports in the gas distributor itself, such ports typically being directed to an angle from the vertical so that the oxygen streams impinge upon the streams of the gaseous oxygen-hydrocarbon mixture. An example of a gas distributor unit to which the present invention may be applied is disclosed in U.S. Patent 3,285,707. This mode of operation, in addition to providing enhanced amounts of oxygen within the reaction zone, causes the production of small, localized flame cones of high heat radiation in that portion of the flame chamber nearest the gas distributor. The result is an extremely high heat flux on the surface of the distributor apparatus. In fact, flame temperatures in this region approach 500° F. and the heat flux on the surface of the gas distributor is in excess of 1,000,000 B.t.u. per square foot per hour.

Provision may be made for dissipating much of this heat by constructing the gas distributor such that the portion nearest the flame chamber is provided with metal conduits surrounding the ends of the tubular gas channels, through which conduits is passed a cooling fluid such as water. While this cooling fluid circulation is effective for the maintenance of the gas distributor at a reasonable temperature, the effect of the same on the surface of the gas distributor facing the flame chamber is to create severe thermal stresses therein. These stresses may ultimately result in the cracking of the gas distributor surface.

It is further believed that a problem encountered in the the flame chamber is the result of the fact that a substantial amount of carbon (in the form of soot) is produced in the flame reaction. This carbon, in combination with the other gases present, affords a carburizing atmosphere which diffuses carbon into metal surfaces exposed to the reaction chamber, thereby embrittling such surfaces and deleteriously affecting their resistance to thermal stresses. Thus, if a low-carbon steel is used for the construction of a gas distributor, the surface of the distributor is converted to high-carbon steel after a relatively short period of use.

Because such high-carbon steels are extremely hard and brittle, carburization increases the susceptibility of the surface to cracking as a result of the thermal stresses. On the other hand, use of a less carburization-susceptible steel alloy such as stainless steel is undesirable because the thermal conductivity of such alloys is substantially lower than that of ordinary carbon steel. Thus, the temperature difference between the flame chamber-facing surface of the gas distributor and the interior thereof is considerably greater, and consequently the thermal stresses are greater and cracking is more likely.

SUMMARY OF THE INVENTION

A principal object of the present invention, therefore, is to provide an improved metal surface for the portions of the flame chamber subject to high heat fluxes, which surface is resistant to cracking as a result of thermal stresses and is also resistant to carburization.

A further object is to provide a metal surface for high-temperature work which combines the advantages of carburization resistance characteristic of stainless steel and other steel alloys with high thermal conductivity which is a characteristic of non-alloy low-carbon steel.

Other objects will in part be obvious and will in part appear hereinafter.

It has been discovered that the foregoing objects can be attained by providing, on the surface of the gas dis-

tributor exposed to the flame reaction, such gas distributor being constructed of low-carbon steel, a surface of elemental chromium which is diffused into the low-carbon steel.

Examples of gas distributor units to which the present invention may be applied are disclosed and claimed in the following U.S. Patents: 3,285,707, 3,285,708, and 3,287,090. These units are similar in design, and the present invention will be described in terms of the apparatus of U.S. Patent 3,285,707.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a vertical cross section of a gas distributor unit as disclosed in U.S. Patent 3,285,707 and as contemplated in connection with the present invention. Numeral 1 indicates a mixing chamber wherein the hydrocarbon and oxygen fed from means not shown are mixed and preheated. The gaseous mixture then passes through the gas distributor apparatus via distributor tubes 2 to flame chamber 4. Distributor tubes 2, through a portion of their length, may be surrounded by suitable insulating or refractory material in the spaces 5. The lower portion of the gas distributor is fitted with an upper metal sheet 6, and intermediate metal sheet 8, and a lower metal tube sheet 7, through which the distributor tubes 2 pass, and which sheets thereby form a double-pass shell-and-tube heat exchanger through which a coolant such as water is passed, the coolant entering the exchanger through conduit 9 from coolant supply means not shown and passing into chamber 10 and out through ports 11. Auxiliary oxygen for the maintenance of a stable flame in flame chamber 4 is provided from means not shown through conduit 12, and passes therefrom via downcomers 13 into openings 3 through lower tube sheet 7 and thence into the flame chamber. The distributor also contains coolant deflecting members 14, the purpose of which is to fill out the symmetry of the groups of tubular channels and downcomers in the outer reaches of the cooling chamber.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order that heat shall be readily carried from the flame chamber through the walls of the gas distributor to the cooling fluid, the gas distributor is constructed of low-carbon steel. But, on the surface of lower tube sheet 7 facing the reaction chamber, chromium is diffused into the low-carbon steel thereby preparing a chromium diffusion surface by a process known to those skilled in the art as "chromizing."

The chromizing process involves heating a metal object in the presence of a chromium material, for example a compound having a relatively high vapor pressure which is reduced to metallic chromium during chromizing. At the high chromizing temperatures chromium contacting the surface of the metal workpiece diffuses into the surface of the object being treated.

Suitable chromizing methods described in the prior art which are useful for producing the apparatus of this invention include the particularly efficient and useful method described in U.S. Patent 3,152,007, i.e., contacting the workpiece to be chromized at a temperature of between about 1300–2000° F. with a gaseous chromium halide. U.S. Patent 3,152,007 shows that although the chromium halide can be a mixture of chromium chlorides, such halide can be simply chromic chloride which is passed into contact with the workpiece by a transmitting gas, such as hydrogen, for reduction of the vaporized chromic chloride to form gaseous chromous chloride and elemental chromium which diffuses into the surface of the workpiece thereby preparing the chromium diffusion surface within the treated workpiece.

Also among the prior art methods which are particularly efficient and useful for chromizing, and which are thus useful for producing the apparatus of this invention, is the method described in U.S. Patent 3,021,231, i.e., contacting the workpiece with a solid chromium-providing material in mixture with a halide-containing substance at a temperature suitably in the range of 1650–2400° F. to provide diffusion coatings of chromium within the surface of low-carbon steel up to a depth of diffused chromium of about 0.019 inch. Although U.S. Patent 3,152,007 discloses the solid chromium-providing material can be elemental chromium, U.S. Patent 3,021,231 employs ferrochrome containing at least 30 weight percent chromium as the solid chromium-providing material and as the halide-containing substance employs a chromous or chromic halide, or for example, a hydrogen halide, or a metallic salt such as iron chloride, or an activator such as ammonium halide or sodium or potassium bifluoride.

By applying a thin layer of elemental chromium diffused into the flame-exposed, low-carbon steel surface of the gas distributor, it is possible to render this surface essentially impervious to the atmosphere existing in the flame chamber during the acetylene-forming reaction. At the same time, because the resulting surface is extremely thin it does not noticeably decrease the thermal conductivity of the low-carbon steel gas distributor. Therefore, the high heat fluxes across the face of the distributor do not cause cracking or other deterioration.

It is to be understood that the invention is not limited by the embodiments described hereinabove, but includes such changes and modifications as may be apparent to one skilled in the art upon reading the appended claim.

We claim:

1. In an apparatus for the production of acetylene by incomplete oxidation of saturated hydrocarbons in a flame reaction, such apparatus having

a mixing chamber for said hydrocarbons and oxygen,

a flame chamber into which a plurality of auxiliary streams of oxygen are introduced to stabilize the position of said flame,

a gas-distributor section interconnecting said chambers, and having a plurality of tubular channels opening into said mixing chamber and said flame chamber,

a liquid-cooled heat exchanger interposed between said mixing chamber and said flame chamber, said exchanger having a metal tube sheet forming one boundary of said flame chamber and surrounding the portion of said tubular channels opening into said flame chamber, and

means positioned within said exchanger for introducing said plurality of auxiliary streams of oxygen into said flame chamber through perforations in said tube sheet between adjacent groups of the openings of said tubular channels into said flame chamber,

the improvement in said apparatus comprising a low-carbon steel metal tube sheet for said liquid-cooled heat exchanger having a surface exposed to said flame chamber of low-carbon steel containing chromium diffused within said steel to a depth of not substantially above about 0.019 inch and provided by contacting a low-carbon steel tube sheet on at least said surface, at a temperature of between about 1300–2400° F., with a composition comprising a compound selected from the group consisting of gaseous chromium halides, and solid chromium-providing material in mixture with halide-containing substance.

No references cited.

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