DEVICE FOR PRODUCING AN AIR/HYDROCARBON MIXTURE

Inventor: Gunter Eberspach, Wolfschlugen (DE)

Correspondence Address:
MCGLEW & TUTTLE, PC
P.O. BOX 9227
SCARBOROUGH STATION
SCARBOROUGH, NY 10510-9227 (US)

Appl. No.: 11/034,544
Filed: Jan. 13, 2005

Publication Classification

Int. Cl. 7 
U.S. Cl. 

ABSTRACT

A device for producing an air/hydrocarbon mixture has an atomizing arrangement (10) with a hydrocarbon feed means (14) and with an air feed means (16, 18, 20) for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon. A heating arrangement (37), with which hydrocarbon (28) applied to the surface (26) of the first air flow guiding element (22) can be heated, is provided in a first air flow guiding element (22). The heated and consequently less viscous hydrocarbon (28) is moved to an atomizing lip (30) by corresponding air flows, which are generated by the air flow space areas (18, 20), and is atomized there, so that an air/hydrocarbon mixture suitable for combustion or reforming is formed.
DEVICE FOR PRODUCING AN AIR/HYDROCARBON MIXTURE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority under 35 U.S.C. § 119 of German patent application DE 10 2004 002 246.1 filed Jan. 15, 2004 the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention pertains to a device for producing an air/hydrocarbon mixture, comprising an atomizing arrangement with a hydrocarbon feed means and an air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon.

BACKGROUND OF THE INVENTION

Such a device in the form of an atomizing nozzle for a burner, especially for a heater that can be used on a vehicle, is known from DE 102 07 311 A1. The atomizing nozzle comprises air flow guiding elements, which define air flow guiding areas for the supply of combustion air, and a fuel feed device for applying fuel to the surface of an air flow guiding element. The fuel applied to the surface of the air flow guiding element is atomized in the atomizing nozzle with the use of the air flowing past the air flow guiding element.

Atomizing burners, which have an atomizing nozzle of this type, have the drawback that especially at low temperatures, the fuel or hydrocarbon cannot be atomized in a fine enough form because of its viscosity. This causes larger liquid hydrocarbon particles, which must travel over a longer flight path to be evaporated, to be entrained in the combustion air flow. There is a risk in case of such particles that they will condense into larger drops and condensate, i.e., a liquid, will thus be present in the atomizing burner. Such liquid drops compromise the operation of the atomizing burner because the liquid hydrocarbon affects the properties of the mixture due to its condensation from the air/hydrocarbon mixture such that a leaner mixture will be burned. Furthermore, the operation may be compromised by the fact that the drops precipitate on walls, for example, on inner walls or baffle plates of the atomizing burner. Because of the insufficient atomization, the liquid fuel may consequently collect in areas not intended for it in the atomizing burner, for example, in the form of a so-called fuel sump, or it may leave the burner unburned, in the liquid form or as a white smoke.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a device of this type for producing an air/hydrocarbon mixture such that the operation of a system fed with the mixture can be compromised less by the formation of drops.

According to a first aspect of the present invention, this object is accomplished by a device for producing an air/hydrocarbon mixture, which comprises an atomizing arrangement with a hydrocarbon feed means and an air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon.

Furthermore, a heating arrangement for heating the hydrocarbon prior to the atomization is provided with such a device for producing an air/hydrocarbon mixture according to the present invention.

The viscosity of the hydrocarbon is reduced due to the heating of the fuel, which causes the hydrocarbon to be able to be better atomized in the air, especially also at low temperatures. The entrainment of larger hydrocarbon particles in the air/hydrocarbon mixture can thus be reduced or even prevented.

The hydrocarbon feed means may comprise at least one tubular feed area that can be heated by means of the heating arrangement. This makes it possible to heat the hydrocarbon directly in the feed means, and it is advantageous in this connection that there usually is easy access in the area of the feed means for accommodating the heating arrangement.

It is possible in this connection for the feed area to comprise a venturi section. Such a device can be used, for example, in devices that atomize hydrocarbon with air according to the Venturi principle to heat the corresponding venturi sections before the hydrocarbon is atomized.

To improve the atomization of the hydrocarbon, the device may be designed such that the atomizing arrangement comprises at least one air flow guiding element, past which the air can flow; that the hydrocarbon feed means is designed to deliver the liquid hydrocarbon onto the surface of the air flow guiding element; and that the hydrocarbon on the surface of the air flow guiding element can be heated by the heating arrangement. The heating of the hydrocarbon on the surface leads to better distribution of the liquid hydrocarbon applied to the surface because of the reduced viscosity. As a result, a thinner film of hydrocarbon will be atomized on the surface, so that an air/hydrocarbon mixture can be formed that contains either a very small amount of hydrocarbon particles in the liquid form or no such hydrocarbon particles in the optimal case.

Provisions may be made, for example, for the air flow guiding element to be able to be heated by the heating arrangement. The heating of the air flow guiding element leads to heating of the surface of the air flow guiding element and thus to heating of the liquid hydrocarbon applied.

The heating arrangement preferably comprises at least one heating element arranged in the air flow guiding element. The provision of at least one heating element in the air flow guiding element has the advantage that the heating element can be arranged such that effective heating of the surface is made possible. Furthermore, such a heating element or a plurality of such heating elements may be installed as part of an atomizing nozzle directly at the time of the manufacture of the air flow guiding element.

According to another aspect of the present invention, the object is accomplished by providing at least one receiving element for receiving liquid hydrocarbon from the air/hydrocarbon mixture in a space area that contains the air/hydrocarbon mixture. Such a receiving element is used to receive liquid hydrocarbon particles that are entrained in the air/hydrocarbon mixture because of the insufficient atomization. It is thus possible to prevent, at least partially and in the ideal case completely, liquid hydrocarbon particles from
being further entrained in the air/hydrocarbon mixture and the operation of the system fed with the mixture from being compromised thereby.

[0015] The at least one receiving element is provided in a preferred embodiment at least one wall defining the space area. This makes it possible to arrange at least one receiving element at walls at which there is a risk of precipitation of insufficiently atomized liquid hydrocarbon particles being entrained in the air/hydrocarbon mixture because of the design, because of the prevailing flow conditions and especially because of low temperatures.

[0016] The at least one receiving element may be provided at a deflecting element deflecting the flow of the air/hydrocarbon mixture. Such deflecting elements may be, for example, baffle plates, flame screens or the like, which are usually arranged directly in the main flow of the air/hydrocarbon mixture, i.e., the risk of precipitation of insufficiently atomized, liquid hydrocarbon particles at these deflecting elements is relatively high. The baffle plates are used both, but also without a receiving element to prevent the unimpeded entrainment of liquid hydrocarbon particles in the air/hydrocarbon mixture in order to make it possible to capture at least part of the liquid hydrocarbon particles. Due to the arrangement of at least one receiving element at a deflecting element, liquid hydrocarbon particles from the air/hydrocarbon mixture can be captured even more efficiently and quasi filtered out. Furthermore, the particles can be retained in the receiving element such that the formation of hydrocarbon drops at the deflecting element can be prevented from occurring in the optimal case.

[0017] Efficient uptake of liquid hydrocarbon particles at the receiving elements can be achieved if these elements are able to absorb the liquid hydrocarbon. The liquid hydrocarbon is absorbed by the material of the receiving element due to the absorption and it does not adhere to the receiving element in the form of large droplets due to friction, viscosity or surface tension. In principle, a larger amount of liquid hydrocarbon can also be taken up because of the absorption compared with a non-absorbing material without these being a risk of formation of hydrocarbon drops at the deflecting element provided with absorbing material.

[0018] It is especially advantageous in this connection if the at least one receiving element is formed from a porous material. The use of porous materials makes it possible to take up larger amounts of liquid hydrocarbon compared with other, especially nonporous materials. As a result, the formation of drops after the uptake of hydrocarbon at the surface of the receiving element is reduced or even prevented from occurring altogether. Furthermore, porous material also makes possible the evaporation of the hydrocarbon taken up, besides the absorption, so that liquid hydrocarbon, which was absorbed by the receiving element at lower temperatures, can again be fed to the air/hydrocarbon mixture. Such an arrangement exerts a supportive action for the complete processing of the hydrocarbon and prevents the operation from being compromised by newly formed drops of liquid hydrocarbon. The material may be such in terms of its porosity that it possesses optimal properties in terms of absorption capacity for the particular arrangement of the receiving element and for the particular type of hydrocarbon being used.

[0019] To obtain as optimal an arrangement as possible, it is especially advantageous to combine the atomizing arrangement and/or the heating arrangement and/or the receiving element and/or the space area with one another in the device. In such an embodiment, the hydrocarbon can be better atomized in the air, on the one hand, especially also at low temperatures, which can reduce or even eliminate the entrainment of coarser hydrocarbon particles in the air/hydrocarbon mixture, and, on the other hand, drops of liquid hydrocarbon, which could nevertheless be present in the air/hydrocarbon mixture despite the improved atomization, are taken up or absorbed by the receiving element. Improvements of the operation of a system fed with the mixture, which are induced by the formation of drops, especially the escape of unburned liquid hydrogen or of white smoke, can be prevented from occurring in the optimal case according to the invention.

[0020] The device according to the present invention may be used, for example, in a heater in order to optimize the combustion. Furthermore, it is also possible to use the device in a reformer, which is used to obtain hydrogen, e.g., for fuel cells, in which case optimized combustion is made possible, on the one hand, for example, for heating the reformer to the operating temperature, and, on the other hand, the formation of the air/hydrocarbon mixture used for the reforming can be improved.

[0021] The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The present invention will be described below with reference to the drawings attached. In the drawings:

[0023] FIG. 1 is a schematic longitudinal sectional view of an atomizing burner, in which two alternative heating arrangements according to the present invention of a device for producing an air/hydrocarbon mixture are provided as an example;

[0024] FIG. 2 is a schematic longitudinal sectional view of an atomizing burner, in which a venturi section is provided as a hydrocarbon feed means;

[0025] FIG. 3a is a view showing an embodiment variant of the heating arrangement in the venturi section;

[0026] FIG. 3b is a view showing another embodiment variant of the heating arrangement in the venturi section; and

[0027] FIG. 4 is a schematic longitudinal sectional view of receiving elements according to the present invention in a space area into which the air/hydrocarbon mixture can be fed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0028] Referring to the drawings in particular, a device for producing an air/hydrocarbon mixture has, with reference to FIG. 1, an atomizing arrangement designated by 10 and a space area designated by 12, into which the air/hydrocarbon mixture can be fed. The atomizing arrangement 10 comprises a hydrocarbon feed means 14, via which liquid
hydrocarbon, e.g., gasoline, diesel fuel, biodiesel or the like, is fed to the atomizing arrangement 10. The hydrocarbon fed in is atomized in the atomizing arrangement 10 and enters the space area 12 together with the air likewise fed in via the atomizing arrangement 10. The air is distributed in the space area 12 into two air flow space areas 18, 20 via a space area 16. The two air flow space areas 18, 20 are separated from one another by a first air flow guiding element 22. Together with the first air flow guiding element 22, a second air flow guiding element 24 defines the first air flow space area 18. Together with the first air flow guiding element 22, a third air flow guiding element 26 defines the second air flow space area 20. The hydrocarbon fed in by the hydrocarbon feed means 14 is applied by an inner swirl flow to the first air flow space area 18 onto a surface 26 of the first air flow guiding element 22, which said surface 26 defines the first air flow space area. The liquid hydrocarbon forms a fuel film 28 on the surface 26, which said fuel film is moved by the inner swirl flow to an atomizing lip 30. The liquid hydrocarbon is atomized at the atomizing lip 30 because of a shearing action between the inner swirl flow and an outer swirl flow generated in the second air flow space area 20. The air/hydrocarbon mixture formed in this manner enters the space area 12 downstream, in which the mixture may, for example, be burned. An igniting device 32, for example, in the form of a glow type ignition pin, is provided for the combustion. A deflecting element 34, at which the air/hydrocarbon mixture is deflected and swirled for better combustion, is arranged in the space area 12. Furthermore, liquid hydrocarbon particles that may be entrained in the air/hydrocarbon mixture can be captured at the deflecting element 34. The combustion waste gases produced by the combustion in the space area 12 leave the space area 12 downstream in the direction of a space area 36. The space area 36 may have a reformer module to provide a reformer or may be a combustion chamber of a heater.

Two embodiment variants of a heating arrangement 37 according to the present invention are also shown in the atomizing arrangement 10 according to FIG. 1. Both heating arrangements 37 are arranged in the first air flow guiding element 22 in order to make it possible to heat the surface 26 of the first air flow guiding element 22 and consequently also the fuel film 28. A first embodiment variant shows five cross sections of a heating wire 38 arranged in the first air flow guiding element 22 in the form of a screw/spiral in the upper part of the longitudinal section of the first air flow guiding element 22. The second embodiment variant shows a glow type pin 40 arranged in the first air flow guiding element 22, with which said pin the air flow guiding element 22, the surface 26 thereof and the fuel film 28 can be heated. The heating wire 38 and the glow type pin 40 are heated by applying an electric voltage, so that an electric current will flow in the heating wire 38 and in the glow type pin 40 and the heating wire 38 and the glow type pin 40 are heated because of their respective electric resistances. However, the fuel film 28 applied to the surface 26 of the first air flow guiding element 22 may also be heated in another manner, for example, by microwave radiation by means of a plurality of glow type pins 40 arranged on the circumference of the air flow guiding element 22.

It is obvious that the atomizing arrangement with the heating arrangement according to the present invention may be used in heaters, for example, a parking heater. Furthermore, such an atomizing arrangement may also be used in a reformer, which generates hydrogen from the air/hydrocarbon mixture, optionally in conjunction with a combustion device, in order to make it possible to heat the reformer to the operating temperature prior to the reforming of the air/hydrocarbon mixture. The reformer module may be arranged at or be the area designated space area 36.

FIG. 2 shows the space area 12 with the igniting device 32 and the deflecting element 34 as well as with the space area 36 of the device for producing an air/hydrocarbon mixture, which said space area 36 is not described in greater detail. A device operating according to the Venturi principle is schematically shown as the atomizing arrangement 10. The hydrocarbon is fed to the atomizing arrangement 10 through a venturi section 50, which is shown in the form of a venturi pipe. The air is fed through an air flow space area 52, which is defined by corresponding air flow guiding elements 54, 56. The air flowing past the venturi section 50 in the air flow space area 52, indicated by the two arrows, atomizes the hydrocarbon being discharged at the end 58 of the venturi section 50. Corresponding to the description given in connection with FIG. 1, the air/hydrocarbon mixture enters the space area 12, in which it can be burned.

If the venturi section 50 is used as a hydrocarbon feed means, the heating arrangement may be arranged directly at the venturi section, as this is shown in two embodiment variants in the cross-sectional views corresponding to section line III-III in FIG. 2 in FIGS. 3a and 3b. The venturi section 50 and consequently the hydrocarbon being fed therein can be heated according to FIG. 3a by a heating wire 60 arranged in a suitable manner at the venturi section 50, for example, by the heating wire 60 being arranged in a helical pattern around the tubular feed area 61 of the venturi section 50, which said feed area 61 carries the hydrocarbon. Another embodiment variant provides for arranging one or more glow type pins 62, for example, radially around the tubular feed area 61 of the venturi section 50, which said feed area 61 carries the hydrocarbon. As was described above, the heating wire 60 or the glow type ignition pins 62 are heated by an electric resistor. Another, suitable form of heating arrangement 37 may be provided in case of the use of a venturi section as well.

The atomizing arrangement 10 in FIG. 4 is shown as a representative of all the atomizing arrangements suitable for the device for producing an air/hydrocarbon mixture. The space area 12, the space area 36, which is not described in greater detail, the igniting device 32, as well as the deflecting element 34 can be recognized. The space area 12 is defined by walls 70, at which receiving elements 72 are arranged at least partly. A receiving element 72 is likewise arranged on the deflecting element 34, which may be, for example, a baffle plate. The receiving elements 72, 72 arranged at the walls 70 of the space area 12 and at the deflecting element 34 take up liquid hydrocarbon particles, which are entrained in the air/hydrocarbon mixture formed by the atomizing arrangement 10. The preferably absorbent and porous receiving elements 72, 72 are arranged such that, taking into account the flow conditions prevailing in space area 12, the most optimal absorption possible of liquid hydrocarbon particles from the air/hydrocarbon mixture can take place. It is also conceivable in this connection that the walls 70 are lined completely with receiving elements 72 or that, for example, parts projecting into the space area 12, e.g., the igniting device 32, are also provided with corre-
sponding receiving elements. In particular, liquid hydrocarbon particles, which are brought to the walls by corresponding radial components of the prevailing flow, can be taken up from the air/hydrocarbon mixture by the receiving elements 72 on the walls 70. The receiving element 72 arranged at the deflecting element 34 takes up especially liquid hydrocarbon particles that are not completely evaporated in the principal direction of flow because of high air flow velocities. Liquid hydrocarbon particles are thus prevented from leaving the space area 12 in the direction of the space area 16 in an uninhibited manner.

[0034] The receiving elements 72, 72' shown in FIG. 4 may be preferably combined with atomizing arrangements 10, 10', which contain the heating arrangement 37 for heating the hydrocarbon to be atomized. On the one hand, this improves the atomization, which can reduce or even eliminate the entrainment of larger hydrocarbon particles in the flow of the air/hydrocarbon mixture, and, on the other hand, particles of liquid hydrocarbon that are present despite the preceding heating can be absorbed by the receiving elements 72, 72'.

[0035] In summary, a device for producing an air/hydrocarbon mixture comprises an atomizing arrangement with a hydrocarbon feed means and with an air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon. A heating arrangement, with which hydrocarbon applied to the surface of the first air flow guiding element can be heated, is provided in a first air flow guiding element. The heated and consequently less viscous hydrocarbon is moved by corresponding air flows, which are generated by the air flow space areas, to an atomizing lip and is atomized there, so that an air/hydrocarbon mixture suitable for combustion or reforming is formed.

[0036] While specific embodiments of the invention have been shown and described to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A device for producing an air/hydrocarbon mixture, comprising

   an atomizing arrangement with a hydrocarbon feed means and with an air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon; and

   a heating arrangement provided for heating the hydrocarbon prior to the atomization.

2. A device in accordance with claim 1, wherein said hydrocarbon feed means comprises at least one tubular feed area heated by means of said heating arrangement.

3. A device in accordance with claim 2, wherein said feed area comprises a venturi section.

4. A device in accordance with claim 1, wherein said atomizing arrangement comprises at least one air flow guiding element having a surface, past which the air can flow; and said hydrocarbon feed means delivers the liquid hydrocarbon onto said surface of said air flow guiding element; and the hydrocarbon on said surface of said air flow guiding element is heated by said heating arrangement.

5. A device in accordance with claim 4, wherein said air flow guiding element is heated by said heating arrangement.

6. A device in accordance with claim 5, wherein said heating arrangement comprises at least one heating element arranged in said air flow guiding element.

7. A device for producing an air/hydrocarbon mixture, comprising

   an atomizing arrangement with a hydrocarbon feed means and with an air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon; and

   a space area, to which the air/hydrocarbon mixture is fed; at least one receiving element in said space area for taking up liquid hydrocarbon from the air/hydrocarbon mixture.

8. A device in accordance with claim 7, wherein said at least one receiving element is provided at at least one wall defining said space area.

9. A device in accordance with claim 7, further comprising a deflecting element deflecting the flow of the air/hydrocarbon mixture wherein said, at least one receiving element is arranged at said deflecting element.

10. A device in accordance with claim 8, further comprising a deflecting element deflecting the flow of the air/hydrocarbon mixture wherein said, at least one receiving element is arranged at said deflecting element.

11. A device in accordance with claim 7, wherein said at least one receiving element absorbs liquid hydrocarbon.

12. A device in accordance with claim 8, wherein said at least one receiving element absorbs liquid hydrocarbon.

13. A device in accordance with claim 9, wherein said at least one receiving element absorbs liquid hydrocarbon.

14. A device in accordance with claim 7, wherein said at least one receiving element is made of a porous material.

15. A device in accordance with claim 7, further comprising a heating arrangement for heating the hydrocarbon prior to the atomization.

16. A device in accordance with claim 15, wherein said hydrocarbon feed means comprises at least one tubular feed area heated by means of said heating arrangement.

17. A device in accordance with claim 16, wherein said feed area comprises a venturi section.

18. A device in accordance with claim 15, wherein said atomizing arrangement comprises at least one air flow guiding element having a surface, past which the air can flow; and said hydrocarbon feed means delivers the liquid hydrocarbon onto said surface of said air flow guiding element; and the hydrocarbon on said surface of said air flow guiding element is heated by said heating arrangement.

19. A device in accordance with claim 18, wherein said air flow guiding element is heated by said heating arrangement.

20. A device in accordance with claim 19, wherein said heating arrangement comprises at least one heating element arranged in said air flow guiding element.

21. A heater device comprising: a device for producing an air/hydrocarbon mixture, with an atomizing arrangement with a hydrocarbon feed means and with a air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon; and means for at least partially reducing the entrainment of larger hydrocarbon particles in the air/hydrocarbon mixture including at least one of: a heating arrangement provided for heating the hydrocarbon prior to the atomization, and a space area, to which the air/hydro-
carbon mixture is fed with at least one receiving element in said space area for taking up liquid hydrocarbon from the air/hydrocarbon mixture.

22. A heater device according to claim 21, further comprising a combustion chamber receiving said air/hydrocarbon mixture.

23. A reformer device comprising: a device for producing an air/hydrocarbon mixture, with an atomizing arrangement with a hydrocarbon feed means and with an air feed means for producing the air/hydrocarbon mixture by atomizing liquid hydrocarbon; and means for at least partially reducing the entrainment of larger hydrocarbon particles in the air/hydrocarbon mixture including at least one of: a heating arrangement provided for heating the hydrocarbon prior to the atomization, and a space area, to which the air/hydrocarbon mixture is fed with at least one receiving element in said space area for taking up liquid hydrocarbon from the air/hydrocarbon mixture.

24. A reformer device according to claim 23, further comprising a reformer module receiving said air/hydrocarbon mixture.