A gas burner (10), preferably a premix burner, comprising a support (12) which has a central gas inlet port for supply of gas into a gas supply chamber. The gas supply chamber is enclosed by a perforated metal plate (22). The perforated metal plate is connected at the bottom to the support through a base section. The perforations in the perforated metal plate provide a burner deck (20). The burner deck has an overall porosity which is equal to or lower than 11%. The present invention also provides use of this burner, e.g. in heat exchangers.
BURNER WITH LOW POROSITY BURNER DECK

TECHNICAL FIELD

[0001] The present invention relates to a premix burner, more in particular a burner having a flameholder made of perforated metal plate material. Preferably, the burner is a tubular burner having a cylindrical shape. These burners are especially suitable for use in combustion boilers.

BACKGROUND ART

[0002] One known type of premix burner consist of one or more of the following components: a) an end cap located at the top of the burner, b) a burner deck, the burner deck consists of a blind piece at the bottom, a perforated piece, with a regular (circular) pattern, with sometimes locally an additional modification for ignition purposes, in the centre part and a blind piece at the top. The pattern is mostly circumferential, and mostly repeating itself in height after a pitch of 1-10 mm; c) a distributor, having a blind piece at the bottom, a perforated part in the centre and a blind piece at the top; d) a distributor end cap; e) a flange; f) an anti-noise tube which is a device located in or nearby the flange to adjust the pressure distribution. Such premix burners are described in e.g. EP 1337789, EP037175, WO2009/077333, WO2009/065733, WO2009/059933. As can be seen in most of above referenced documents, these burners are provided with devices in the mixing chamber, such as e.g. an inner liner, also called distributor and/or anti-noise tube or other devices such as swirls or perforated disks in or nearby the flange. These devices are needed for stabilization of flames on these burners, which has an effect on noise and emissions. The need of using these devices implies a considerable complication for making the burner and for the assembling and implies a considerable cost.

DISCLOSURE OF INVENTION

[0003] The object of the present invention is to obviate the drawbacks mentioned above.

[0004] An object of the present invention is to provide a premix burner which does not need such devices in the mixing chamber of the burner to obtain a good stability of the flames and to reduce or even eliminate noise problems.

[0005] A further object of the present invention is to provide a premix burner with a good stability over the full operating range of high to low CO₂ and for the full band of customary or natural gas qualities.

[0006] This full band of customary and natural gas qualities covers all gases selected from hydrocarbons such as methane, ethane, propane, butane, ethene, propene, butene, acetylene, and the like. In contrast with WO 95/23315, the present invention does not relate specifically to high reactive fuel gases, which are a mixture of hydrogen and customary fuel gases.

[0007] A further object of the present invention is to provide a premix burner producing low NOx levels.

[0008] An aspect of the claimed invention provides a gas burner preferably a premix burner, comprising a support having a central gas inlet port for supply of gas into a gas supply chamber. The gas supply chamber is enclosed by a perforated metal plate. The perforations in said perforated metal plate providing a burner deck. The perforated metal plate is connected at the bottom to the support through a base section. The burner deck has an overall porosity which is equal to or lower than 11%, preferably lower than 10%, even more preferably lower than 9%.

[0009] In a further aspect, the present invention provides a gas burner as described above wherein the burner further comprises an end cap connected to the perforated metal plate substantially opposite to said gas inlet port.

[0010] In a preferred aspect, the present invention provides a gas burner as described in paragraph 8, wherein the end cap is also provided with perforations. These perforations thereby enlarge and are part of the burner deck. In a preferred aspect, the end cap is made of metal plate material. In a further preferred aspect, the perforation patterns in the end cap and in the perforated metal plate are equal. In an alternative further aspect, the perforation patterns in the end cap and in the perforated metal plate are different. In a further preferred aspect, the perforations, such as e.g. slots and holes, in the end cap and in the perforated metal plate are equal. In an alternative further aspect, the perforations in the end cap and in the perforated metal plate are different.

[0011] Conventional premix burners have a porosity in the range of 14 to 18%. It was surprisingly found that lowering the porosity of the burner deck decreased acoustic time-lag of the flames formed on the burner deck, which enabled us to make a burner which did not need a diffuser anymore. It was also surprisingly found that this burner had an unstable burning when this burner was operated in open air, but when applied inside a heat exchanger, this burner had a stable flame and burning pattern. This burner also had a more stable response on the first Helmholtz resonance of the heat exchanger and its peripheral parts, which therefore made that the burner did not provoke low frequency thermo-acoustic instabilities, often referred to as humming. However, during start sequences under cold conditions with this burner build in, the boiler sometimes suffered a humming sound which sometimes makes the burner still needing an anti-noise device in its mixing chamber. The use of the anti-noise device in this burner also has a positive effect on the CO emission. Also it was found that lowering the porosity did not dampen thermo-acoustic instabilities with a higher frequency than the first Helmholtz resonance of the boiler, often referred to as whistling or howling. To cancel these frequencies, the anti-noise device was necessary again.

[0012] In a further aspect of the present invention, the gas burner of the type described above has a burner deck wherein more than 50% of the burner deck has a porosity being equal to or lower than 9% and wherein up to 50% of the burner deck has a porosity being higher than 11% and with an overall porosity which is equal to or lower than 11%. This modification of the perforation pattern of the burner deck provided a burner which, next to the effect of the deletion of the diffuser and the removal of the humming noise, also had a more stable response on the second and higher Helmholtz or instable acoustic resonances of the heat exchanger, which therefore made that the boiler, with this build in burner did not provoke a whistling sound anymore. Next to that, during start sequences under cold conditions, the humming sound was eliminated and therefore the use of anti-noise devices in the mixing chamber of the burner could be omitted. Furthermore, this provided a stabilized deck over the full operating range of high to low CO₂ and for a broad range of gas qualities.

[0013] Another aspect of the claimed invention provides a gas burner as described in [0007], [0008], [0009], or [0011] wherein the burner deck has different patterns of perforations.
Adding more patterns with different pitches showed an increased stability for a broader range of gas qualities and induced less NOx-emissions. In a preferred aspect, the burner is provided with an abrupt and stepwise variation of the perforation pattern in the burner deck.

In a preferred aspect, the present invention provides a burner with gradually increasing or decreasing perforation pattern or gradually increasing or decreasing pitches in between the perforation pattern of the burner deck. This grading can go in axial or circumferential direction. Gradually increasing or decreasing the perforation of the decks allows an almost step less variety of the perforation, and thus creating a varying perforation of the surface of the deck. In another preferred embodiment of the present invention, the burner has a completely random deck with no repeatability over the full height or circumference of the burner deck which provides a stabilized deck without the additional devices as mentioned above.

Most preferably, in order to improve flame stability, there is a decreased porosity when going downstream. In an embodiment, the part with a porosity higher than 11% is closest to the gas inlet. The part with a porosity equal to or lower than 9% is most remote, i.e, downstream, from the gas inlet.

Definitions

The term “burner deck” is to be understood, in the light of this invention, to be that part of the burner where the totalities of perforations are present. In case two or more distinct regions of perforations can be detected on the burner surface, the burner deck is defined as being the surface spanning of all regions with perforations.

The term “overall porosity of the burner deck” is to be understood, in the light of this invention, as ratio of the surfaces of the holes, slots or other openings divided by the surface of the burner over which the perforated part(s) is(are) located.

The term “perforation pattern” is to be understood, in the light of this invention, to be a recurring scheme of perforations.

BRIEF DESCRIPTION OF DRAWINGS

Example embodiments of the invention are described hereinafter with reference to the accompanying drawings in which:

FIG. 1 shows an example embodiment according to a first aspect of the present invention.

FIGS. 2A and 2B show an example embodiment according to a second aspect of the present invention. FIG. 2C shows an example perforation pattern according to a second aspect of the present invention.

FIG. 3 shows an example embodiment according to a third aspect of the present invention.

FIG. 4 shows an example embodiment according to a further aspect of the present invention.

FIG. 5 shows an example embodiment according to a further aspect of the present invention.

FIG. 6 shows an example embodiment according to a further aspect of the present invention.

FIG. 7 shows an example embodiment according to a further aspect of the present invention.

FIG. 8 shows an example embodiment according to a further aspect of the present invention.

FIG. 9 shows an example embodiment according to a further aspect of the present invention.

FIG. 10 shows a further example embodiment according to an aspect of the present invention.

FIG. 11 shows a further example embodiment according to an aspect of the present invention.

REFERENCE NUMBERS

10 gas burner
12 support or flange
14 central gas inlet port
16 gas supply or mixing chamber
18 end cap
20 burner deck
22 perforated metal plate
24 perforation
30 perforation

MODE(S) FOR CARRYING OUT THE INVENTION

Examples of a burner according to the present invention will be described with reference to FIGS. 1 to 11.

FIG. 1 shows a gas burner 10, preferably a premix burner, comprising a support or flange 12 which has a central gas inlet port 14 for supply of gas into a gas supply or mixing chamber 16. The gas supply chamber 16 is enclosed by a perforated metal plate 22. The perforated metal plate 22 is connected at the bottom to the support or flange 12 through a base section. The perforations 24 in the perforated metal plate 22 provide the burner deck 20. The burner deck 20 has an overall porosity which is equal to or lower than 11%, preferably lower than 10%, even more preferably lower than 9%.

FIG. 2A shows a perspective view of a burner according to the present invention. FIG. 2B shows a cross sectional view taken along the line II-III in FIG. 2A. FIGS. 2A and 2B show a gas burner 10, preferably a premix burner, comprising a support or flange 12 which has a central gas inlet port 14 for supply of gas into a gas supply or mixing chamber 16. The gas supply chamber 16 is enclosed by a perforated metal plate 22 and an end cap 18 substantially opposite to said gas inlet port 14. The perforations 24 in the perforated metal plate 22 provide the burner deck 20. The end cap 18 is connected to the top of the perforated metal plate 22 and the perforated metal plate 22 is connected at the bottom to the support or flange 18 through a base section. The burner deck 20 has an overall porosity which is equal to or lower than 11%, preferably lower than 10%, even more preferably lower than 9%. In an exemplary embodiment, a burner 10 with a perforation pattern as shown in FIG. 2C, has a length of 102.4 mm and diameter of 70.4 mm. The burner deck has a length of 81.2 mm and has a porosity of 7.7%. The perforation pattern in the perforated plate is a combination of slits and round holes. For a thickness of the perforated plate of 0.6 mm, the slits being 4.0×0.5 mm, the holes having a diameter of 0.8 mm. The perforations are grouped in a pattern of 4.8 mm and this pattern is repeated over the burner deck in an equal division. As explained above, this burner still needed an anti-noise device, but no pressure divider or distributor anymore.

A further aspect of the present invention provides a burner 10 wherein the end cap 18 is also provided with perforations. FIG. 3 shows an exemplary burner according to the present invention wherein the end cap is provided with perforations 30. The burner deck of this burner is as shown by reference number 20.
A further aspect of the present invention provides a burner 10 with a burner deck wherein more than 50% of the burner deck has a porosity being equal to or lower than 9% and wherein 10 to 50% of the burner deck has a porosity being higher than 11%. The burner deck has an overall porosity which is equal to or lower than 11%. In an exemplary embodiment, a burner 10 as shown in FIG. 4 has a length of 94.8 mm and diameter of 70.4 mm. The burner deck 20 has a length of 93.6 mm. The perforation pattern in the perforated plate 22 is a combination of slits and round holes. The thickness of the perforated plate 22 is 0.6 mm, the slits being 4.0x0.5 mm, the holes having a diameter of 0.8 mm. The perforations are grouped in a pattern as shown in FIG. 4, wherein the first 11.8 mm of the burner deck length has a porosity of 15%, thereafter is a zone of 46.8 mm of the burner deck length with a porosity of 7.3% and the last zone with a length of 5.8 mm of the burner deck length having a porosity of 16.5%. This pattern is repeated over the burner deck on the circumference of the burner. This provides a burner deck which has an overall porosity of 9.8%. This modification of the perforation pattern of the burner deck provided a burner which, next to the effect of the deletion of the diffuser and the removal of the humming noise, also had a more stable response on the second and higher Helmholtz or instable acoustic resonances of the heat exchanger, which therefore made that the burner did not provoke a whistling sound anymore. Next to that, during start sequences under cold conditions, the humming sound was eliminated and therefore the use of anti-noise devices in the mixing chamber of the burner could be omitted. Furthermore, this provided a stabilized deck over the full operating range of high to low CO2’s, and for a broad range of gas qualities. Furthermore, for this specific example of FIG. 4, the use of the relatively high porosity at the beginning and end of the burner deck 20 provide an even more stable flame pattern of the burner.

An example embodiment according to a further aspect of the claimed invention provides a gas burner with a perforated metal plate 22 with a perforation pattern as shown in FIG. 5. The shown perforation pattern is repeated over the circumference of the burner. Here the burner deck 20 has different patterns of perforations. Adding more patterns with different pitches showed an increased stability for a broader range of gas qualities and induced less NOx-emissions. The exemplary perforation pattern of FIG. 5 is an abrupt and stepwise variation of the perforation pattern in the burner deck 20.

FIG. 6 shows another example of a perforation pattern of burner deck 20 according to a preferred aspect of the present invention, wherein the porosity of the burner deck 20 decreases stepwise in downstream direction. The shown perforation pattern is repeated in the perforated metal plate 22 over the circumference of the burner.

FIG. 7 shows an example of a perforation pattern of burner deck 20 according to a preferred aspect of the present invention, wherein the porosity is gradually increasing. This perforation pattern is repeated in the perforated metal plate 22 over the circumference of the burner.

FIG. 8 shows an exemplary perforation pattern of the burner deck 20, which is repeated lengthwise over the perforated metal plate 22.

FIG. 9 shows a further exemplary perforation pattern which is repeated on the circumference of a burner. The perforation pattern is such that no repeat of pattern is occurring along the length of the burner deck 20. An exemplary burner with a length of 91.2 mm and diameter of 70.4 mm. The burner deck has a length of 70.4 mm. The perforation pattern in the perforated plate 22 is a combination of slits and round holes as shown in FIG. 9. For a thickness of the perforated plate 22 of 0.6 mm, the slits being 4.0x0.5 mm, the holes having a diameter of 0.8 mm, this burner deck has an overall porosity of 7.3%.

The person skilled in the art will acknowledge that any perforation pattern or set of perforation patterns can be repeated lengthwise or over the circumference to obtain the burner according to the present invention.

Another preferred embodiment of the present invention is shown in FIG. 10. The burner 10 made out of perforated metal plate 22 has a completely random perforated burner deck 20 with no repeatability over the full height or circumference of the burner deck which provides a stabilized deck without the additional devices as mentioned above.

FIG. 11 shows another exemplary embodiment of the present invention. This burner has a perforated end cap 24 with different perforation pattern than the perforated metal plate 22. The perforations 30 together with the perforations 24 provide the burner deck 20.

Thus there has been described a gas burner, preferably a premix burner, comprising a support which has a central gas inlet port for supply of gas into a gas supply chamber. The gas supply chamber is enclosed by a perforated metal plate and an end cap substantially opposite to said gas inlet port. The perforations in the perforated metal plate provide a burner deck. The end cap is connected to the top of the perforated metal plate and the perforated metal plate is connected at the bottom to the support through a base section. The burner deck has an overall porosity which is equal to or lower than 11%. The present invention also provides use of this burner, e.g. in heat exchangers.

1-11. (canceled)

12. A gas burner, preferably a premix burner, comprising a support having a central gas inlet port for supply of gas into a gas supply chamber, said gas supply chamber being enclosed by a perforated metal plate, said perforated metal plate connected at the bottom to said support through a base section, said perforation in said perforated metal plate providing a burner deck, characterised in that said burner deck has an overall porosity being equal to or lower than 11%.

13. A gas burner, as in claim 12, said burner further comprising an end cap substantially opposite to said gas inlet port, said end cap being connected to said perforated metal plate.

14. A gas burner as in claim 13, wherein said end cap is also provided with perforations, said perforations thereby enlarging said burner deck.

15. A gas burner as in claim 12, wherein more than 50% of the burner deck has a porosity being equal to or lower than 9% and wherein up to 50% of the burner deck has a porosity being higher than 11%.

16. A gas burner as in claim 12, wherein said burner deck has different patterns of perforations.

17. A gas burner as in claim 16, wherein said burner deck has at least two different patterns of perforations.

18. A gas burner as in claim 16, wherein said burner deck has a gradually changing porosity.

19. A gas burner as in claim 16, wherein said burner deck has a substantially completely random porosity.

20. Use of the gas burner as in claim 12, in a heat exchanger.

21. Use of the gas burner as in claim 12, in a furnace or air heater.
22. A gas burner, preferably a premix burner, comprising a support having a central gas inlet port for supply of gas into a gas supply chamber, said gas supply chamber being enclosed by a perforated metal plate thereby eliminating a gas diffuser between the gas inlet port and the perforated metal plate, said perforated metal plate connected at the bottom to said support through a base section, said perforation in said perforated metal plate providing a burner deck, characterised in that said burner deck has an overall porosity being equal to or lower than 11%.

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