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(54) HOMOGEOUS COMBUSTION METHOD AND THERMAL GENERATOR USING SUCH A METHOD

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(57) **ABSTRACT**

The invention relates to a combustion method wherein a fuel and a combustion agent with a high oxygen content are injected into a combustion chamber (**20**), particularly of a thermal generator (**10**), said combustion chamber having at least one fuel injection means (**28**) and at least one wall (**22**) essentially parallel to the axis (XX') of said injection means.

According to the invention, the method comprises:
- injection of a fuel from the axis (XX') of the fuel injection means (**28**) to wall (**22**);
- injection, at a rate of 1 to 300 m/s, of a combustion agent at a distance from said axis, encountering the fuel in the vicinity of said wall in order to effect mixing over the entire volume of the combustion chamber before entering into reaction.

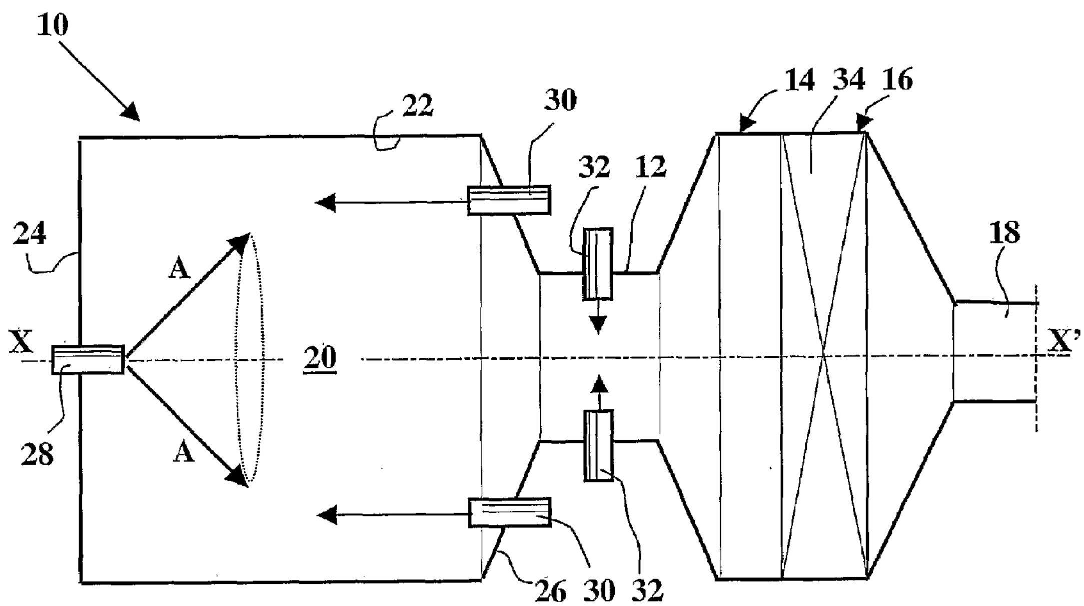


FIGURE 1

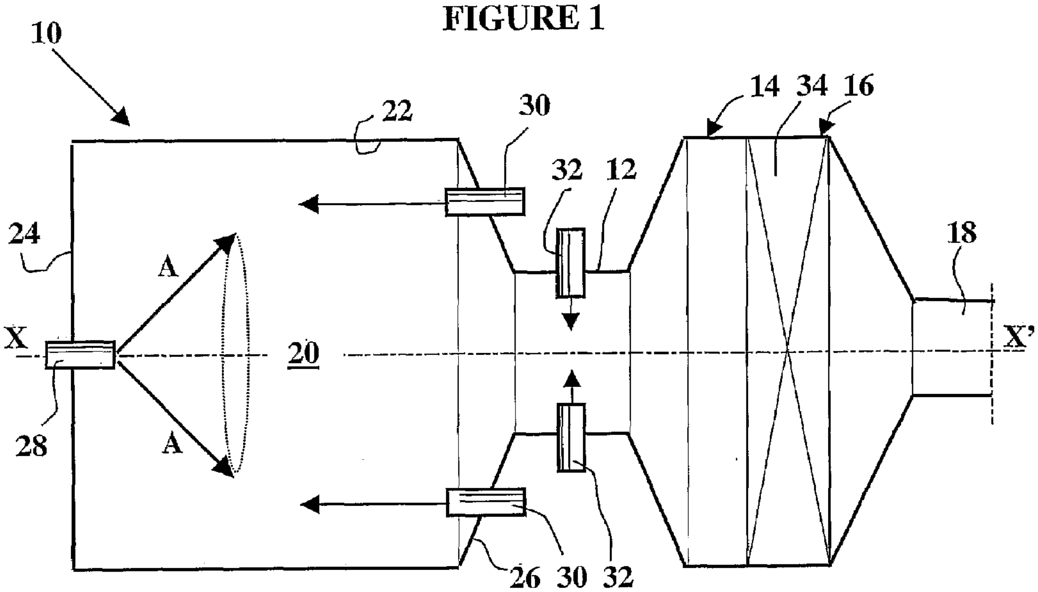


FIGURE 2

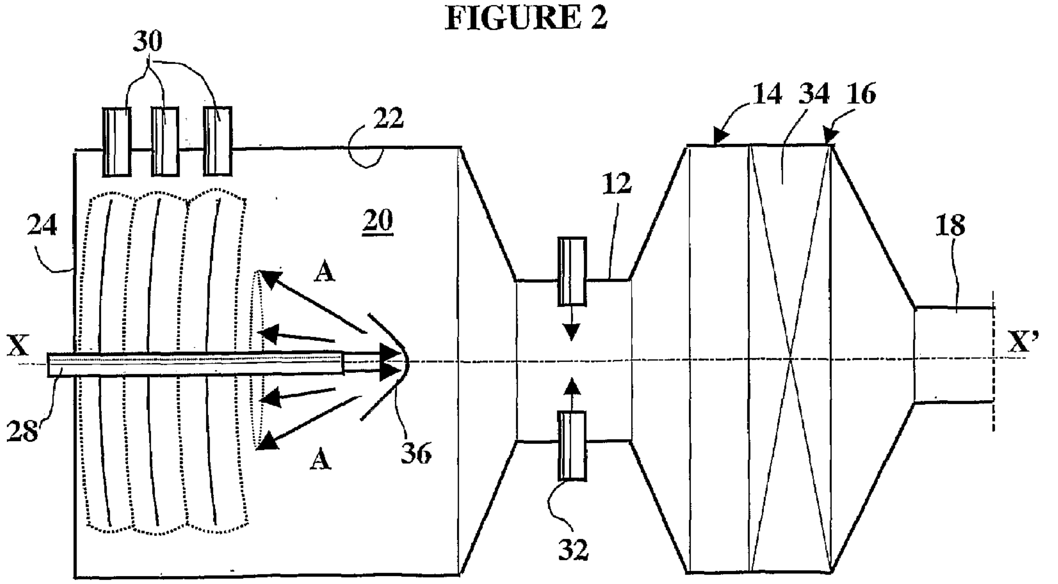


FIGURE 3

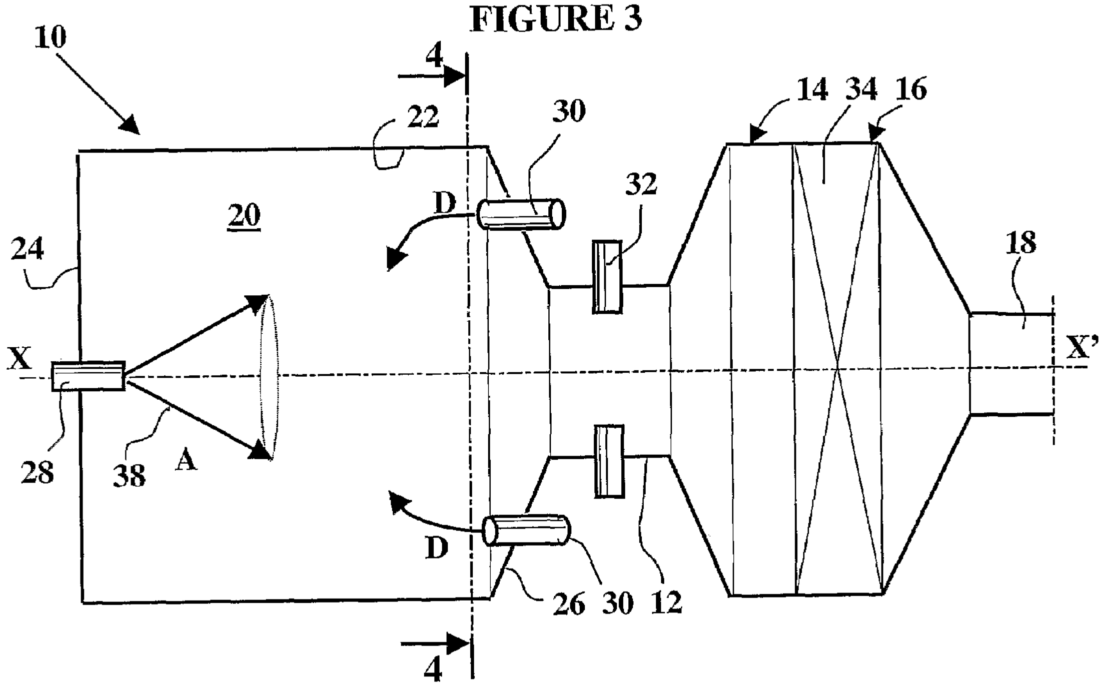


FIGURE 4

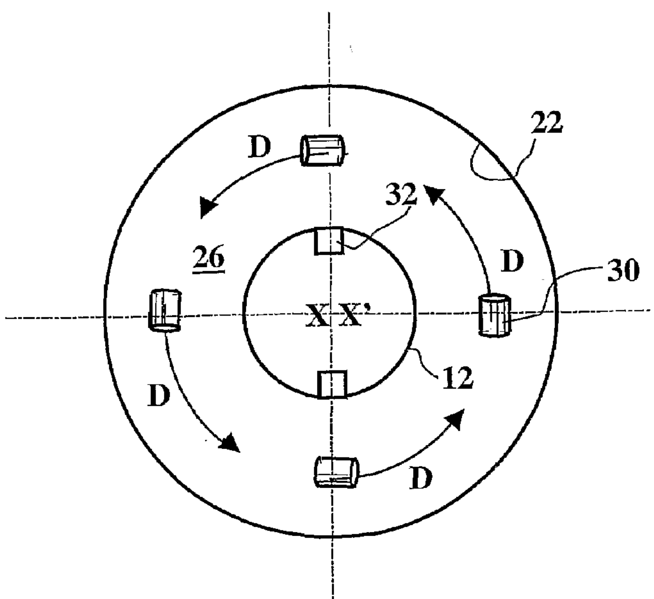


FIGURE 5

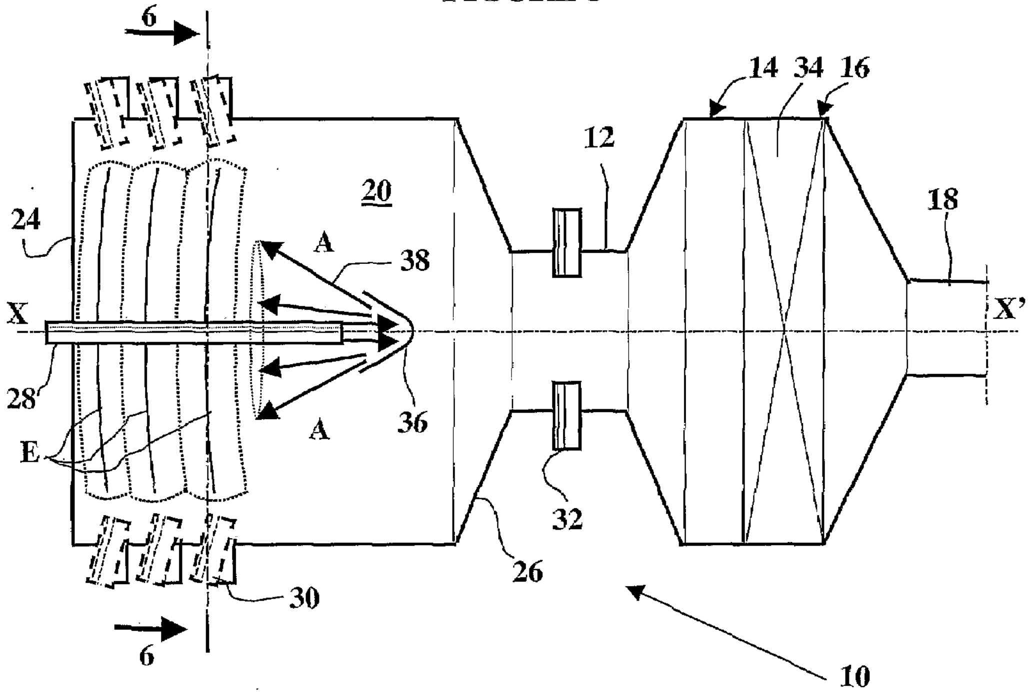


FIGURE 6

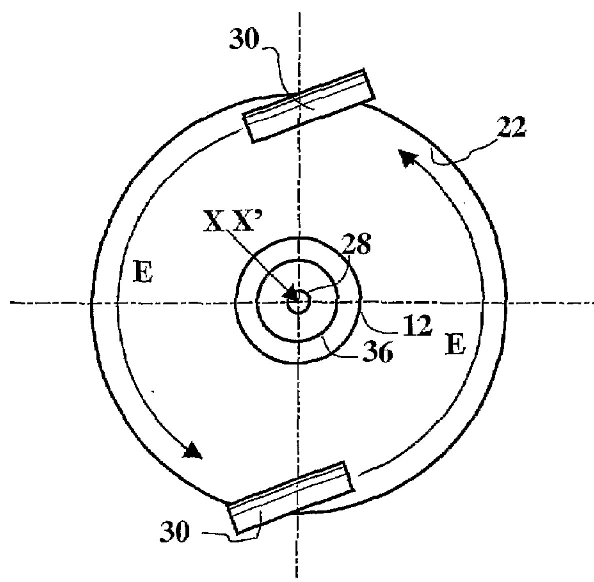
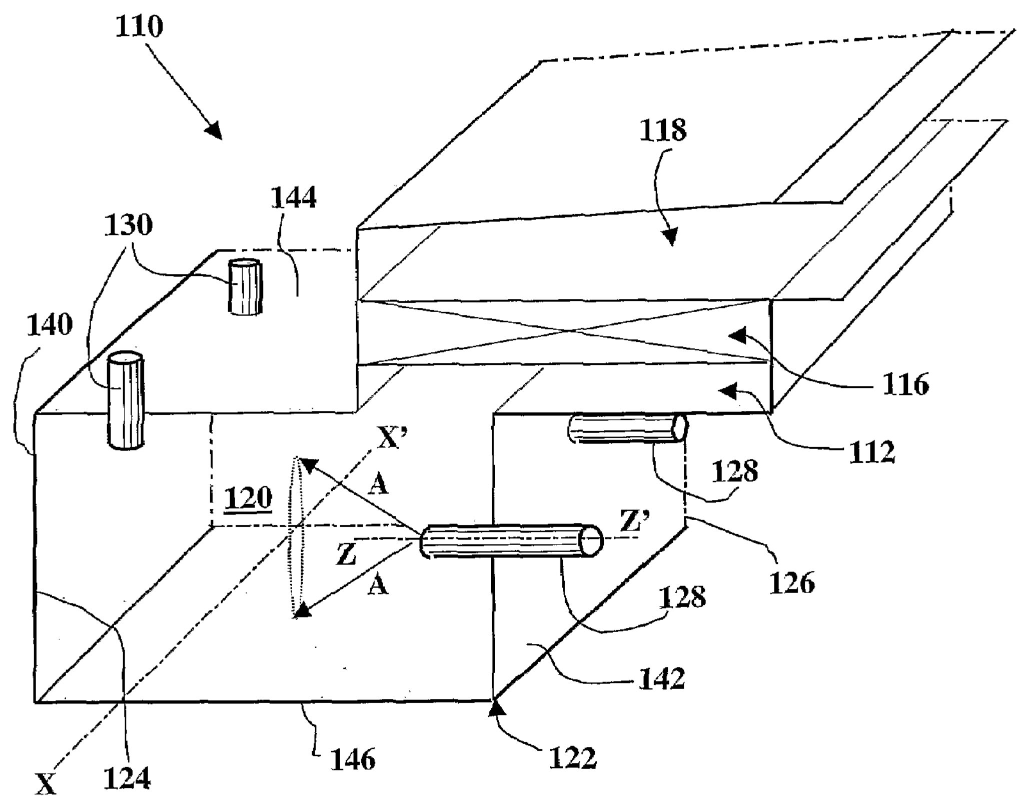


FIGURE 7


110
118
144
130
140
116
112
X'
A
120
128
Z'
Z
A
126
128
142
X
124
146
122

HOMOGEOUS COMBUSTION METHOD AND THERMAL GENERATOR USING SUCH A METHOD

[0001] The present invention relates to a method for burning a fuel and a high-oxygen-content combustion agent, and to a thermal generator using such a method.

[0002] It is applied in particular in boilers, furnaces, and power plants burning oil residues such as petroleum pitches or cokes.

[0003] A number of methods and designs of this type are already known, which employ a fuel and a high-oxygen-content combustion agent whose percentage of oxygen by weight is greater than 80%, in order to effect a combustion operation in the combustion of a thermal generator.

[0004] These methods are based on boiler designs that are identical or close to those of conventional boilers, in order to preserve the same heat exchanger arrangement. For this purpose, the fumes are partially recycled in order to control the thermal profile in the boiler. The advantages of these methods and designs are:

[0005] Fuel economy due to the reduction in sensible heat loss at the chimney, thanks to improved combustion which limits unburned particle formation and thanks to a reduction in heat loss by radiation from the walls,

[0006] Reduction in nitrogen oxide emissions due to reduction of the nitrogen content of the combustion agent,

[0007] Reduction in equipment size: both the “combustion chamber” and “heat exchanger” parts and the “fumes processing” part resulting from smaller fume volumes,

[0008] Relative to air combustion, the possibility of more easily recovering CO_2 from the fumes to that it can be separated or used as an industrial gas.

[0009] However, these methods have drawbacks linked to the economic and energy cost of oxygen production and the risks involved in using this agent.

[0010] Moreover, in the case of oil residues or heavy products with high pollutant contents, the problems posed by such combustion relate to formation of unburned substances, corrosion which can develop both in the combustion chamber and heat exchangers and in the downstream fume processing parts, and possible external recycling of the fumes generated by this combustion, which requires a major fume processing installation.

[0011] Moreover, there may be local temperature spikes (temperature higher than 2000° C.) leading to production of thermal NO with nitrogen supplied by the combustion agent and/or resulting from unwanted air intake.

[0012] However, document EP 0,507,995 teaches the possibility of reducing NOx production by using a method wherein an oxidizing combustion agent is injected into a combustion chamber such that it mixes with combustion gases in an oxidizing mixing zone, then this oxidizing mixture is combined with a fuel in another zone, known as the fuel reaction zone, where combustion takes place, and the gases emerging from this reaction zone are then sent to a third zone corresponding to the rest of the combustion chamber volume, where the turbulence levels are sufficiently high for the gas composition to be homogenous at all points of this third zone.

[0013] Hence combustion is highly localized and takes place in a smaller space than the total volume of the combustion chamber.

[0014] This combustion takes place in the form of a flame, which brings about temperature spikes with formation of thermal NO and difficulty in controlling heat flows which are intense and localized.

[0015] Moreover, the separation of the combustion chamber into three zones leads to temperature gradients between these zones and hence an increase in NO production.

[0016] The goal of the present invention is to overcome the above drawbacks.

[0017] For this purpose, the invention relates to a combustion method wherein a fuel and a combustion agent with a high oxygen content are injected into a combustion chamber, particularly a thermal generator, said combustion chamber having at least one fuel injection means and at least one wall essentially parallel to the axis of said injection means, characterized by comprising:

[0018] injection of a fuel from the axis of the fuel injection means to the wall and

[0019] injection, at a rate of 1 to 300 m/s, of a combustion agent at a distance from said axis, encountering the fuel in the vicinity of said wall in order to effect mixing over the entire volume of the combustion chamber before entering into reaction.

[0020] Advantageously, the combustion agent injection can be counter-current to the fuel injection.

[0021] Preferably, the combustion agent can be injected in a helical or circular movement around the axis of the fuel injection means.

[0022] The combustion agent can be injected essentially perpendicularly to the axis of the fuel injection means.

[0023] Advantageously, the combustion agent injection rate can be between 50 and 150 m/s.

[0024] The oxidizing combustion agent can be a fluid containing at least 90% oxygen.

[0025] Preferably, the fuel can be injected in the shape of a cone.

[0026] The method can also include post-combustion of the fumes at the combustion chamber outlet.

[0027] The invention also relates to a thermal generator having a combustion chamber in which combustion of a mixture of a fuel and an oxidizing combustion agent occurs, said combustion chamber having at least one fuel injection means and at least one wall essentially parallel to the axis of said injection means, characterized by having at least one means for injecting the fuel in the direction of the wall and at least one means for injecting the combustion agent such that it encounters the fuel in the vicinity of said wall at a rate between 1 and 300 m/s such that said fuel and said combustion agent are distributed over the entire volume of the combustion chamber before entering into reaction.

[0028] Advantageously, the fuel injection means can also have a deflector.

[0029] In the case that the combustion chamber is delimited by a peripheral wall and two lateral faces, the fuel injection means can be mounted on one of the faces and be disposed substantially in the axis of the combustion chamber.

[0030] The combustion agent injection means can be mounted on the other face and be disposed at a distance from the axis of the combustion chamber and in the vicinity of the wall.

[0031] At least one combustion agent injection means can be mounted on the peripheral wall.

[0032] The combustion agent injection means can be located at a distance from the fuel injection means.

[0033] The fuel injection means can be mounted on the wall and be disposed essentially orthogonally to the axis of combustion chamber.

[0034] The combustion agent injection means can be mounted on the wall and be essentially orthogonal to the axis of fuel injection means.

[0035] A plurality of injection means extending along the combustion chamber axis can be provided.

[0036] The combustion agent injection means can be sloping in order to obtain a circular or helical movement of the combustion agent around the axis of the fuel injection means.

[0037] The other features and advantages of the invention will appear from the description below, provided solely as an example, with reference to the attached drawings.

[0038] FIG. **1** is a schematic view in axial section of a thermal generator using the method according to the invention;

[0039] FIG. **2** is a schematic view in axial section of an alternative generator using the method according to the invention;

[0040] FIG. **3** is a schematic view in axial section of a variant of the generator in FIG. **1**.

[0041] FIG. **4** is a cross-sectional view along line **4-4** in FIG. **3**;

[0042] FIG. **5** is a cross-sectional view showing a variant of FIG. **2**;

[0043] FIG. **6** is a cross-sectional view along line **6-6** in FIG. **5**; and

[0044] FIG. **7** is a perspective view with a local cross section showing another embodiment of the invention.

[0045] With reference to FIG. **1**, a thermal generator **10** has, sequentially, a combustion chamber **20** with heat recovery at the walls, a zone **12** linking this combustion chamber to a post-combustion zone **14**, a supplementary heat recovery zone **16**, and a zone **18** for evacuating and/or processing the fumes coming from combustion.

[0046] The walls of generator **10** are advantageously membrane walls formed by tubes connected to each other by welded fins in order to seal these walls off from the outside. These membrane walls preferably have the function of heating and/or vaporizing water in the case of steam production. Certain parts of these walls can be covered with insulating materials to limit heat exchange and/or contact of the tubes with locally corrosive atmospheres. On the outside, the walls are also covered with insulating materials to limit heat losses.

[0047] The combustion chamber **20**, with a lengthwise axis XX, can be of the cylindrical type as illustrated in the figure, or of any parallelepipedic type. This chamber has a peripheral wall **22**, in this case a horizontal cylindrical wall concentric with axis XX', delimited by two substantially vertical lateral faces **24** and **26** which, to simplify the following description, are called front face **24** and rear face **26**, the rear face being the face toward the linking zone **12**.

[0048] Front face **24** has a fuel injection means preferably located in the axis XX' of the generator and for this reason the same axis designation is retained for this fuel injection means.

[0049] In the case of liquid fuels, this injection means is preferably an injector **28**, advantageously provided with internal parts ensuring mixture of the fuel with an atomizing fluid. In the case of a solid fuel, the injector **28** can consist of a tube in which said fuel is carried by a fluid such as steam.

[0050] This injector, whose axis is the same as the combustion chamber axis, is configured such that it sprays the fuel from axis XX' into the entire combustion chamber, both toward the center of the chamber and toward the peripheral wall **22** of the chamber, in the form of a cone as shown by arrows A in order to distribute the fuel throughout the chamber.

[0051] Preferably, the vertex angle of this cone is between 15 and 1800, and preferably between 60 and 150°, and the injection rate is chosen by the individual skilled in the art as a function of operating conditions in order to favor good penetration of the fuel droplets in the chamber.

[0052] The total volume of the combustion chamber is preferably between 0.5 and 50 m^3. An industrial boiler or a thermal generating plant can be comprised of a set of combustion chambers **20**, which chambers may or may not have a common face, and the combustion products generated in these chambers spill into one or more zones common to several or all of said chambers. If the chambers have a common face, said face may or may not be impermeable to gas, namely it can be comprised for example of a membrane wall or of pipes that are not connected.

[0053] In the case where a liquid fuel such as heavy fuel oil or pitch is injected, it is preheated to a temperature between 50 and 300° C. to obtain an appropriate viscosity enabling this fuel to be thoroughly atomized. This atomization can be effected simply by pressure or with the assistance of an auxiliary atomizing fluid such as steam.

[0054] For utilization of solid fuels such as oil cokes, the fuel is introduced into the generator in atomized form with most of the mass flow having a particle size less than 500 μm. This fuel is carried and dispersed by an auxiliary fluid such as steam, with the ratio by weight between the fuel and the carrier fluid being between 0.1 and 10.

[0055] The present invention is not limited to the fuel types described above but also encompasses the use of gaseous fuels such as natural gas, fuel oil, refinery gas, etc.

[0056] The rear face **26** has at least one means for injecting an oxidizing combustion agent which is either a gas with a very high oxygen concentration, generally over 90%, or pure oxygen.

[0057] This combustion agent injection means is an injector **30**, preferably tubular and made of refractory material, whose axis is substantially parallel to axis XX' while being disposed at a distance therefrom, preferably in the vicinity of wall **22**.

[0058] Injection of the fuel can also be assisted by any means, such as by fumes recycled from the dust arrester, which has the advantage of speeding up the combustion agent injection rate and favoring operation of combustion chamber **20** as an agitated reactor, limiting concentration heterogeneities due to oxygen injection.

[0059] It is also possible to assist injection of the combustion agent by steam, reducing formation of unburned solids such as soot for example.

[0060] Typically, the combustion agent injection rate is between 1 and 300 m/s and more particularly between 50 and 150 m/s.

[0061] The number of combustion agent injectors **30**, their locations, and the combustion agent injection rate will be determined by any means, particularly by digital simulation, to obtain substantial circulation of fuel as will be explained in the remainder of the description.

[0062] To produce the combustion agent/fuel mixture designed to burn throughout combustion chamber **20**, the fuel is injected into said chamber, through injector **28**, in all directions in space and particularly in the direction of the combustion agent injectors **30**, as indicated by arrows A, in order to ensure mingling of the fuel and the combustion agent.

[0063] Combustion agent injection and fuel injection are performed in such a way as to ensure intense turbulence throughout combustion chamber **20**.

[0064] The term "mingling" means that the direction of the combustion agent stream is essentially opposite that of the fuel and that the angle formed by the direction of the combustion agent stream and the fuel stream is between 90° and 180°.

[0065] More specifically, the combustion agent is injected such that it encounters this fuel in an extensive volume near wall **22** to create swirls that will lead to fuel/combustion agent mixing near this wall then extend over the entire combustion chamber section.

[0066] For a given geometry of combustion chamber **20**, with a heat exchange surface at a given temperature, the fuel injection conditions such as initial fuel rate, spatial distribution of fuel, droplet and particle size, number of injectors, and atomization or carrier fluid flowrate, and the combustion agent injection conditions such as the number of injection points, combustion agent rate, orientation of jets relative to the combustion chamber axis, and the flowrate of any carrier gas such as steam or recycled fumes, are determined for example by digital simulation such that the characteristic time of the turbulent fuel mixing remains less than the characteristic time of the chemical kinetics. Under these conditions, the reagents and products are mixed by turbulence before reacting. Thus, at no point in the combustion chamber does combustion speed up and create hot spots. Theoretically, combustion chamber **20** functions as a fully agitated reactor.

[0067] The fume temperature and composition are substantially homogenous throughout combustion chamber **20**. This temperature is, in normal operation, between 600 and 2000° C. and preferably between 800 and 1500° C. so as to limit NOx formation associated with any unwanted air intake or the nitrogen in the fuel.

[0068] These temperature levels, relatively moderate by comparison with those of a classical air flame and even more moderate by comparison to an oxygen flame, avoid premature wear of the materials of wall **22** and the fuel and combustion agent injection devices.

[0069] In a preferred embodiment of the invention, the rates of fuel and combustion agent injection into combustion chamber **20** are such that the mixture obtained has an overall stoichiometry less than 1, i.e. with excess fuel relative to the combustion agent. This limits formation of nitrogen oxides from the nitrogen in the fuel.

[0070] Moreover, the temperature homogeneity prevents formation of thermal NO with the nitrogen coming from any air entering the combustion chamber.

[0071] The injections of combustion agent can be organized, still with the aid of digital simulation, such as to keep a slightly oxidizing atmosphere near the wall, while keeping the atmosphere rich overall to spare the wall from reducing corrosion phenomena.

[0072] The linking zone **12**, which in this case is tubular in shape, connects the outlet of combustion chamber **20** to the post-combustion zone **14** which precedes the heat recovery zone **16** at the outlet of which the combustion fumes are evacuated and/or processed.

[0073] At its periphery, the linking zone has at least one additional oxidizing combustion agent injector **32** that mixes this fuel with the fumes coming from combustion chamber **20**. This fuel/combustion agent mixture then penetrates into post-combustion zone **14** where combustion is completed.

[0074] The heat resulting from combustion in the post-combustion zone is recovered directly in this post-combustion zone thanks to, for example, means not shown such as membrane walls or suspended tubes, or in the heat recovery zone **16** by any means such as a heat exchanger **34** or a sequence of exchangers accommodated in this recovery zone.

[0075] The fumes coming from this recovery zone, which are generally at a temperature between 150 and 300° C., are directed by zone **18** to an evacuation and/or processing means such as for example a dust arrester and a chimney (not shown in the figure).

[0076] Reference will now be made to FIG. **2** which shows a variant of FIG. **1** and which has the same reference numerals as this figure.

[0077] In this variant, the fuel is injected through an injector **28**, mounted on the front face **24**, extending inside combustion chamber **20** in the form of a tube.

[0078] This tube **28**, whose axis is also the same as axis XX' of combustion chamber **20**, has at its end a deflector **36** whose purpose is to convert the jets of fuel leaving the tube into jets directed at the peripheral wall **22** of combustion chamber **20** and to its front face **24**.

[0079] As stated above, the fuel can be a solid, liquid, or gaseous fuel and the injection can be assisted or unassisted.

[0080] Advantageously, this tube is cooled either by a fluid such as water or by the mixture of fuel and booster fluid.

[0081] The combustion agent injection means is an injector **30**, or a series of injectors spaced axially along the axis of the combustion chamber, which is disposed on the peripheral horizontal wall **22** of combustion chamber **20**.

[0082] In the example of FIG. **2**, two series of three injectors are provided, located at a distance from the fuel outlet of injector **28**, and preferably in the vicinity of the front face **24**, each of the series being circumferentially spaced regularly from the other.

[0083] As in the example of FIG. **1**, the fuel injection conditions, such as initial fuel flowrate, spatial distribution of fuel, size of droplets or particles, number of injectors, and atomization or carrier fluid flowrate, and the combustion agent injection conditions such as number of injection points, combustion agent flowrate, orientation of jets relative to combustion chamber axis, and flowrate of any carrier gas such as steam or recycled fumes, are determined for example by digital simulation so that the characteristic time of the fuel turbulent mixing remains less than the characteristic time of the chemical kinetics. Thus, at no point in the combustion chamber does combustion speed up and create hot spots.

[0084] In operation, the fuel is injected into said combustion chamber **20** from injector **28**, in all directions of space and particularly in the direction of the combustion agent injectors **30**, as indicated by arrows A, in order to ensure mingling of the fuel and the combustion agent.

[0085] Because of this arrangement, combustion develops over a substantial volume of combustion chamber **20** and the walls of this chamber **20** are also kept in an oxidizing atmosphere with the advantages listed above.

[0086] Of course, fuel that is not fully burned leaves the combustion chamber **20** to pass through the linking zone **12** where it completes its combustion in zone **14** thanks to the additional combustion agent injectors **32** as described above.

[0087] Reference will now be made to FIGS. **3** and **4** which show a variant of FIG. **1** and which, for clarity, have the same reference numerals as this figure.

[0088] As in the case of FIGS. **1** and **2**, the linking zone **12** has at least one injector of additional oxidizing combustion agent **32** which ensures mixing of this agent with the fumes coming from combustion chamber **20**; this mixture of fuel and combustion agent then penetrates into the post-combustion zone **14** to complete combustion.

[0089] Reference will now be made to FIGS. **5** and **6** which illustrate a variant of the embodiment of FIG. **2** and which also have the same main reference numerals.

[0090] In this variant, the fuel is also injected into combustion chamber **20** in the form of a fuel cone **38**.

[0091] This fuel cone results from the action of deflector **36** which generates this cone whose base is opposite the front face **24**.

[0092] As can be more clearly seen in FIG. **6**, the injectors **30** or series of injectors are distributed circumferentially around the peripheral wall **22** and are sloped such as to introduce the combustion agent tangentially into combustion chamber **20**.

[0093] Because of this arrangement, a swirling movement of the combustion agent around axis XX' is created, as shown by arrows E in FIG. **6**. To accentuate movement of the combustion agent, the axes of the injectors **30** are staggered in the axial direction toward rear face **26**, as shown in dotted lines in FIG. **5**, so that the movement of the combustion agent is helical.

[0094] Once again, this arrangement has the purpose of favoring the mingling of fuel and combustion agent.

[0095] This agent, which is injected circularly or helically, encounters the fuel near the wall **22** and mixes therewith, generating a mixture that develops over the entire combustion chamber. Thus, combustion can develop over a substantial volume of combustion chamber **20**.

[0096] Because of this arrangement, the walls of combustion chamber **20** are also kept in an oxidizing atmosphere with the advantages listed above.

[0097] Of course, the unused fuel leaves combustion chamber **20** through linking zone **12** where it completes combustion due to the additional combustion agent injectors **32** as described above.

[0098] Reference will now be made to FIG. **7** which shows another embodiment of the invention and which has the same reference numerals as the previously described examples plus 100.

[0099] Thus, a thermal generator **110** has a combustion chamber **120**, a linking zone **112**, a heat recovery zone **116**, and a zone **118** for evacuating and/or processing the fumes coming from combustion.

[0100] The generator has a combustion chamber **120** with a lengthwise axis XX' which can be cylindrical or substantially parallelepipedic in shape. In the example of FIG. **7**, the combustion chamber is parallelepipedic with a rectangular section whose peripheral wall **122** is formed of a succession of walls around axis XX'. This succession of walls comprises vertical walls **140** and **142** and upper horizontal wall **144** and lower horizontal wall **146**. The generator also has a front face **124** as well as a rear face **126**.

[0101] The vertical wall **142** has at least one fuel injector **128** with an axis ZZ' essentially perpendicular to the axis XX' of combustion chamber **120** and the horizontal wall **144** has at least one combustion agent injector **130** such that the axis of the combustion agent injector is essentially perpendicular to the axis ZZ' of the fuel injector.

[0102] The linking zone **112** is located at the intersection of the upper horizontal wall **144** and the vertical wall **142**, particularly at the right part of the generator as illustrated in this figure.

[0103] The combustion chamber can also be subdivided into permeable or impermeable compartments by means of walls, which can be membrane walls for example, substantially parallel to the two vertical faces **124**, **126** which close off the two ends of the combustion chamber. The purpose of this provision is to limit the volume of each unit combustion chamber to less than 50 m^3 as indicated above.

[0104] The fuel injector **128** with axis ZZ' sprays the fuel into combustion chamber **120** in very wide jets (arrow A) so as to ensure good distribution of the fuel throughout the combustion chamber **120** and good mingling of the fuel and combustion agent.

[0105] Advantageously, an essentially horizontal row of fuel injectors spaced regularly apart is provided along axis XX' of the combustion chamber. The injectors can also have other arrangements, staggered for example, and/or sloping relative to wall **142**.

[0106] The combustion agent injector **130** is located on the upper horizontal wall **144**.

[0107] Preferably, a row of combustion agent injectors is provided, regularly spaced along axis XX', whose positions match or do not match those of the row of fuel injectors.

[0108] During operation, the fuel is injected into combustion chamber **120** from injector **128** in all directions of space, particularly in the direction of the combustion agent injectors **30**[1], as indicated by arrows A, to ensure mingling of the fuel and combustion agent near walls **140**, **144**, and **146** so that they can mix and then occupy the entire section of the combustion chamber.

[1] Sic—should be "130." Translator.

[0109] Next, the fumes resulting from combustion leave combustion chamber **120** through linking zone **112** and arrive in heat recovery zone **116**.

[0110] It should be noted that, thanks to this arrangement of injectors, the entire combustion chamber is at a homogenous temperature.

[0111] As already mentioned for FIGS. **1** to **6**, the walls of combustion chamber **120** are advantageous comprised of membrane walls formed of tubes connected together by welded fins in order to seal said walls off from the outside.

[0112] Some parts of these walls can be covered with insulating materials to limit heat exchange and/or contact of the tubes with locally corrosive atmospheres. The walls are also covered externally with insulating materials to limit heat losses.

[0113] It should be noted that, in the examples described above, the combustion zone takes up the entire combustion chamber due to the very high turbulence generated by injecting the combustion agent.

[0114] It is also possible to increase this turbulence by injecting fuel while ensuring a distribution of this fuel over the entire combustion chamber that is as homogenous as possible. For this purpose, as described above, the conditions under which the fuel, and possibly the combustion agent, is injected are manipulated to obtain an adequate particle size distribution yielding small fuel droplets which vaporize in the vicinity of the fuel injection point and larger droplets which diffuse this fuel over their entire path along the combustion chamber.

1) Combustion method wherein a fuel and a combustion agent with a high oxygen content are injected into a combustion chamber, particularly of a thermal generator said combustion chamber having at least one fuel injection means and at least one wall essentially parallel to the axis of said injection means, characterized by comprising:

injection of a fuel from the axis of the fuel injection means to wall;

injection, at a rate of 1 to 300 m/s, of a combustion agent at a distance from said axis, encountering the fuel in the vicinity of said wall in order to effect mixing over the entire volume of the combustion chamber before entering into reaction.

2) Method according to claim **1**, characterized in that the combustion agent injection is counter-current to the fuel injection.

3) Method according to claim **1**, characterized in that the combustion agent is injected in a helical or circular movement around the axis of the fuel injection means.

4) Method according to claim **1**, characterized in that the combustion agent is injected essentially perpendicularly to the axis of the fuel injection means.

5) Method according to claim **1**, characterized in that the combustion agent injection rate is between 50 and 150 m/s.

6) Method according to claim **1**, characterized in that the oxidizing combustion agent is a fluid containing at least 90% oxygen.

7) Method according to claim **1**, characterized in that the fuel is injected in the shape of a cone.

8) Method according to claim **1**, characterized in that it includes a post-combustion step at the outlet from combustion chamber.

9) Thermal generator having a combustion chamber in which combustion of a mixture of a fuel and an oxidizing combustion agent occurs, said combustion chamber having at least one fuel injection means and at least one wall essentially parallel to the axis of said injection means, characterized by having at least one means for injecting the fuel in the direction of wall and at least one means for injecting the combustion agent such that it encounters the fuel in the vicinity of said wall at a rate between 1 and 300 m/s such that said fuel and said combustion agent are distributed over the entire volume of the combustion chamber before entering into reaction.

10) Generator according to claim **9**, characterized in that the fuel injection means also has a deflector.

11) Generator according to claim **9** wherein the combustion chamber is delimited by a peripheral wall and two lateral faces, characterized in that the fuel injection means is mounted on one of the faces and is disposed substantially in the axis of the combustion chamber.

12) Generator according to claim **11**, characterized in that the combustion agent injection means is mounted on the other face and is disposed at a distance from the axis of combustion chamber and in the vicinity of wall.

13) Generator according to claim **9**, characterized in that at least one combustion agent injection means is mounted on the peripheral wall.

14) Generator according to claim **9**, characterized in that the combustion agent injection means is located at a distance from the fuel injection means.

15) Generator according to claim **9**, characterized in that the fuel injection means is mounted on wall and is disposed essentially orthogonally to the axis of combustion chamber.

16) Generator according to claim **15**, characterized in that the combustion agent injection means is mounted on wall and is essentially orthogonal to the axis of fuel injection means.

17) Generator according to claim **16**, characterized by the provision of a plurality of injection means extending along the combustion chamber axis.

18) Generator according to one of the foregoing claims, characterized in that the combustion agent injection means slopes in order to obtain a circular or helical movement of the combustion agent around the axis of the fuel injection means.

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