Title: METHOD FOR MODIFYING A GAS TURBINE BURNER ASSEMBLY

Abstract: A method for modifying a gas turbine burner assembly (1), which extends along an axis (A) and comprises a premix main burner (3) and a pilot burner (5), about which the main burner (3) is arranged; the pilot burner (5) comprises a swirler (20), a first body (17) and a second body (18), arranged about the first body (17) so as to define an annular channel (19) having a first passage section; the swirler (20) is arranged along the annular passage channel (19) and comprises a plurality of blades (21) radially extending between the first body (17) and the second body (18); the method includes the step of reducing the passage section of the annular channel (19).
METHOD FOR MODIFYING A GAS TURBINE BURNER ASSEMBLY

TECHNICAL FIELD

The present invention relates to a method for modifying a gas turbine burner assembly.

BACKGROUND ART

In recent years, spurred by increasingly more stringent regulations in the matter of polluting substance emissions, combustion techniques have tended towards the use of "lean premix" technology, which includes the use of burners in which the fuel is premixed with air before being burnt.

Burners of this type ensure a lower amount of polluting substance emissions. In contrast, premixed combustion determines the onset of flame stability problems.

At present, the known techniques include installing swirlers (a diagonal swirler and/or an axial swirler) in the burners, the effect of which is to improve the flame stability.

The pilot burner feeding is often adjusted to further improve the flame stability. However, the operation of adjusting the pilot burner feeding is limited by the increase of polluting substance emissions.

Installing swirlers and adjusting pilot burner feeding are not however sufficient to stabilize the flame.
Indeed, natural modes of oscillation of the swirling flows (hereinafter referred to as Precessing Vortex Cores (PVCs)), which interact with the flame thus determining its lifting off from the edge of the swirler and producing undesired oscillations which, on the long run, may impair burner integrity, are generated in the air-fuel mixture outlet zone of the burner.

**DISCLOSURE OF INVENTION**

Therefore, it is an object of the present invention to provide a method for modifying a gas turbine burner so as to reduce the interaction between flame and precessing vortex cores, while respecting the legal limits related to polluting substance emissions.

In accordance with such objects, the present invention relates to a method for modifying a gas turbine burner assembly; the burner assembly extending along an axis and comprising a premix main burner and a pilot burner, about which the main burner is arranged; the pilot burner comprising a swirler, a first body and a second body, arranged about the first body so as to define an annular passage channel having a first passage section; the swirler being arranged along the annular passage channel and comprising a plurality of blades radially extending between the first body and the second body, the method comprising the step of reducing the passage section of the annular channel.

Thereby, the speed at which the air-fuel mixture flows into the combustion chamber increases. Therefore,
the motion field, shape and position of the flame vary, thus contributing to reducing the interaction between flame and precessing vortex cores in the air-fuel mixture outlet zone of the burner.

Preferably, the method according to the present invention includes reducing the passage section of the annular channel by reducing the radial extension of the blades and accommodating an obstructive element in the annular channel; the obstructive element being shaped so as to reduce the passage section of the annular channel.

The dimension and geometry of the obstructive element are defined according to the type and dimensions of the burner assembly in which the obstructive element must be accommodated.

According to a first embodiment, the obstructive element has a substantially cylindrical shape.

According to a second embodiment, the obstructive element has a substantial truncated-cone shape.

In both embodiments, the obstructive element conveniently reduces the passage section of the annular channel so as to reduce the interaction between flame and PVCs.

The obstructive element is preferably fixed to the first body so that the obstructive element is centred on the burner assembly axis.

Thereby, the obstructive element is integral with the burner assembly and smoothly reduces the passage section of the annular channel in the radial direction.
The obstructive element preferably axially extends up to the outer edge of the second body, when it is accommodated in the annular channel. Thereby, the motion field, shape and position of the flame conveniently vary so as to reduce the interaction between flame and precessing vortex cores (PVCs).

**BRIEF DESCRIPTION OF THE DRAWINGS**

The present invention will now be described with reference to the accompanying drawings, which show a non-limitative embodiment thereof, in which:

- figure 1 is a side, longitudinal section view of a burner assembly;
- figure 2 is a side section view of a detail in figure 1;
- figure 3 is a perspective section view of a burner assembly modified in accordance with a first embodiment of the method according to the present invention;
- figure 4 is a side section view of a burner assembly modified in accordance with a second embodiment of the method according to the present invention.

**BEST MODE FOR CARRYING OUT THE INVENTION**

In figure 1, reference numeral 1 indicates as a whole a burner assembly for feeding fuel, in particular a gas, into a combustion chamber 2 of a gas turbine (only partially shown here). Burner assembly 1 extends along an axis A and comprises a main peripheral burner 3, a central pilot burner 5, and an electric arc.
ignition device 6.

Main burner 3 is of the premixing type, is arranged about the pilot burner 5, and is provided with a vortex or turbulence generator, referred to as "swirler" and indicated by reference numeral 7.

Swirler 7 is radially defined between a body 8 and a substantially truncated cone-shaped, annular wall 9. Body 8 has a cylindrical axial cavity and is also truncated cone-shaped outwards. Swirler 7 further comprises a plurality of blades 10, defining respective flow channels therebetween for conveying a flow of comburent air towards the combustion chamber 2 with a diagonal pattern with respect to axis A. For this reason, swirler 7 is also referred to as "diagonal swirler".

Main burner 3 is coupled to a premix feeding line 13. Premix line 13 is defined for a portion of a pipe which extends along axis A and ends with an annular manifold, obtained in body 8 and communicating with the flow channels by means of passages obtained in blades 10.

Swirler 7 provides for a vigorous mixing of the fuel and air flow which is formed in the flow channels, with an air amount which is higher than the theoretical stoichiometric ratio to generate a premix flame with excess of air.

Pilot burner 5 extends along axis A and comprises a first truncated cone-shaped body 17 and a second
truncated cone-shaped body 18 arranged about the first truncated cone-shaped body 17 so as to define an annular channel 19 having a first passage section.

Pilot burner 5 further comprises an axial-type swirler 20 arranged along the annular channel 19 and provided with a plurality of blades 21, which radially extend between the first truncated cone-shaped body 17 and the second truncated cone-shaped body 18.

With reference to figure 2, the first truncated cone-shaped body 17 extends about axis A and is hollow inside.

A through axial cavity 23 crosses the first truncated cone-shaped body 17 and has, in sequence along axis A, a first cylindrical portion having diameter D1, a truncated cone-shaped connecting portion and a second cylindrical portion having diameter D2, which is smaller than diameter D1.

The second truncated cone-shaped body 18, also being hollow, is arranged about the first truncated cone-shaped body 17, and is coaxial thereto. Furthermore, the second truncated cone-shaped body 18 is connected to the outer truncated cone-shaped surface of body 8 (see figure 1).

A front edge 18a of the second truncated cone-shaped body 18 is axially advanced (with reference to the flow direction of the fed air-duel mixture) with respect to a front edge 17a of the first truncated cone-shaped body 17.
The blades 21 extend beyond the front lip 17a of the first truncated cone-shaped body 17, up to the front lip 18a of the second truncated cone-shaped body 18. Therefore, a radially inner edge 23 of the blades 21 is free over a portion thereof, while a radially outer edge 24 ends close to the front lip 18a of the second truncated cone-shaped body 18.

With reference to figure 1, pilot burner 5 is coupled to a pilot feeding line 25 defined, over a portion thereof, by an annular pipe arranged about axis A.

The pilot feeding line 25 feeds a first flow of fuel to the combustion chamber in order to generate a premix pilot flame to support the main premix flame, generated by the main burner 3.

The ignition device 6 is at least partially arranged within the annular channel 19 and is fed by an electric line 31.

Burner assembly 1 finally comprises a nozzle 32 for injecting a third flow of fuel into the combustion chamber 2. Nozzle 32 is axially arranged and is within the pilot feeding line 25. The third flow of fuel may be, for example, diesel fuel or a mixture of diesel fuel and air, or diesel fuel and water.

With reference to figure 3, the method for modifying the burner assembly 1 according to the present invention substantially includes modifying the passage section of the annular channel 19 defined by the first
truncated cone-shaped body 17 and by the second truncated cone-shaped body 18.

In particular, the method according to the present invention includes reducing the passage section of the annular channel 19 by reducing the radial extension of the blades 21 and accommodating an obstructive element 30 in the annular channel 19.

The radial extension of the blades 21 is reduced by substantially removing the free portion of the radially inner edge 23 of the blades 21.

The obstructive element 30 is substantially shaped so as to reduce the passage section of the annular channel 19. Thereby, the speed at which the air-fuel mixture flows into the combustion chamber increases. Therefore, the motion field, shape and position of the flame vary, thus contributing to reducing the interaction between flame and precessing vortex cores (PVC) in the air-fuel mixture outlet zone of the burner assembly 1.

In particular, the obstructive element 30 is dimensioned according to the type and dimensions of the burner assembly 1 on which it is to be installed.

Preferably, the shape and dimensions of the obstructive element are determined experimentally.

Alternatively, the shape and dimensions of the obstructive element may be determined by means of numerical analyses based on various parameters, such as for example total load losses allowed on the burner
assembly, the tendency of the flame to lift off (blow-out) from the swirler and to be instable, the tendency of the obstructive element to overheat, the PVC-flame interaction etc. In particular, the flame instability tendency may be numerically analyzed by means of Large Eddy Simulation analyses combined with acoustic analyses with Flame Transfer Function specifications.

In the non-limitative example shown in figure 3, the obstructive element 30 has a substantially cylindrical shape and is accommodated in the main burner 5 so as to be centred on axis A of burner assembly 1.

In particular, the obstructive element 30 is fixed to the front edge 17a of the first truncated cone-shaped body 17 and axially extends up to the front edge 18a of the second truncated cone-shaped body 18.

The obstructive element 30 is preferably welded to the front edge 17a.

In the non-limitative example shown in figure 3, the inner diameter of the obstructive element 30 is equal to the diameter D2 of the second cylindrical portion of the through axial cavity 23 which crosses the first truncated cone-shaped body 17.

Figure 4 shows a second embodiment of an obstructive element 35. Such an embodiment allows to obtain a greater reduction of the passage section of annular channel 19.

In detail, the obstructive element 35 is substantially truncated cone-shaped and has a rear edge
36 having a first diameter, and a front edge 37 having a second diameter which is larger than the first diameter.

The obstructive element 35 is accommodated in the main burner 5 so as to be centred on axis A of burner assembly 1.

In particular, the rear edge 36 of the obstructive element 35 is fixed to the front edge 17a of the first truncated cone-shaped body 17. The obstructive element 35 axially extends substantially up to the front edge 18a of the second truncated cone-shaped body 18. The obstructive element 35 is preferably welded to the front edge 17a.

In the non-limitative example shown in figure 4, the inner diameter of the rear edge 38 of the obstructive element 35 is equal to the diameter D2 of the second cylindrical portion of the through axial cavity 23 which crosses the first truncated cone-shaped body 17.
CLAIMS

1. Method for modifying a gas turbine burner assembly; the burner assembly (1) extending along an axis (A) and comprising a premix main burner (3) and a pilot burner (5), about which the main burner (3) is arranged; the pilot burner (5) comprising a swirler (20), a first body (17) and a second body (18), arranged about the first body (17) so as to define an annular channel (19) having a passage section; the swirler (20) being arranged along the annular channel (19) and comprising a plurality of blades (21) which extend radially between the first body (17) and the second body (18); the method comprising the step of reducing the passage section of the annular channel (19).

2. Method according to claim 1, wherein the step of reducing the passage section of the annular channel (19) comprises the steps of:
   - radially reducing the dimensions of the blades (21);
   - accommodating an obstructive element (30; 35) in the annular channel (19); the obstructive element (30; 35) being shaped so as to reduce the passage section of the annular channel (19).

3. Method according to claim 2, wherein the step of radially reducing the dimensions of the blades (21) comprises the step of removing substantially a portion of a radially inner edge (23) of each blade (21).

4. Method according to claim 2 or 3, comprising
the step of defining the dimensions and the geometry of
the obstructive element (30; 35) on the basis of the
typology and the dimensions of the burner assembly (1)
where the obstructive element (30; 35) is accommodated.

5. - Method according to claim 4, wherein the step
of defining the dimensions and the geometry of the
obstructive element (30; 35) comprises the step of
defining the dimensions and the geometry of the
obstructive element (30; 35) experimentally.

6. - Method according to claim 4, wherein the step
of defining the dimensions and the geometry of the
obstructive element (30; 35) comprises the step of
defining the dimensions and the geometry of the
obstructive element (30; 35) by means of numerical
analysis.

7. - Method according to any one of claims from 2 to
6, wherein the obstructive element (30) is substantially
cylindrical shaped.

8. - Method according to any one of claims from 2 to
7, wherein the obstructive element (30) is substantially
truncated cone-shaped.

9. - Method according to claim 7 or 8, wherein the
step of accommodating an obstructive element (30; 35) in
the annular channel (19) comprises the step of fixing
the obstructive element (30; 35) at the first body (17)
in such a way that the obstructive element (30; 35) is
centred on the axis (A) of the burner assembly (1).

10. - Method according to claim 9, wherein the step
of fixing the obstructive element (30; 35) at the first body (17) comprises the step of welding the obstructive element (30; 35) to the first body (17).

11.- Method according to any one of claims from 2 to 10, wherein the obstructive element (30; 35) extends axially up to the outer edge (18a) of the second body (18), when accommodated in the annular channel (19).
**INTERNATIONAL SEARCH REPORT**

**International application No**
PCT/IB2012/055926

**A. CLASSIFICATION OF SUBJECT MATTER**
INV. F02C3/22 F02C7/22 F23R3/34

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
F23R F23D F02C F23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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- **O** document referring to an oral disclosure, use, exhibition or other means
- **P** document published prior to the international filing date but later than the priority date claimed

**X** further documents are listed in the continuation of Box C. **X** See patent family annex.

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28 January 2013

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