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Changwon-si (KR)(57) **ABSTRACT**(21) Appl. No.: **16/010,053**(22) Filed: **Jun. 15, 2018**(30) **Foreign Application Priority Data**

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A swirler assembly includes: a base plate having an opening at a center thereof; a plurality of vanes arranged on a first region of a surface of the base plate, the plurality of vanes being spaced apart from one another along a circumferential direction of the base plate; and a plurality of air injection holes arranged in a second region of the surface of the base plate, the second region located between the opening and the first region of the surface of the base plate in a radial direction of the base plate.

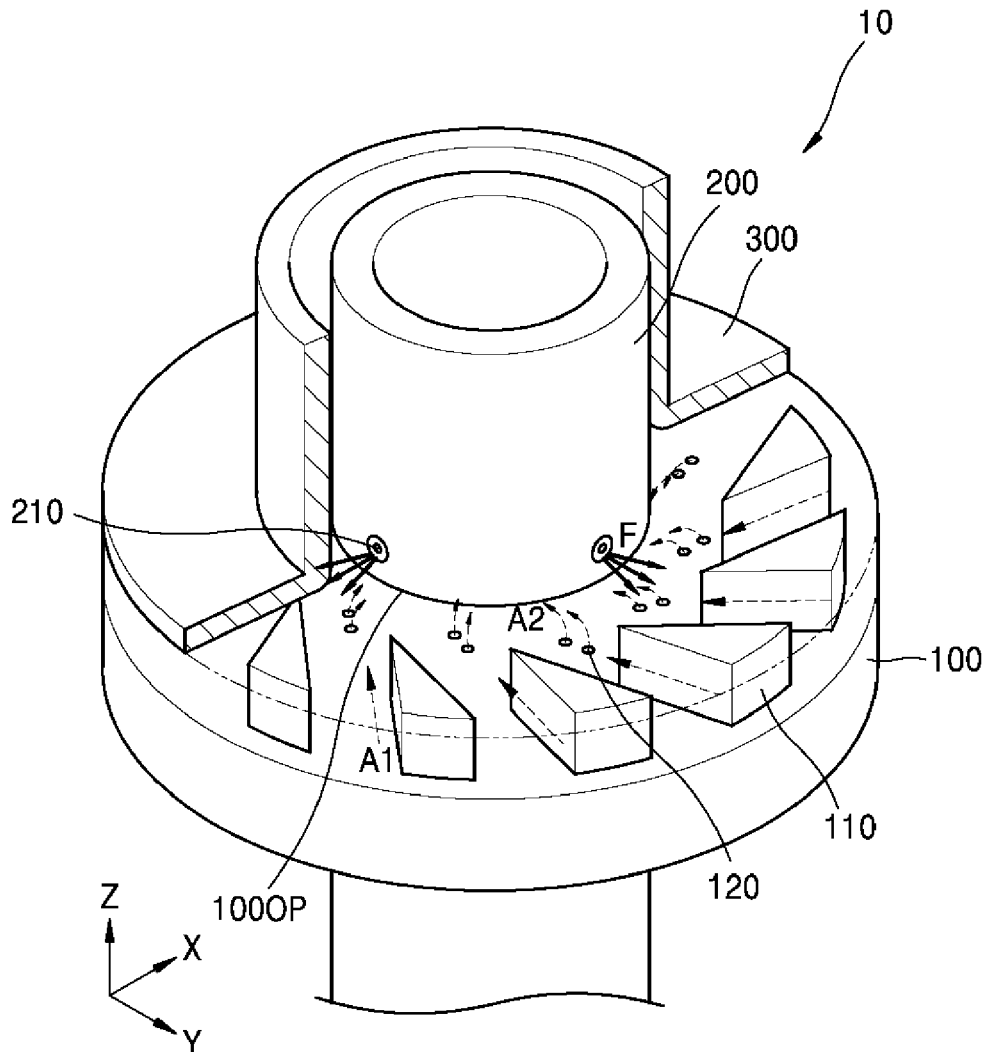


FIG. 1

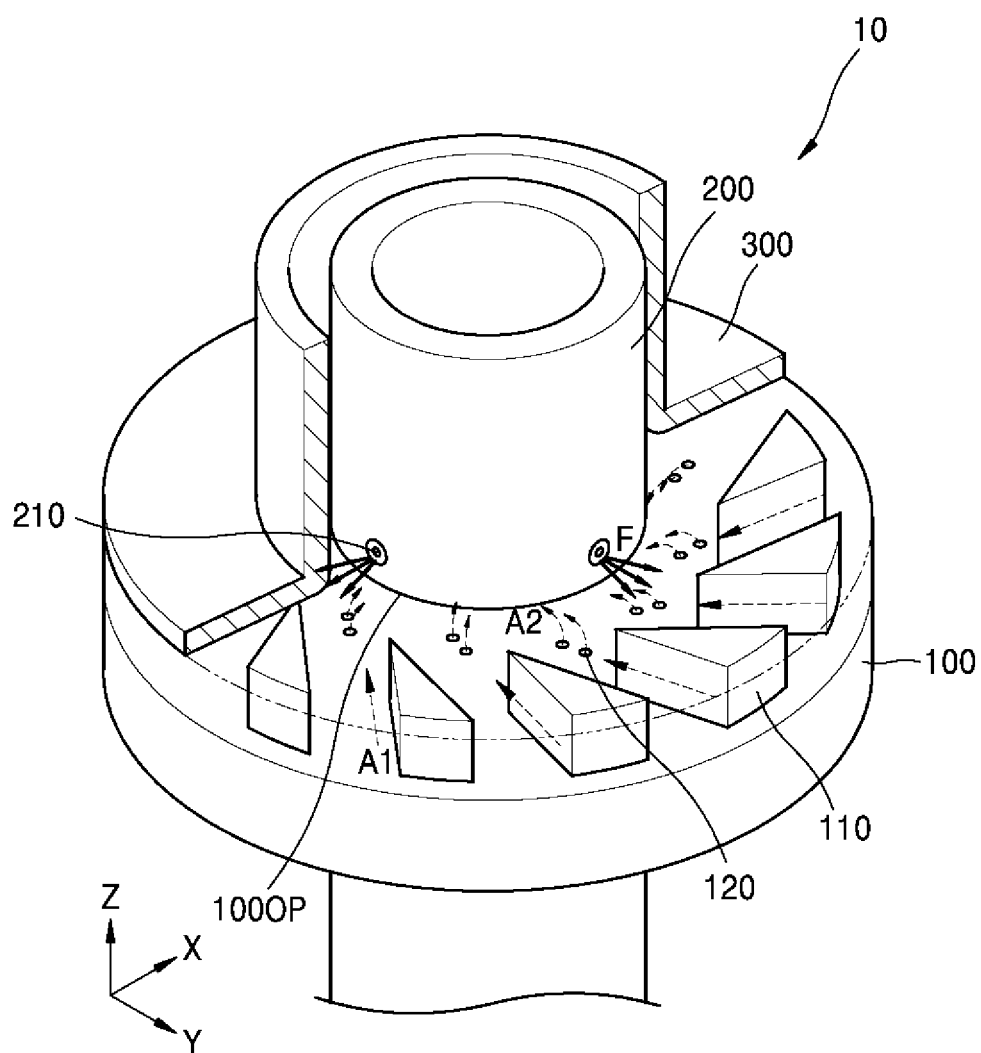


FIG. 2

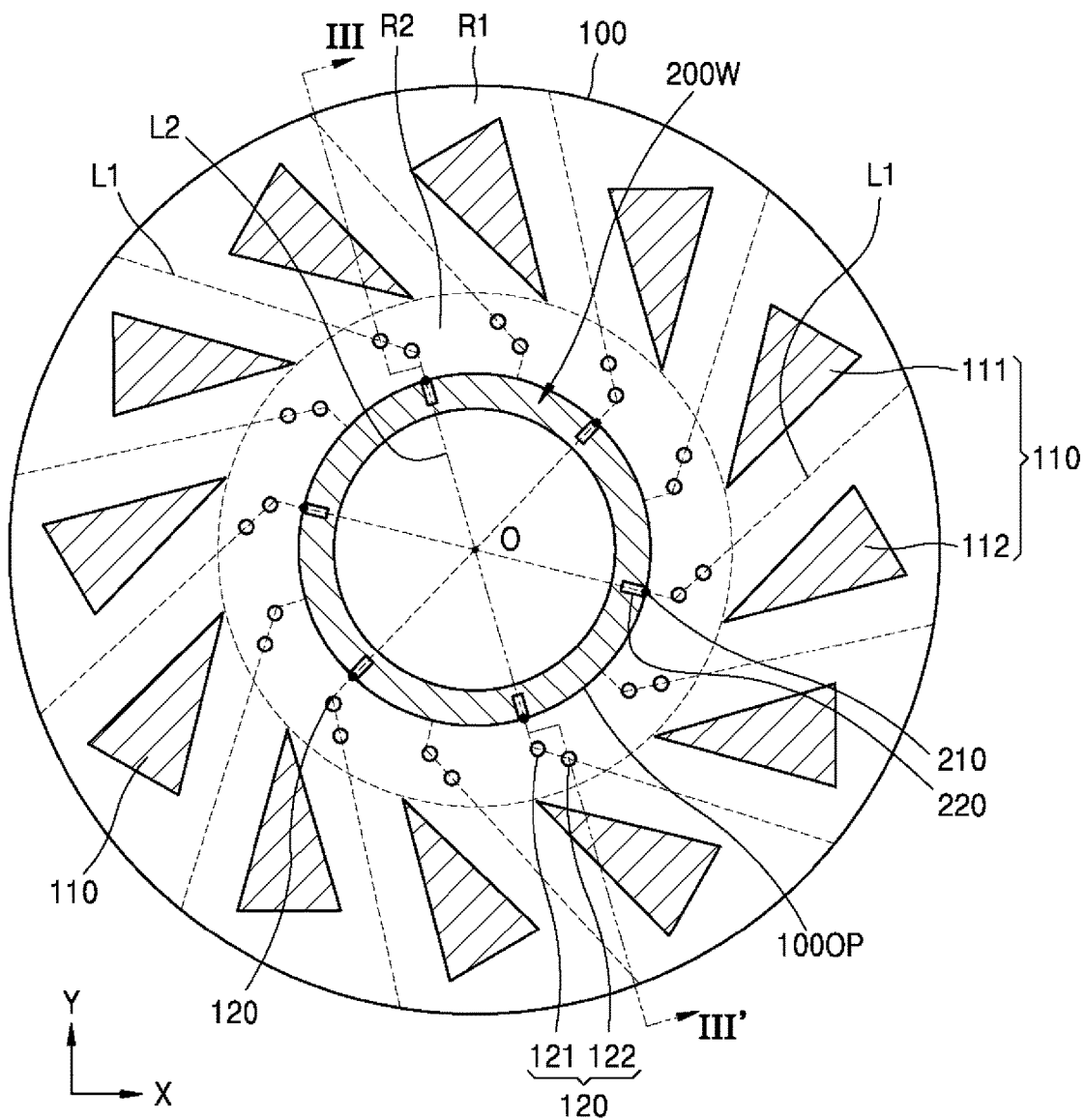
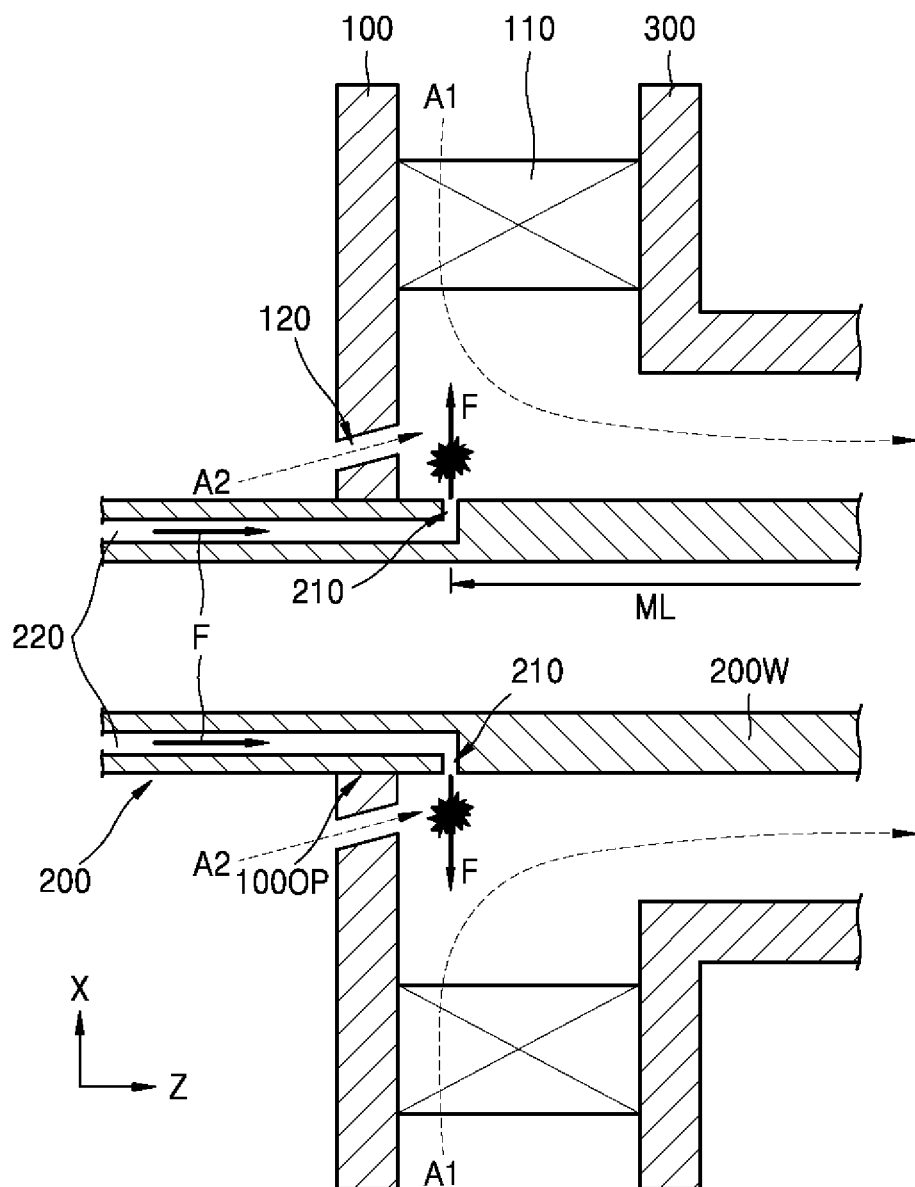


FIG. 4



SWIRLER ASSEMBLY

CROSS-REFERENCE TO THE RELATED APPLICATION

[0001] This application claims priority from Korean Patent Application No. 10-2017-0139541, filed on Oct. 25, 2017, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field

[0002] Apparatuses consistent with exemplary embodiments relate to a swirler assembly, and more particularly, to a swirler assembly of a gas turbine combustor, capable of improving performance of mixing fuel and air.

2. Description of the Related Art

[0003] A gas turbine is a heat engine which drives a turbine by using a combustion gas having high temperature and high pressure, and generally includes a compressor, a combustor, and a turbine. First, in a gas turbine, air is compressed by the compressor, second, the compressed air having high pressure and fuel supplied from a fuel system are mixed in a pre-chamber in advance so as to reduce a flame temperature, and third, the fuel-air mixture is combusted in a main chamber. High-temperature and high-pressure gas (i.e., the combusted gas) generated as above is discharged to the turbine to expand and rotate the turbine. Here, in order to efficiently and rapidly combust the fuel, a swirler is used to distribute the fuel-air mixture evenly into the main chamber.

[0004] That is, the swirler causes the compressed air and the fuel mix with each other rapidly and evenly to prompt the combustion reaction of the fuel-air mixture. When the extent of mixing of the fuel-air mixture supplied to the flame is not uniform, a portion of higher temperature is locally generated and an amount of nitrogen oxide (NOx), which is discharged, increases. Because NOx is one of the main causes of air pollution, strict regulations on the discharge of nitrogen oxide have been applied globally.

[0005] However, in a swirler assembly of the related art, fuel is injected from an outlet side of the swirler, through which the fuel-air mixture is discharged, not from an inlet side of the swirler, through which the air is introduced, and thus, there is insufficient time to mix the fuel and the air. That is, the fuel-air mixture is not mixed sufficiently, and thus, an amount of NOx that is discharged increases. Accordingly, there is a limitation in improving low-polluting performance of the combustor.

SUMMARY

[0006] One or more exemplary embodiments include a swirler assembly of a gas turbine combustor capable of improving performance of mixing fuel and air.

[0007] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the exemplary embodiments.

[0008] According to an aspect of an exemplary embodiment, there is provided a swirler assembly including: a base plate of a disc shape having an opening at a center thereof;

a plurality of vanes arranged on a first region of a surface of the base plate, the plurality of vanes being spaced apart from one another along a circumferential direction of the base plate; and a plurality of air injection holes arranged in a second region that is located between the opening and the first region of the surface of the base plate.

[0009] The swirler assembly may further include a cover plate arranged to cover the plurality of vanes, the cover plate facing the base plate.

[0010] Each of the plurality of vanes may be arranged to be inclined with respect to a radial direction of the base plate.

[0011] The plurality of air injection holes may be arranged between neighboring vanes of the plurality of vanes.

[0012] The plurality of vanes may include a first vane and a second vane adjacent to the first vane, and a set of air injection holes of the plurality of air injection holes may be arranged in a region extending from a region between the first vane and the second vane.

[0013] The set of air injection holes may be arranged in a direction inclined with respect to the radial direction of the base plate.

[0014] Each of the plurality of air injection holes may be inclined with respect to a thickness direction of the base plate.

[0015] The swirler assembly may further include a shaft portion inserted in the opening to support the base plate.

[0016] The shaft portion may include a plurality of fuel injection nozzles that inject fuel in the radial direction of the base plate.

[0017] The shaft portion may have a hollow rod shape, and may include a fuel supply pipe embedded in an external wall of the shaft portion and extending along a lengthwise direction of the shaft portion and to supply the fuel to each of the plurality of fuel injection nozzles.

[0018] The swirler assembly may further include a cover plate arranged to cover the plurality of vanes, the cover plate facing the base plate, wherein the plurality of fuel injection nozzles are located closer to the base plate than to the cover plate.

[0019] According to an aspect of another exemplary embodiment, there is provided a swirler assembly including: a base plate having an opening at a center thereof; a plurality of vanes arranged on a first region of a surface of the base plate, the plurality of vanes being spaced apart from one another along a circumferential direction of the base plate; and a plurality of air injection holes arranged in a second region of the surface of the base plate, the second region located between the opening and the first region of the surface of the base plate in a radial direction of the base plate.

[0020] The swirler assembly may further include a cover plate covering the plurality of vanes, the plurality of vanes provided between the cover plate and the base plate.

[0021] Each of the plurality of vanes may be arranged to be inclined with respect to the radial direction of the base plate.

[0022] The plurality of air injection holes may be arranged between adjacent vanes of the plurality of vanes.

[0023] The plurality of vanes may include: a first vane; and a second vane adjacent to the first vane. A set of air injection holes of the plurality of air injection holes may be arranged in a portion of the second region provided between the first vane and the second vane.

[0024] The set of air injection holes may be arranged with respect to one another in a direction inclined with respect to the radial direction of the base plate.

[0025] Each of the plurality of air injection holes may be inclined with respect to a thickness direction of the base plate.

[0026] The swirler assembly may further include a shaft portion inserted through the opening to support the base plate.

[0027] The shaft portion may include a plurality of fuel injection nozzles configured to inject fuel in the radial direction of the base plate.

[0028] The shaft portion may have a hollow rod shape, and may include a fuel supply pipe embedded in an external wall of the shaft portion. The fuel supply pipe may extend along a lengthwise direction of the shaft portion and may be configured to supply the fuel to each of the plurality of fuel injection nozzles.

[0029] The swirler assembly may further include a cover plate covering the plurality of vanes, the cover plate facing the base plate. The plurality of fuel injection nozzles may be located closer to the base plate than to the cover plate.

[0030] According to an aspect of another exemplary embodiment, there is provided a swirler assembly including: a base plate having an opening at a center thereof; a plurality of vanes arranged along a circumferential direction, the plurality of vanes provided at an outer region on the base plate in a radial direction of the base plate; a plurality of air injection holes arranged in an inner region of the base plate, the inner region located between the opening and the outer region of the base plate in the radial direction of the base plate; and a shaft provided through the opening and comprising a plurality of fuel injection nozzles provided on an outer surface of the shaft. The plurality of vanes may be configured to guide air toward the plurality of air injection holes and the plurality of fuel injection nozzles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The above and/or other aspects of the disclosure will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with the accompanying drawings in which:

[0032] FIG. 1 is a schematic perspective view of a swirler assembly according to an exemplary embodiment;

[0033] FIG. 2 is a schematic cross-sectional view of a swirler assembly according to an exemplary embodiment;

[0034] FIG. 3 is a cross-sectional view taken along line III-III' of FIG. 2;

[0035] FIG. 4 is a schematic cross-sectional view of a swirler assembly according to an exemplary embodiment; and

[0036] FIG. 5 is a schematic cross-sectional view of a swirler assembly according to an exemplary embodiment.

DETAILED DESCRIPTION

[0037] Reference will now be made in detail to exemplary embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. In this regard, the exemplary embodiments may have different forms and should not be construed as being limited to the descriptions set forth herein. Accordingly, the exemplary embodiments are merely described below, by referring to the figures, to explain

aspects of the present description. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Expressions such as “at least one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0038] As the disclosure allows for various changes and numerous exemplary embodiments, particular exemplary embodiments will be illustrated in the drawings and described in detail in the written description. However, this is not intended to limit the present disclosure to particular modes of practice, and it is to be appreciated that all modifications, equivalents, and/or alternatives that do not depart from the spirit and technical scope are encompassed in the disclosure. In the description, certain detailed explanations of the related art are omitted when it is deemed that they may unnecessarily obscure the essence of the present disclosure.

[0039] It will be understood that although the terms “first” and “second” are used herein to describe various elements, these elements should not be limited by these terms. Terms are only used to distinguish one element from other elements.

[0040] It will be understood that when an element such as a layer, film, region or substrate is referred to as being placed “on” another element, it can be directly placed on the other element, or an intervening layer(s) may also be present.

[0041] The x-axis, the y-axis and the z-axis are not limited to three axes of the rectangular coordinate system, and may be interpreted in a broader sense. For example, the x-axis, the y-axis, and the z-axis may be perpendicular to one another, or may represent different directions that are not perpendicular to one another.

[0042] Hereinafter, the exemplary embodiments will be described in detail with reference to the accompanying drawings. In the drawings, like reference numerals denote like or corresponding elements, and repeated descriptions thereof will be omitted. In the drawings, the thicknesses of layers and regions are enlarged for clarity. In addition, in the drawings, the thicknesses of layers and regions are exaggerated for convenience of description.

[0043] FIG. 1 is a schematic perspective view of a swirler assembly 10 according to an exemplary embodiment, and FIG. 2 is a schematic cross-sectional view of the swirler assembly 10 according to an exemplary embodiment.

[0044] Referring to FIGS. 1 and 2, the swirler assembly 10 according to the exemplary embodiment includes a base plate 100, a plurality of vanes 110 and a plurality of air injection holes 120 arranged on a surface of the base plate 100.

[0045] The base plate 100 has a disc shape and includes an opening 100OP at a center thereof (see also FIG. 3), and the plurality of vanes 110 are arranged on a flat surface of the base plate 100. That is, the base plate 100 supports the plurality of vanes 110. Here, the surface of the base plate 100, on which the plurality of vanes 110 are arranged, denotes a surface extending in a direction across a center O of the base plate 100, and in FIGS. 1 and 2, the surface is shown to correspond to an X-Y plane.

[0046] The plurality of vanes 110 are arranged on a first region R1 of the surface supporting the plurality of vanes 110. Here, the first region R1 denotes a region on the surface, which is spaced apart from the opening 100OP and extends towards an outer edge of the base plate 100. That is, the first

region R1 corresponds to an outer region of the surface in a radial direction of the swirler assembly 10 or a radial direction of the base plate 100. Therefore, the plurality of vanes 110 may be disposed closer to the outer edge of the base plate 100 than to the opening 100OP.

[0047] The plurality of vanes 110 are arranged in the first region R1 to be spaced apart from one another along a circumferential direction of the base plate 100. Each of the plurality of vanes 110 may be inclined with respect to the radial direction of the base plate 100. Therefore, when compressed air is introduced into a space between neighboring vanes 110 among the plurality of vanes 110, swirl flow of the air may be easily generated. Hereinafter, a flow of the compressed air introduced between the neighboring vanes 110 will be referred to as a first air flow A1 (FIG. 1), for convenience of description. The first air flow A1 is mixed with a fuel flow F to generate a fuel-air mixture, and supplies the generated fuel-air mixture to a chamber.

[0048] The plurality of vanes 110 have cross-sectional widths that gradually increase from the opening 100OP towards the outer portion of the base plate 100. That is, the plurality of vanes 110 have cross-sectional widths that gradually increase from an inner side of the base plate 100 and an outer side of the base plate 100 along the radial direction of the base plate 100. In FIG. 2, for example, the plurality of vanes 110 have triangular cross-sections, but the exemplary embodiment is not limited thereto. As another example, the cross-sections of the plurality of vanes 110 may partially have a curved contour section, and in this case, each of the plurality of vanes 110 may be arranged spirally towards the center O of the base plate 100.

[0049] Each of the plurality of vanes 110 may be arranged simply in the radial direction towards the center O of the base plate 100, but in order to increase a time period during which the fuel-air mixture stays by increasing swirl strength, each of the plurality of vanes 110 may be arranged to be inclined with respect to the radial direction of the swirler assembly 10 as described above.

[0050] The plurality of air injection holes 120 are arranged in a second region R2 of the surface of the base plate 100 corresponding to the X-Y plane shown in FIG. 1. Here, the second region R2 denotes a region located between the opening 100OP and the first region R1 in the surface. Therefore, the plurality of air injection holes 120 may be arranged closer to the opening 100OP than to the outer side of the base plate 100.

[0051] The plurality of air injection holes 120 penetrate through the base plate 100. As such, the air is introduced from a lower surface of the base plate 100 towards the upper surface of the base plate 100 through the plurality of air injection holes 120, and then, a second air flow A2 augmenting or supplementing the first air flow A1 described above is generated. Here, the upper surface of the base plate 100 denotes the surface on which the plurality of vanes 110 are arranged, and the lower surface of the base plate 100 denotes an opposite surface to the upper surface. The second air flow A2 introduced penetrating through the base plate 100 collides with the fuel flow F and prompts atomization of the fuel.

[0052] The plurality of air injection holes 120 are arranged between neighboring vanes 110 among the plurality of vanes 110 along the circumferential direction of the base plate 100. In detail, when it is assumed that two neighboring vanes among the plurality of vanes 110 are a first vane 111 and a

second vane 112 (FIG. 2), the air injection holes 120 are arranged between the first vane 111 and the second vane 112 along the circumferential direction of the base plate 100. In more detail, a set of air injection holes 121 and 122 are arranged in the second region R2 between the first vane 111 and the second vane 112 along the circumferential direction of the base plate 100. As an example, a set of air injection holes 121 and 122 may be arranged on a first line L1 that is a center line of the region between the first vane 111 and the second vane 112. The first line L1 may extend in a direction inclined with respect to the radial direction of the base plate 100, and thus, the set of air injection holes 121 and 122 may be also arranged in a direction inclined with respect to the radial direction of the base plate 100.

[0053] Here, among edges of the first vane 111 and edges of the second vane 112, neighboring edges may be in parallel with each other, and the first line L1 that is a center line between the neighboring edges may be also in parallel with the neighboring edges. Therefore, the set of air injection holes 121 and 122 arranged on the first line L1 may be also arranged in parallel with the neighboring edges. However, the first line L1 is not limited to the above example, but may be a center line between a center line of the first vane 111 and a center line of the second vane 112, or may be a line of various type, which passes through the region between the first vane 111 and the second vane 112.

[0054] In addition, in FIGS. 1 and 2, the set of air injection holes 121 and 122 includes two air injection holes, but the set may include various numbers of air injection holes according to design intent.

[0055] A shaft portion 200 is inserted through the opening 100OP of the base plate 100. The shaft portion 200 supports the base plate 100 and guides the flow of the fuel-air mixture generated in the swirler assembly 10 in a +Z direction. Here, the flow of the fuel-air mixture guided by the shaft portion 200 may move along the shaft portion 200 or swirl around the shaft portion 200. As shown in FIGS. 1 and 2, when the plurality of vanes 110 are arranged to be inclined with respect to the radial direction of the base plate 100, the flow guided by the shaft portion 200 may be a swirl flow about the shaft portion 200.

[0056] The shaft portion 200 may be provided as a rod having circular (oval) or polygonal cross-section, and hereinafter, a case where the shaft portion 200 has a circular cross-sectional shape will be described in detail for convenience of description.

[0057] The shaft portion 200 includes a plurality of fuel injection nozzles 210, and the plurality of fuel injection nozzles 210 are formed in an external wall 200W of the shaft portion 200 to be adjacent to the surface of the base plate 100, on which the plurality of vanes 110 are arranged. In detail, the plurality of fuel injection nozzles 210 are formed in an outer surface of the external wall 200W of the shaft portion 200, and may be arranged along a second line L2 that is a radial line crossing the center O of the opening 100OP. Thus, the plurality of fuel injection nozzles 210 may inject the fuel in a radial direction of the base plate 100.

[0058] Also, the shaft portion 200 includes a fuel supply pipe 220 supplying the fuel to each of the plurality of fuel injection nozzles 210. The fuel supply pipe 220 is buried in the external wall 200W of the shaft portion 200, and detailed shape of the fuel supply pipe 220 will be described later with reference to FIGS. 3 to 5.

[0059] In addition, FIG. 1 shows the shaft portion 200 being a hollow rod, but the exemplary embodiment is not limited thereto. That is, the shaft portion 200 may be a solid rod. When the shaft portion 200 is a solid rod, the fuel supply pipe 220 may be provided as a pipe radially extending from a pipe at a center of the shaft portion 200.

[0060] In addition, the number of the fuel injection nozzles 210 and the number of fuel supply pipe 220 provided at the shaft portion 200 may vary depending on the design intent. Therefore, the fuel injection nozzles 210 and the fuel supply pipe 220 may be provided to correspond to some of the air injection holes 120 as shown in FIGS. 1 and 2, or to correspond respectively to the air injection holes 120.

[0061] A cover plate 300 may be provided on the base plate 100. In detail, the cover plate 300 may face the base plate 100 to cover top portions of the plurality of vanes 110.

[0062] Also, the cover plate 300 may be bent at a location adjacent to the shaft portion 200 to partially surround the shaft portion 200. As such, the compressed air and the fuel-air mixture flow through a space between the cover plate 300 and the shaft portion 200 towards a chamber (not shown).

[0063] Hereinafter, referring to FIGS. 3 to 5, processes of introducing the air and the fuel into the swirler assembly 10 according to the exemplary embodiments and forming the fuel-air mixture will be described in more detail.

[0064] FIG. 3 is a cross-sectional view taken along a line III-III' of FIG. 2, FIG. 4 is a schematic cross-sectional view of a swirler assembly according to another exemplary embodiment, and FIG. 5 is a schematic cross-sectional view of a swirler assembly according to another exemplary embodiment.

[0065] Referring to FIG. 3 with FIGS. 1 and 2, the plurality of vanes 110 are arranged between the base plate 100 and the cover plate 300 in the Z-direction, and the air compressed by a compressor (not shown) is introduced among (and through) the plurality of vanes 110 to form the first air flow A1. As described above, the first air flow A1 passing through two neighboring/adjacent vanes on the base plate 100 is curved or turned at the location adjacent to the shaft portion 200, and after that, the first air flow A1 proceeds in about +Z direction through the space between the cover plate 300 and the shaft portion 200.

[0066] The first air flow A1 is mixed with the fuel flow F to generate the fuel-air mixture that is supplied to a combustor (not shown), and at this time, in order to evenly mix the first air flow A1 and the fuel flow F, a time period taken for the flows to be mixed has to be increased.

[0067] Therefore, in the exemplary embodiments, the fuel injection nozzles 210 are arranged at the side of the base plate 100, where the first air flow A1 is introduced, in order to increase a mixing length ML through which the first air flow A1 and the fuel flow F are mixed. Here, the mixing length ML denotes a length in the +Z direction, from a point the above-described fuel and air flows meet each other and to a point where the flows are discharged from the swirler assembly. As described above, by increasing the mixing length ML, a sufficient time period for mixing the first air flow A1 and the fuel flow F may be obtained.

[0068] Here, the fuel supply pipe 220 may be connected to the fuel injection nozzles 210 in order to supply the fuel to the fuel injection nozzles 210. As an example, the fuel supply pipe 220 is buried in the external wall 200W of the

shaft portion 200, and the fuel supply pipe 220 extends in a lengthwise direction of the shaft portion 200 to reach the fuel injection nozzles 210. The fuel supply pipe 220 is connected to an additional fuel storage (not shown) to convey the fuel stored in the fuel storage to the fuel injection nozzles 210, and the fuel may be injected through a relatively narrow outlet of the fuel injection nozzles 210 with a high injection force.

[0069] Moreover, in order to improve a mixing performance of the first air flow A1 and the fuel flow F, it is necessary to atomize the fuel. Here, one of methods of prompting the atomization of the fuel is having the fuel to be collided with the air to atomize the fuel.

[0070] In addition, because the fuel injection nozzle 210 is located adjacent to the base plate 100 rather than the cover plate 300, the fuel flow F collides with the first air flow A1 at a curved region B where the first air flow A1 is curved or turned. Here, because the first air flow A1 is curved or turned at the curved region B, a force of colliding with the fuel flow F is reduced, and accordingly, atomizing effect of the fuel also degrades.

[0071] Therefore, according to the exemplary embodiments of the disclosure, the air injection holes 120 are provided to penetrate through the base plate 100, and thus, the second air flow A2 introduced through the air injection holes 120 collides with the fuel flow F. As such, the fuel atomization process that is not sufficiently performed only with the first air flow A1 may be triggered by the second air flow A2.

[0072] In the exemplary embodiment illustrated in FIG. 3, the air injection hole 120 may penetrate through the base plate 100 in a direction parallel with a thickness direction (+Z direction) of the base plate 100. As such, a time taken for the second air flow A2 to pass through the base plate 100 may be reduced, and the second air flow A2 may rapidly reach the fuel flow F.

[0073] Next, the exemplary embodiment illustrated in FIG. 4 may have a structure that is the same as or similar to the previous embodiment illustrated in FIG. 3, except for a direction in which the air injection hole 120 penetrates through the base plate 100.

[0074] Referring to FIG. 4, the air injection hole 120 may penetrate through the base plate 100 in a direction inclined with respect to the thickness direction (+Z direction) of the base plate 100. As such, a turbulent flow characteristic of the second air flow A2 is reinforced, and thus, mixing strength between the second air flow A2 and the fuel flow F may be further improved.

[0075] In detail, the air injection holes 120 arranged at opposite sides of the shaft portion 200 may penetrate through the base plate 100 in parallel with each other. Therefore, the air injection hole 120 located in a +X direction of the shaft portion 200 injects the air in the same direction as the fuel flow F with respect to the X-axis, and the air injection hole 120 located in a -X direction of the shaft portion 200 injects the air in a direction opposite to the fuel flow F with respect to the X-axis. That is, the second air flows A2 injected from the air injection holes 120 that face each other in the radial direction of the base plate 100 may be in the same direction.

[0076] Next, the embodiment illustrated in FIG. 5 is the same as or similar to the previous embodiment illustrated in FIG. 4, except for the inclination of the air injection holes 120 with respect to the thickness direction (+Z direction) of

the base plate **100**. That is, the exemplary embodiment is different from the previous embodiment illustrated in FIG. **3** and modified example thereof, in that the air injection hole **120** penetrates through the base plate **100** to be inclined with respect to the thickness direction (+Z direction) of the base plate **100**, and is different from the previous embodiment illustrated in FIG. **4** and modified examples thereof in that each of the second air flows **A2** proceeds in a similar direction to the fuel flow **F** on the base plate **100**.

[0077] Referring to FIG. **5**, like in the embodiment illustrated in FIG. **4** and modified examples thereof, the air injection hole **120** may penetrate through the base plate **100** to be inclined with respect to the thickness direction (+Z direction) of the base plate **100**. Therefore, as described above, a turbulent flow characteristic of the second air flow **A2** is reinforced, and thus, mixing strength between the second air flow **A2** and the fuel flow **F** may be further improved.

[0078] In detail, the air injection holes **120** arranged at opposite sides of the shaft portion **200** may penetrate through the base plate **100** symmetrically with each other based on the Z-axis. Therefore, the air injection holes **120** located in the +X direction and -X direction of the shaft portion **200** may inject the air in the same direction as that of the fuel flow **F** with respect to the X-axis. That is, the second air flows **A2** injected from the air injection holes **120** that face each other in the radial direction of the base plate **100** may be opposite each other.

[0079] In addition, in the set of air injection holes **120** illustrated in FIG. **2**, inclined direction of each of the air injection holes **120** may be formed differently from the others.

[0080] As described above, according to the embodiment of the present disclosure, the mixing time of the fuel and the air may be increased and the atomization of the fuel may be prompted, and accordingly, generation of the nitrogen oxide may be reduced and low-polluting performance of the combustor may be improved.

[0081] According to the embodiment of the present disclosure, the mixing time of the fuel and the air may be increased.

[0082] Also, the atomization of the fuel may be triggered and intensified.

[0083] Also, because the generation of nitrogen oxide is reduced, the low-polluting performance of the combustor may be improved.

[0084] However, the scope of the present disclosure is not limited to the above effects.

[0085] It should be understood that exemplary embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each embodiment should typically be considered as available for other similar features or aspects in other embodiments.

[0086] While one or more exemplary embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the disclosure as defined by the following claims.

1. A swirler assembly comprising:
 - a base plate having an opening at a center thereof;
 - a plurality of vanes arranged on a first region of a surface of the base plate, the plurality of vanes being spaced apart from one another along a circumferential direction of the base plate; and
 - a plurality of air injection holes arranged in a second region of the surface of the base plate, the second region located between the opening and the first region of the surface of the base plate.
2. The swirler assembly of claim 1, further comprising a cover plate covering the plurality of vanes, the plurality of vanes provided between the cover plate and the base plate.
3. The swirler assembly of claim 1, wherein each of the plurality of vanes is arranged to be inclined with respect to the radial direction of the base plate.
4. The swirler assembly of claim 1, wherein the plurality of air injection holes are arranged between adjacent vanes of the plurality of vanes.
5. The swirler assembly of claim 1, wherein the plurality of vanes comprise:
 - a first vane; and
 - a second vane adjacent to the first vane, and
 wherein a set of air injection holes of the plurality of air injection holes is arranged in a portion of the second region provided between the first vane and the second vane.
6. The swirler assembly of claim 5, wherein the set of air injection holes is arranged with respect to one another in a direction inclined with respect to the radial direction of the base plate.
7. The swirler assembly of claim 1, wherein each of the plurality of air injection holes is inclined with respect to a thickness direction of the base plate.
8. The swirler assembly of claim 1, further comprising a shaft portion inserted through the opening to support the base plate.
9. The swirler assembly of claim 8, wherein the shaft portion comprises a plurality of fuel injection nozzles configured to inject fuel in the radial direction of the base plate.
10. The swirler assembly of claim 9, wherein the shaft portion has a hollow rod shape, and comprises a fuel supply pipe embedded in an external wall of the shaft portion, the fuel supply pipe extending along a lengthwise direction of the shaft portion and configured to supply the fuel to each of the plurality of fuel injection nozzles.
11. The swirler assembly of claim 9, further comprising a cover plate covering the plurality of vanes, the cover plate facing the base plate,
 - wherein the plurality of fuel injection nozzles are located closer to the base plate than to the cover plate.
12. A swirler assembly comprising:
 - a base plate having an opening at a center thereof;
 - a plurality of vanes arranged along a circumferential direction, the plurality of vanes provided at an outer region on the base plate in a radial direction of the base plate;
 - a plurality of air injection holes arranged in an inner region of the base plate, the inner region located between the opening and the outer region of the base plate in the radial direction of the base plate; and
 - a shaft provided through the opening and comprising a plurality of fuel injection nozzles provided on an outer surface of the shaft,

wherein the plurality of vanes are configured to guide air toward the plurality of air injection holes and the plurality of fuel injection nozzles.

13. The swirler assembly of claim **12** further comprising a cover plate covering the plurality of vanes, the plurality of vanes provided between the cover plate and the base plate.

14. The swirler assembly of claim **12**, wherein the plurality of vanes comprise:

a first vane; and

a second vane adjacent to the first vane, and

wherein a set of air injection holes of the plurality of air injection holes is arranged in a portion of the inner region provided between the first vane and the second vane.

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