A gas turbine blade has a main hollow body substantially extending along a longitudinal axis and having a leading edge, a trailing edge, opposite to the leading edge, a suction side, and a pressure side, both comprised between the leading edge and the trailing edge; a hollow cooling element extending along the axis, which is equipped with a plurality of cooling holes and is set within the main body so as to define a gap between the main body and the cooling element; and a rib, which is set within the gap for connecting the main body with the cooling element on the suction side, in an area of the main body without holes for communication between the gap and the outside of the blade.
SPACER FOR GAS TURBINE BLADE INSERT

TECHNICAL FIELD

[0001] The present invention relates to a gas turbine blade.

[0002] In particular, the present invention relates to a gas turbine stator blade.

BACKGROUND ART

[0003] A known type of stator blade comprises a main hollow body substantially extending along a longitudinal axis and having a leading edge, a trailing edge, opposite to the leading edge, and a suction side and a pressure side, both comprised between the leading edge and the trailing edge. A hollow cooling element, which extends along the longitudinal axis, is equipped with a plurality of cooling holes and is set within the main body so as to define a gap between the main body and the cooling element. The stator blade moreover comprises at least one rib, which is set within the gap on the leading edge for connecting the main body with the cooling element.

[0004] Stator blades of this type exploit the technique of cooling referred to as “impingement cooling”. Said technique envisages that the cooling fluid, generally air, supplied within the cooling element, exits from the holes of the cooling element in a direction substantially orthogonal to the wall of the cooling element, comes to impinge upon the internal surface of the blade and laps it, guaranteeing proper cooling thereof.

[0005] The fluid is then expelled from the gap by means of one or more holes for communication between the gap and the outside of the blade on the suction side and/or the pressure side and/or the trailing edge of the blade. In this way, the temperature of the metal of the blade is maintained substantially below the critical values. In particular, the presence of a rib in the gap optimizes cooling in the areas surrounding it in so far as it generates at the sides of the rib itself two areas of stagnation of the cooling fluid. In said areas, the flow of the cooling fluid does not have components tangential to the wall of the cooling element due to the return of “hot” fluid from other areas of the gap, but only components orthogonal to the wall of the cooling element basically due to exit of the cooling fluid from the holes.

[0006] However, stator blades of this type suffer from a main drawback due to the fact that the holes for passage of the cooling fluid have a very small section and consequently are frequently subject to phenomena of partial or total occlusion on account of the presence of impurities in suspension in the cooling fluid that tend to aggregate. Furthermore, different environmental conditions can aggravate the phenomena of soiling referred to above, for example in desert environments or in the proximity of industrial settlements, in particular siderurgical centres, or in the case of use of cooling systems external to the gas turbine of the “cooler and booster” type.

[0007] In particular, the area most concerned by this phenomenon of “soiling” is the leading edge, which is impinged upon directly by the hot gases coming from the combustion chamber. Said area, in fact, requires a particularly large quantity of cooling fluid, being most subject to thermal stresses. The presence of the rib on the leading edge in conditions of soiling of the holes does not lead to an optimization of the cooling action but rather a worsening, if not a practically total absence, of cooling. In the points of stagnation, in fact, as already emphasized, the flow of cooling fluid does not present components tangential to the wall of the cooling element but only orthogonal components determined basically by the fluid leaving the holes. Consequently, if the fluid leaving the holes decreases drastically on account of “soiling” cooling in said area is practically absent.

DISCLOSURE OF INVENTION

[0008] An aim of the present invention is to provide a blade that is free from the drawbacks of the known art highlighted herein. In particular, an aim of the invention is to provide a blade that is capable of guaranteeing a correct cooling also in conditions of soiling of the holes of the cooling element and is at the same time easy and inexpensive to produce.

[0009] In accordance with said aims, the present invention relates to a gas turbine blade comprising a main hollow body substantially extending along a longitudinal axis A and having a leading edge, a trailing edge, opposite to the leading edge, a suction side, and a pressure side, both comprised between the leading edge and the trailing edge. A hollow cooling element extends along the axis A, which is equipped with a plurality of cooling holes and is set within the main body so as to define a gap between the main body and the cooling element, and a rib, which is set within the gap for connecting the main body with the cooling element, the blade being characterized in that the rib is set on the suction side in an area of the main body without holes for communication between the gap and the outside of the blade.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Further characteristics and advantages of the present invention will appear clearly from the ensuing description of a non-limiting example of embodiment thereof, with reference to the figures of the annexed plate of drawings, wherein:

[0011] FIG. 1 is a cross-sectional view, with parts removed for reasons of clarity, of a gas turbine blade according to the present invention;

[0012] FIG. 2 is a cross-sectional view at an enlarged scale, with parts removed for reasons of clarity, of a detail of the blade of FIG. 1;

[0013] FIG. 3 is a cross-sectional view at an enlarged scale, with parts removed for reasons of clarity, of a further detail of the blade of FIG. 1; and

[0014] FIG. 4 is a partial perspective view, with parts removed for reasons of clarity, of the blade of FIG. 1.

BEST MODE FOR CARRYING OUT THE INVENTION

[0015] Designated by the reference number 1 in FIG. 1 is a stator blade of a gas turbine (as a whole known and not illustrated in the figures for reasons of simplicity).

[0016] The blade 1 comprises a main hollow body 2, a cooling element 3, a rib 4, and a plurality of spacers 5.

[0017] The main body 2 extends along a longitudinal axis A and has a leading edge 6, a trailing edge 7 opposite to the leading edge 6, a suction side 8 (also referred to as “suction face” or “back”) and a pressure side 9 (also referred to as “pressure face”), both comprised between the leading edge 6 and the trailing edge 7.

[0018] The main body 2 defines a cavity 13, within which the cooling element 3 is set so as to define a gap 14, comprised between the main body 2 and the cooling element 3.

[0019] The cooling element 3 extends along the longitudinal axis A for the entire extension of the main body 2 and
comprises a metal insert 16 shaped and closed in a loop, which is equipped with a plurality of holes 17 suitable for being traversed by a cooling fluid and defines a duct 18 suitable for being supplied with the cooling fluid.

With particular reference to FIG. 4, the holes 17 are set according to a pre-set scheme on the metal insert 16 of the cooling element 3. Preferably, the holes 17 are set so as to form columns parallel to the axis A of the blade 1 and staggered with respect to one another in a direction perpendicular to the axis A.

With reference to FIG. 1, the cooling element 3 preferably has a shape similar to the shape of the blade 1 so that the gap 14 will have a substantially constant width.

Set in the gap 14 is the rib 4 for connecting the main body 2 with the cooling element 3. The rib 4 is set on the suction side 8 in an area of the main body 2 without holes for communication between the gap 14 and the outside of the blade 1 and extends substantially parallel to the longitudinal axis A throughout the length of the blade 1.

In detail, the rib 4 is positioned at a distance from the leading edge 6, measured externally to the blade 1 along the suction side 8, comprised between approximately 20% and approximately 40%, and preferably between approximately 25% and approximately 35%, in particular substantially equal to approximately 30%, of the overall distance, again measured externally to the blade 1 along the suction side 8, between the leading edge 6 and the trailing edge 7.

Preferably, the rib 4 is defined by an external projection of the cooling element 3, but it remains understood that it is also possible to provide a blade 1 in which the rib 4 is defined by an internal projection of the main body 2.

In particular, the metal insert 16 of the cooling element 3 has two terminal flaps 22, bent and coupled to one another to define the rib 4.

With reference to FIGS. 1 and 4, the rib 4 is connected throughout its length to the main body 2 and to the cooling element 3 so as to define two chambers 20 and 21 of the gap 14.

The first chamber 20 of the gap 14 comprises the area of the gap 14 that extends along the suction side 8 starting from the rib 4 up to the trailing edge 7, whilst the second chamber 21 of the gap 14 comprises the area of the gap 14 that extends starting from the rib 4 along the leading edge 6 and the pressure side 9 up to the trailing edge 7.

With reference to FIG. 1, the spacers 5 are set in the gap 14 between the main body 2 and the cooling element 3 and are designed to maintain the distance between the main body 2 and the cooling element 3 fixed during operation of the turbine. In particular, the spacers 5 are distributed so that they are diffused in the gap 14 between the holes 17 and extend substantially orthogonal to the axis A.

The blade 1 moreover comprises further spacers 23 set in the cavity 13 of the main body 2 substantially in a position corresponding to the trailing edge 7 to maintain the distance between opposite walls of the main body 2 fixed during operation of the turbine.

In use, the cooling fluid (schematically represented by the arrows in FIG. 1) is supplied to the cooling element 3 and sent, through the holes 17, into the gap 14 for cooling the blade 1.

As illustrated in detail in FIG. 2, the rib 4 generates, in the gap 14 at the sides of the rib 4 itself, two areas of stagnation of the cooling fluid, in which the flow of the cooling fluid is substantially without components $F_r$, tangential to the metal insert 16 of the cooling element 3, principally due to the return of fluid from other areas of the blade 1, but only components $F_{\perp}$, orthogonal to the metal insert 16 of the cooling element 3 due to the exit of fluid from the holes 17 of the metal insert 16.

With reference to FIG. 3, in the areas of the gap 14 not close to the rib 4, in particular in a position corresponding to the leading edge 6, the flow of the cooling fluid that laps the main body 2 internally has both components $F_r$, tangential and components $F_{\perp}$, orthogonal to the metal insert 16 of the cooling element 3.

The invention presents the advantages described in what follows.

First of all, the presence of the rib 4 substantially on the suction side 8 of the blade 1 imposes upon the flow of the cooling fluid an inevitable path such as to determine, in the gap 14 in a position corresponding to the leading edge 6, a tangential component $F_r$ of the flow of cooling fluid. In this way, even in the condition of possible complete occlusion of the holes 17 in an area corresponding to the leading edge 6, the tangential component $F_r$ of the flow of cooling fluid laps the main body 2 internally, guaranteeing a minimum cooling action, which, by possibly being associated to the adoption of an appropriate external coating of the blade (the so-called “thermal barrier”, which is per se known), is sufficient to maintain the blade 1 intact.

Furthermore, conversion of the blades of a traditional type, equipped with a rib in a position corresponding to the leading edge, into blades according to the present invention, equipped with a rib in a position corresponding to the suction side, is easy to obtain and inexpensive. Said conversion, in fact, maintains the same profile of the blade and requires ease of intervention on the cooling element and certain simple machining operations necessary for accepting the new arrangement of the rib.

Finally, it is evident that further modifications and variations can be made to the turbine blade described and illustrated herein without departing from the scope of the claims.

1. A gas turbine blade comprising a main hollow body substantially extending along a longitudinal axis and having a leading edge, a trailing edge, opposite to the leading edge, a suction side, and a pressure side, both comprised between the leading edge and the trailing edge; a hollow cooling element extending along the axis, which is equipped with a plurality of cooling holes and is set within the main body so as to define a gap between the main body and the cooling element; and a rib, which is set within the gap for connecting the main body with the cooling element; the blade being characterized in that the rib is set on the suction side in an area of the main body without holes for communication between the gap and the outside of the blade.

2. Blade according to claim 1, characterized in that the rib is connected throughout its length to the main body and to the cooling element so as to define two chambers of the gap.

3. Blade according to claim 1, characterized in that the rib extends substantially parallel to said longitudinal axis.

4. Blade according to claim 1, characterized in that the rib is defined by an external projection of the cooling element.

5. Blade according to claim 4, characterized in that the cooling element comprises a shaped metal insert closed in a loop, the metal insert being bent so as to define said rib.
6. Blade according to claim 5, characterized in that the metal insert has two terminal flaps bent and coupled to one another to define said rib.

7. Blade according to claim 1, characterized in that the rib is defined by an internal projection of the main body.

8. Blade according to claim 1, characterized in that it comprises a plurality of spacers, which are set in the gap between the main body and the cooling element.

9. Blade according to claim 8, characterized in that the spacers extend substantially orthogonal to the axis.

10. Blade according to claim 1, characterized in that the rib is positioned at a distance from the leading edge, measured externally to the blade along the suction side, comprised between approximately 20% and approximately 40%, and preferably between approximately 25% and approximately 35%, in particular substantially equal to approximately 30%, of the overall distance, again measured externally to the blade along the suction side, between the leading edge and the trailing edge.

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