Metallic Coating Geometry after its Removal from Trailing Edge Regions

Gas turbines convert high-temperature gas flow into rotational energy to drive electrical generators, among other things. The turbine section consists of multiple stages of stationary and rotating blades that systematically extract energy from the hot gas path. Modern turbine blades operate at very high temperatures and rely on internal cooling systems and protective coatings to maintain structural integrity. Cooling is achieved by a network of internal passages that direct compressed air through the blade, with the air exiting through precisely positioned holes to create a protective barrier. The MCrAlY (Metal-Chromium-Aluminum-Yttrium) coating applied to these components acts as a thermal barrier and provides the oxidation resistance essential for long-term operation in these harsh conditions. Figure 1 shows two different TE (Trailing Edge) designs for the cooling air outlet. A pressure side exit where cooling holes are made on the PS (Pressure Side) or a TE cutback that is part of the casting process. Both designs have challenges after the bond coat MCrAlY coating where the coating can affect the exit area at the TE. A potential challenge is the presence of MCrAlY in the cooling air outlet and the need to mechanically remove this bond coat residue. The removal of such a residue is very important as no base material should be removed, especially in the TE region where the wall thickness is very thin. The remaining shape of the removed residue could affect the exit flow behavior, causing vortices and not having a good cooling effect.

Currently there is no accurate residue removal and the lack of an optimized process to remove the bond coat residue will affect scrap rates and refurbishment efforts. The residues can reduce the amount of cooling air leaving the TE if not removed correctly and if the base material is affected, rapid oxidation can occur.

A new solution to this problem is presented here. Figure 2 shows this approach, where the metallic coating in the TE groove can be removed so that the thickness of the bond layer at the air exit is 0–50 µm. It can be thicker towards the end of the TE groove. It is important to ensure that the throat area at the end of the TE is not reduced by a thick metal coating at its end. To ensure that the throat area is not reduced, the MCrAlY thickness at the end of the TE should be less than the sidewalls of the exit.

The new solution is applicable to PS bleed and cutback designs and has a number of positive effects. It provides better protection of the cooling air outlet area from oxidation. At the same time, the thickness of the base material is not affected and there are no flow vortices that interfere with the cooling effect at the TE. The new design also reduces the manufacturing effort required to remove the residue, scrap rates or rework, and manufacturing costs.

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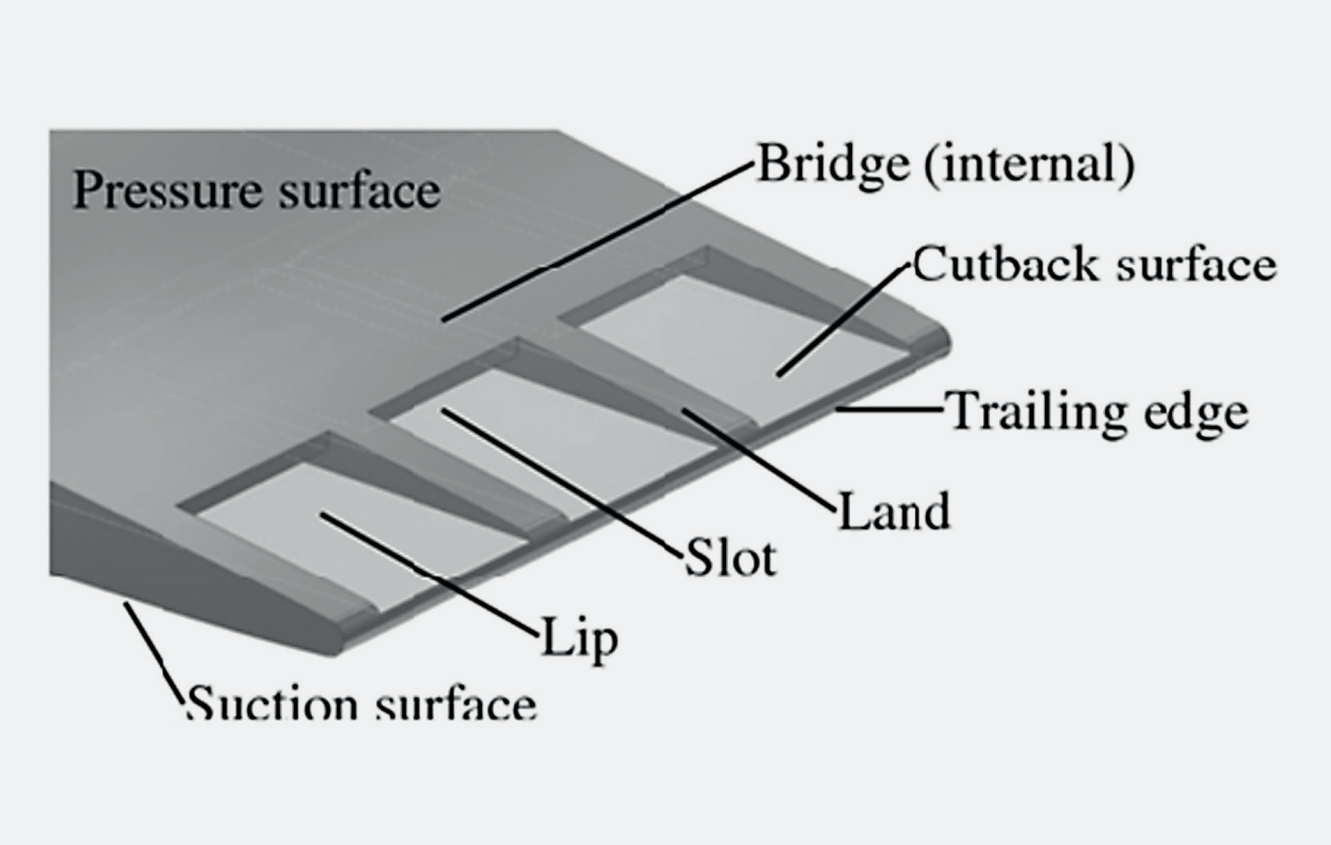

Figure 1: TE cooling air outlet designs

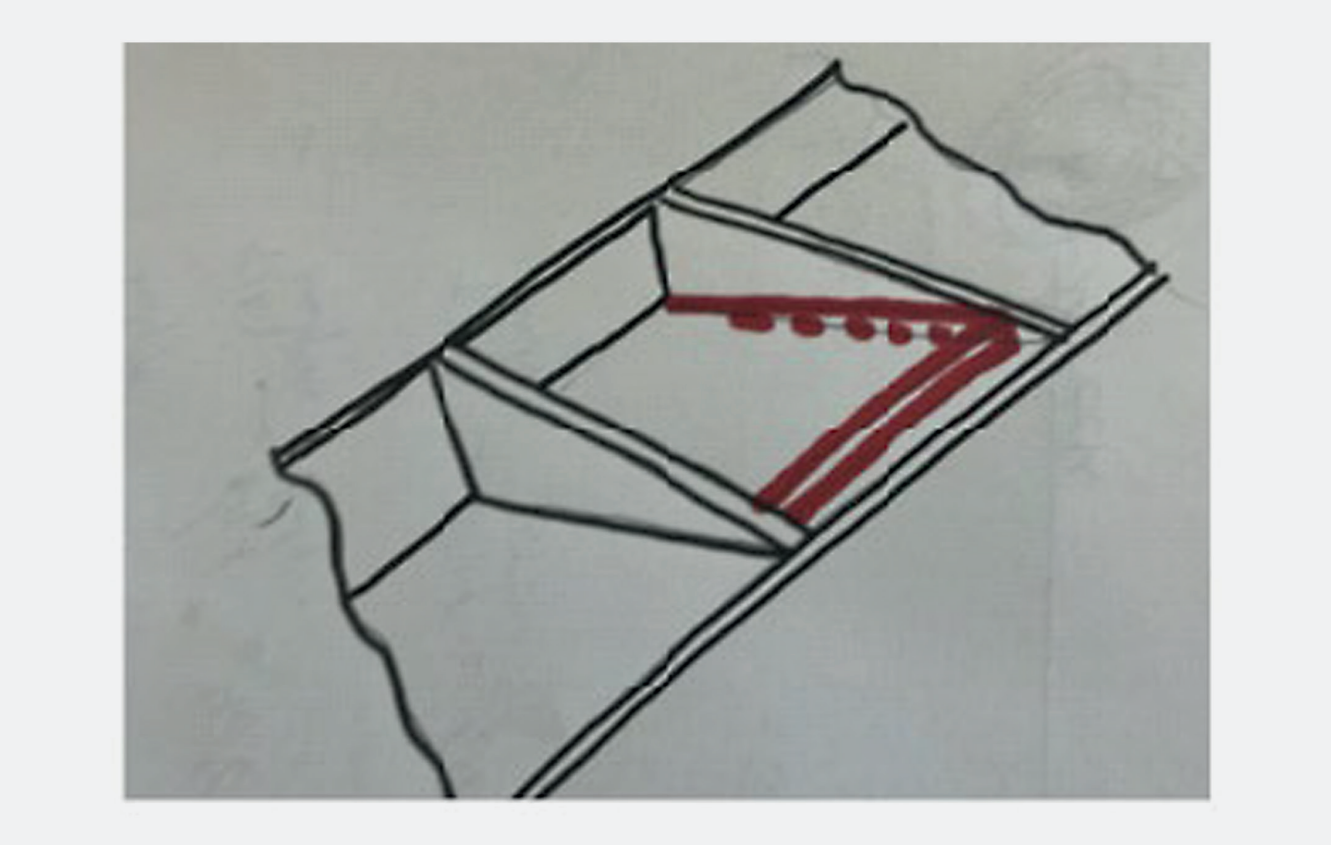

Figure 2: Shape of the reworked MCrAlY residue in the TE exit region