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RESEARCH ON THERMAL STATE OPTIMIZATION OF HIGH PRESSURE TURBINE 1ST STAGE ROTOR BLADE

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This paper takes the first-stage moving blade of high-pressure turbine as the research object, in order to solve the high temperature area on the blade surface and ensure a more uniform temperature distribution of the blade. The layout of gas film holes on the leading edge and pressure surface is optimized, the model is shown in Figure 1and main research contents of this paper are as follows:

1. First, change the layout of the film holes on the leading edge, the film holes on the pressure surface move to the stagnation point, and the middle air film holes move to the pressure surface;

2. Secondly, add air film holes in the middle channel of the pressure surface to improve the high temperature area downstream of the pressure surface.

The CFX calculation results show that changing the position of film hole on the leading edge alone has a positive effect on the overall thermal state of the blade, and moving the film hole (Row3) on the pressure surface has a better effect on reducing the high temperature area of the leading edge; adding on the pressure surface film holes further contribute to reducing the high temperature area of the pressure side and trailing edge.

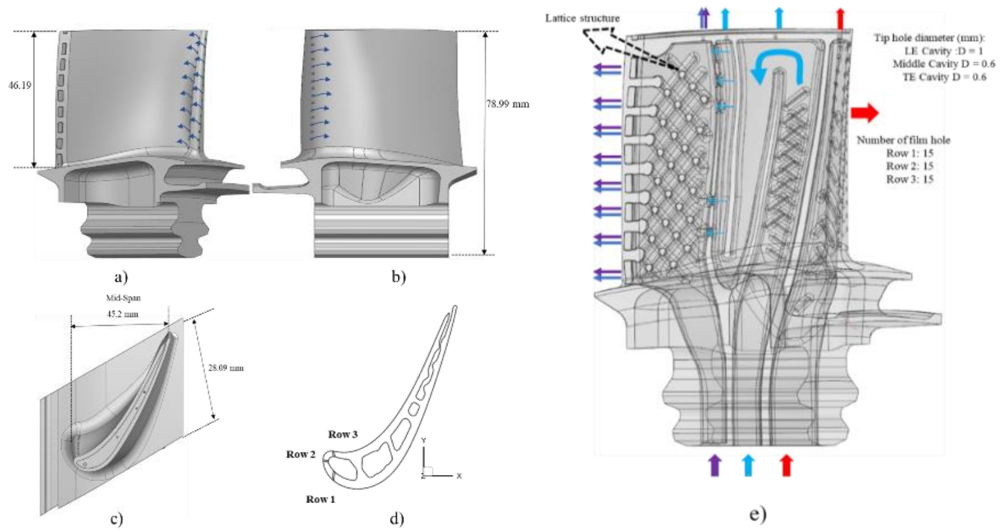

Fig.1 - Rotor blade pressure side a); Rotor blade suction blade b); Rotor blade tip and hub c); Mid-span section and film hole position d); Rotor blade inner structure e)

Table 1 - Specific cases

	Initial	Case 1	Case 2	Case 3	Case 4
Move Row 2 (mm)	---	-Y-1	---	---	---
Move Row 3 (mm)	---	---	+X-1	+X-1	+X-1
PS film hole	---	---	---	Radial 45°	Axial 10° Radial 45°
Radial angle(°)	45				

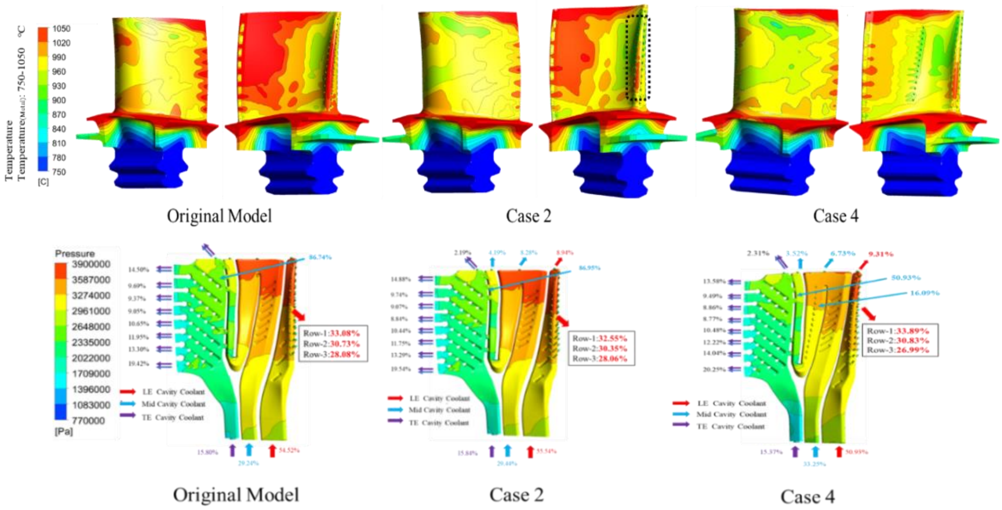

Fig.2 - Temperature of solid blade (Top) and Proportion of outlet flow relative to respective coolant inlet (Bottom)

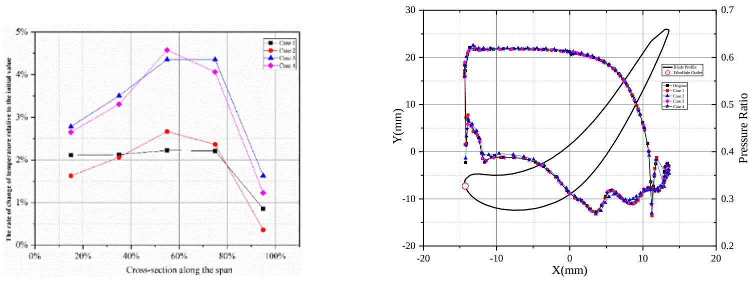

Fig.3 - Average temperature of different sections for solid blade (Left) and Mid-Span static pressure ratio(relative inlet total pressure)distribution along the blade (Right)

$$C_{p,loss} = \frac{P_{t0}-P_{t2}}{P_{t2}-P_{s2}}. \tag{1}$$

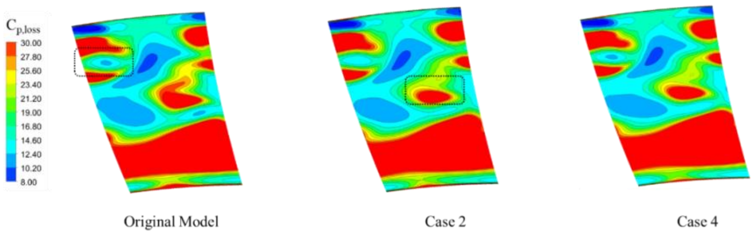

Fig.4 - Distribution of total pressure loss at rotor blade outlet

From above results, firstly both moving leading edge film hole and adding PS film hole will have a positive effect on cooling ; at the same time slight variation of mass flow will be for move leading edge; inlet flow distribution and leading edge gas film outflow have a large change for adding pressure surface film hole ; secondly from the static pressure distribution we can know the static pressure on the pressure surface basically does not change, and the static pressure on the suction surface near the leading edge and trailing edge has a small change; finally moving the film holes on the leading edge or adding air film holes on the pressure surface has little effect on the total pressure loss of the cascade channel.

References

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