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PROCEEDINGS

Numerical Study of Cooling Performance of Laminate Cooling Configuration with Improved Film Holes

Zhimin Chen[1], Bo Yu[2], Yujie Chen[2,*], Xufei Yang[2], Jianqin Zhu[3], Wei Lu[4] and Weihua Cai[1,*]

[1]Laboratory of Thermo-fluid Science and Nuclear Engineering, School of Energy and Power Engineering, Northeast Electric Power University, Jilin, 132012, China

[2]School of Mechanical Engineering, Beijing Institute of Petrochemical Technology, Beijing, 102617, China

[3]School of Energy and Power Engineering, Beihang University, Beijing, 100191, China

[4]State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources, North China Electric Power University, Beijing, 102206, China

[*]Corresponding Author: Yujie Chen. Email: yujiechen@bipt.edu.com

ABSTRACT

The laminated cooling configuration offers significant advantages in enhancing the cooling effectiveness, prolonging the service life, and enhancing the reliability of turbine blades. It stands as one of the key development directions for the cooling structure of next-generation turbine blades. Numerous scholars have conducted extensive research on laminated cooling, which has been widely applied in the aviation industry. With the continuous rise in turbine inlet temperatures, there is a growing need to further enhance the cooling performance of the blades. Therefore, this study proposes the utilization of a shaped film hole to enhance the overall cooling effectiveness, building upon the typical laminated cooling configuration of turbine blades. Regarding the shaped film hole, the equal division method is adopted to improve the film hole design. By maintaining the same area for the circular film hole, it is evenly divided into 2, 4, 6, 8, and 10 sub-holes with consistent spacing between each one. These divisions are sequentially labeled as Scheme 1 to Scheme 5. Comparative analysis was conducted on the adiabatic film cooling effectiveness, overall cooling effectiveness, and total pressure loss of six different film hole arrangements at varying blowing ratios. The results indicate that compared with the complete hole, the air film coverage widens with the increasing of the sub-hole number, leading to an overall increase in overall cooling effectiveness by 2.66% to 12.78%. However, this improvement is accompanied by a gradual rise in total pressure loss by 0.16% to 6.33%. Although Scheme 5 exhibits the highest cooling effectiveness, it also incurs the largest total pressure loss. The overall cooling effectiveness of Scheme 4 is similar to that of Scheme 5, with a lower total pressure loss. Additionally, the sub-hole size of Scheme 5 presents challenges in practical manufacturing. Therefore, considering these factors, Scheme 4 is selected as the optimal improvement scheme.

KEYWORDS

Laminated cooling configuration; shaped film hole; overall cooling effectiveness; total pressure loss

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