НАПРАВЛЕНИЕ «ПРОЦЕССЫ ТЕПЛОМАССООБМЕНА В ТЕПЛОВЫХ ДВИГАТЕЛЯХ И ЭНЕРГЕТИЧЕСКИХ УСТАНОВКАХ» / «HEAT AND MASS TRASNFER PROCESSES IN HEAT ENGINES AND ENERGY PLANTS»

NUMERICAL EFFECTS OF AERODYNAMIC AND CROSS-SECTIONAL CHARACTERISTICS PARAMETERS ON THE EXTERNAL HEAT TRANSFER CHARACTERISTICS OF TURBINE VANES WITH DIFFERENT HEIGHT CROSS-SECTIONS

Xin Liu[1], Guanghua Zheng[1], Junjie Liu[1], Bang Wei[1]
[1]Northwestern Polytechnical University, Xi'an, Shaanxi, China, 2990549033@qq.com

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There are many factors influencing the external heat transfer characteristics of turbine blades, and this paper mainly studies the influence of mainstream Reynolds number and inlet/outlet pressure ratio on the external heat transfer characteristics. In addition to the aforementioned aerodynamic parameters, the design of the blade profile needs to take into account both aerodynamic and heat transfer characteristics, and the impact of the blade profile structure on the external heat transfer characteristics of turbine blades is specifically analyzed here.

In this paper, a commercial software Fluent is used to numerically study five different height cross-sections of a turboshaft engine's first-stage dynamic blades to determine the differences in the effects of aerodynamic and blade shape parameters on external heat transfer. A two-dimensional computational model is used to numerically study the variation of the Nusselt number of the outer surface of different height sections of the first-stage dynamic impeller with the inlet Reynolds number and the inlet and outlet pressure ratios, and further analyze the influence of the section characteristics on the external heat transfer on this basis. In order to realize the comparison of external heat transfer characteristics of different leaf types, this paper takes the midpoint of the arc in the corresponding leaf type of each cross section as the reference, and has a unified reference for the comparison of external heat transfer characteristics of different leaf types on the premise that a unique leaf type can be determined. The distance and angle of each point on the leaf shape characterization variable relative to the midpoint of the mid-arc line are selected specifically, so that the relationship between the leaf shape parameters and external heat transfer characteristics can be established. In the analysis of the influence of the leaf shape parameters on the external heat transfer characteristics only, the influence of the aerodynamic parameters is unified by the Reynolds number multiplier variation and the corresponding Nusselt number multiplier variation.

The results of the numerical study of five different height sections of the first-stage dynamic blade show that: with the increase of Reynolds number, the Nusselt number of the outer surface of the blade shows increasing changes; with the increase of the inlet and outlet pressure ratio, the Nusselt number of the pressure surface remains basically the same, and the Nusselt number of the suction surface decreases with the increase of the pressure ratio; under the same aerodynamic conditions, with the increase of the section height, the Nusselt number of the pressure surface gradually decreases, and the Nusselt number of the suction surface remains basically the same. The pressure coefficient of pressure surface gradually increases with the increase of section height, and the pressure coefficient of suction surface basically stays the same with the increase of section height; according to the relative distance in the set leaf shape parameters, the change of leaf shape can be partitioned, and the relative distance and relative angle of different partitions can be analyzed with the corresponding change of average Nusselt number. Taking 1r-3 and 1r-5 cross-sections as examples, it can be seen that the average relative distance of the latter increases about 1.04 times, the angle increases 1.47 times, and the average Nusselt number increases to 1.07 times compared with the former in the area near the leading edge of the suction surface, while the relative angle and distance decrease in the area near the trailing edge of

the suction surface, but the average Nusselt number increases to 1.14 times compared with the former. The average Nusselt number increases to 1.14 times. In the area near the trailing edge of the pressure surface, the relative distance and the corresponding angle are decreasing, and the Nusselt number of the corresponding area is also decreasing, and the pressure surface near the leading edge is basically the same, but the Nusselt number of the 1r-3 section near the trailing edge is about 1.20 times of the leading edge; based on the numerical calculation results, SPSS neural network analysis is used to further obtain the influence of aerodynamic and leaf type parameters on the external heat transfer characteristics. The degree of influence is 33% and 67%, respectively.