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动力机械与工程

旋转气冷涡轮三维流场的实验与数值研究

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摘要
采用k-e湍流模型对气冷涡轮在静止和旋转2种工况下三维流场进行数值计算，并与PIV测量结果进行对比。计算得到射流和主流的掺混区域三维速度以及射流尾迹区二次流动，k-e湍流模型的计算结果与实验基本吻合。与静止涡轮流场相比，旋转状态下涡轮内部流场中存在的离心力、哥氏力的作用使射流与主流掺混流场三维速度发生改变，其中径向速度的改变明显。计算和实验结果表明，旋转对气冷涡轮叶片压力面侧流场的影响大于吸力面。同时，吹风比增大使射流与主流掺混流场区域以及射流尾迹区的范围扩大。

关键词 气膜冷却涡轮 旋转状态 静止状态 三维流场 激光粒子测速仪测量 数值计算

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Experimental Measurement and Numerical Simulation of Three-dimensional Flow Field in Rotating Film-cooled Turbine

Abstract
Numerical simulations of the three-dimensional flow field in the film-cooled turbine on the rotating and stationary conditions were carried out using k-e turbulence model, and predictions of the three-dimensional velocity were compared with the particle image velocimeter (PIV) experimental measurements. Computational results reveal the mixing flow field of the jet and the mainstream and the secondary flow near the blade surface in the wake region, and the simulations are in fairly good agreement with the experiments. Compared with the stationary condition, there are centrifugal force and Coriolis force existing in the flow field of the turbine on the rotating condition, and these forces make the three-dimensional flow field changed in the rotating turbine, especially for the radial velocity. The effect of rotation on the flow field of the pressure side is more apparent than that of the suction side in the film-cooled turbine from the computational and measured results. The increase of the blowing ratio makes the mixing region and the wake region downstream of the injection hole expanded.

Key words rotating film-cooled turbine rotating condition stationary condition three dimensional flow field particle image velocimeter measurement digital low-pass filter

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