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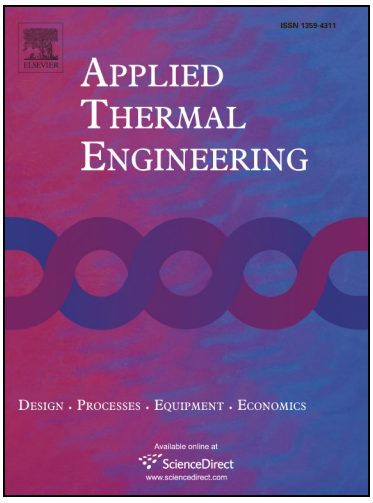

Research Paper

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Large Eddy Simulation of Film Cooling Flow from A Fanshaped Hole

Chunhua Wang[1], Jingzhou Zhang[*,1,2], Hongke Feng[1], Ying Huang[1]

1. Nanjing University of Aeronautics and Astronautics, Key Laboratory of Aero-engine Thermal Environment and Structure, Ministry of Industry and Information Technology, Nanjing, 210016, China

2. Collaborative Innovation Center of Advanced Aero-Engine, Beijing, 100191, China

Abstract: Large eddy simulation was applied for studying interaction between hot crossflow and coolant jet from a fanshaped hole. Simulations were performed at two blowing ratios, M=0.5 and 1.5, and the Reynolds number, Re=45674, based on the crossflow velocity and hole diameter. Downstream of shaped hole, plenty of hairpin vortexes distribute disorderly on the flat plate, and form 'forests of hairpin vortexes'. Roller vortexes and horseshoe vortexes are the important structures in the near filed region. Because of low jet velocity, fanshaped holes show weaker roller vortexes and horseshoe vortexes compared with round holes. In the far filed region, small-scale vortexes originating from break up of large-scale coherent structures take the dominant role. The projections of vortexes on vertical, spanwise and streamwise directions for fanshaped hole were discussed in detail. By time-frequency analysis of velocity fluctuation signals, the dominant frequency for fanshape holes is indistinct, and periodicity of film cooling of shaped holes is weaker than that of round hole.

Keywords: Film cooling; Large eddy simulation; Fanshaped hole; Coherent structures

1. Introduction

Modern gas turbines are designed to operate at high inlet temperature for high efficiency. Therefore, cooling techniques such as film cooling are often used to prevent hot-section components from failing at high temperature. In film cooling, the coolant is injected at an angle into the hot gas stream of the turbine section through small holes drilled in the surface of the blades. The coolant forms a film layer over the blade surface to protect the surface from direct exposure to the hot gas stream. Because film cooling uses bleed air from high-pressure stages in the compressor, the use of more coolant leads to the decrease of the overall engine efficiency. One approach to increase coolant efficiency is to alter the geometry of a film-cooling hole from a standard cylindrical shape to one with a diffused exit shape. The flow deceleration in the diffuser section of the hole allows the

* Corresponding author. Tel: +86 025 84892200; Fax: +86 025 84892200
Email address: zhangjz@nuaa.edu.cn (Jingzhou Zhang)