SURVEY OF NOVEL FILM COOLANT INJECTOR CONFIGURATIONS OF GAS TURBINE BLADES

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1. INTRODUCTION & OBJECTIVE

Film cooling is presently employed in all of today's gas turbine engines and is considered as an efficient method to guarantee higher performance for long duration. The importance of coolant hole geometry on film cooling performance has been noted by many researchers. Various coolant injector configurations have been developed in the past and a number of configurations are successfully accomplished. However, designing of new and novel configurations is still an open research area. The present paper reviews all major configurations proposed recently in the area of gas turbine blade cooling.

2. RESULTS AND HIGHLIGHTS OF IMPORTANT POINTS

Hybrid holes which include two consecutive film hole configurations with interior bending; louver schemes which combine the advantage of traditional design and impingement effect, holes supplemented with anti-vortex holes, holes embedded in trenches, holes with opposite orientation angles, heart-shaped holes, placing tabs/struts or vortex generation in each holes, etc. are some of the new methods proposed. These techniques may gain popularity as most of these schemes are designed to combine the advantage of traditional methods. Figure 1 shows the comparison of laterally averaged film cooling effectiveness of the novel schemes with shaped hole and circular hole at a blowing ratio of 1.0 . The three novel schemes, hybrid, anti-vortex and louver configurations provided better laterally averaged effectiveness than the shaped holes. The louver scheme provided the highest laterally averaged effectiveness compared to all other schemes because of its wide lateral exit area. Some of the encouraging results produced by the novel designs are: hybrid holes showed enhancement of cooling performance at low and high blowing ratios; louver schemes eliminated the possibility of jet lift-off; NIKOMIMI schemes, double jet schemes and anti-vortex holes produced vorticity to counter the detrimental kidney vortices from the main jet, etc. It is noted that often manufacturing constraints influence and limit the geometry of the film holes. Recently, Stimpson et al. [2016] has proposed the potential of additive manufacturing techniques for building gas turbine components. There are number of review papers available on film cooling, but none discusses the latest and novel developments on coolant hole geometry. This paper provides a review of the recently developed coolant hole configurations for gas turbine blading. This article is motivated by the key role that blade cooling play in the performance of advanced gas turbine engines.

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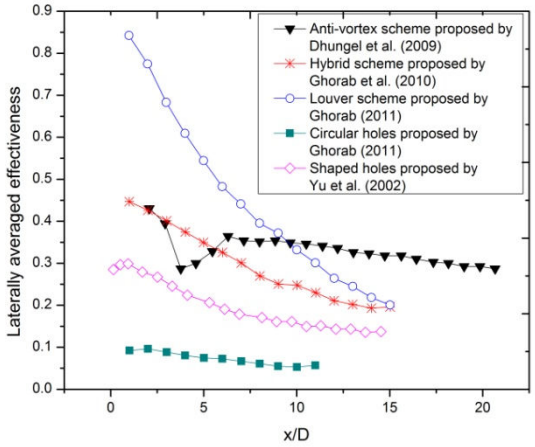

Figure 1: Comparison of various schemes at blowing ratio of 1.

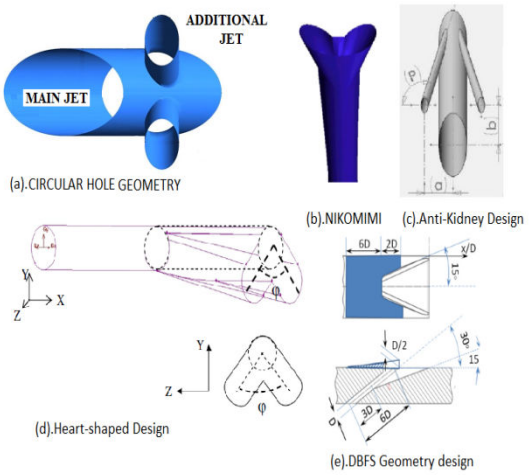

Figure 2: Different film cooling hole Geometries proposed in recent studies.

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