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# 多排反向射流角气膜冷却特性研究

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# Investigation on Characteristics of Multiple Rows of Opposite Lateral Ejection Angle Film Cooling

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摘要

借助正交试验对具有多排反向射流角气膜冷却结构的冷却特性进行了研究分析，采用Realizable $k$-$\varepsilon$湍流模型和速度分布两层模型进行模拟计算，研究了横向射流角$\beta$、开孔率$F$、长宽比$S/P$以及吹风比$M$对冷却特性的影响，并分析了其影响机理。研究结果表明：与单排双射流结构相比，多排反向射流角结构虽然涡量分布不对称，但是依靠持续的冷气注入来维持反向涡对，也可以得到理想的冷却效果。在试验参数范围内，对平均冷却效率影响程度由高到低依次为：开孔率，吹风比，长宽比，横向射流角。对平均对流换热系数影响程度由高到低依次为：吹风比，开孔率，横向射流角，长宽比。综合考虑冷却效率和换热特性，较优的结构与流动参数为$\beta$=55°、$M$=1.2、$F$=2%、$S/P$=1.4。

关键词： 正交试验 冷却 横向射流角 冷却效率 换热系数

Abstract:

An investigation on the cooling characteristics of multiple rows of opposite lateral ejection angle film cooling is conducted by means of an orthogonal numerical simulation test. The numerical simulation is conducted by a Realizable $k$-$\varepsilon$ turbulent model and a two-layer velocity zonal model using commercial numerical calculation software. The purpose of the investigation is to reveal the influence of such parameters as lateral ejection angle $\beta$, orifice coefficient $F$, length to width ratio $S/P$ and blowing ratio $M$, on film cooling. Besides, this paper also tries to find how the above parameters act on cooling respectively. The results show that, compared with the classical counter-rotating vortex pair which appears in the flow field of double-jet film cooling, the vortex pair structure in the downstream of the film-outlet of multiple-rows of opposite lateral ejection angle film cooling is asymmetrical, and cooling is maintained by ejecting cooling jets through rows of holes continuously. It is worth noting that this structure of film cooling achieves excellent cooling effect. The orifice coefficient is found to have the greatest impact on average film cooling effectiveness. Descending order of other parameters, based on their impacts on the average film cooling effectiveness, is: blowing ratio, length to width ratio, and lateral ejection angle, while descending order of the parameters, based on their influence on the heat transfer, is: $\beta$=55, $M$=1.2, $F$=2%, $S/P$=1.4.

Keywords: orthogonal test cooling lateral ejection angle film cooling effectiveness heat transfer coefficient

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