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压电风扇激励非定常流动和换热特性数值研究

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Numerical Investigation on Unsteady Flow and Heat Transfer Characteristics of Piezoelectric Fan

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摘要

利用动网格技术对压电谐振风扇产生的非定常流场进行了数值模拟,以期进一步揭示压电风扇的流场特征和换热特性。研究表明:压电风扇上下两个区域均出现涡流,涡向相反(压电风扇上方为逆时针,下方为顺时针),涡对的尺度、位置和扰动范围随时间呈周期性变化规律;时均速度并非随着与压电风扇自由端距离的增大呈现单调衰减的趋势,而是在距离压电风扇自由端距离为一倍振幅的截面上出现峰值速度最大的速度分布型,该位置正是涡环达到最大型面的瞬间涡核所处位置。涡串发展、运动过程中与周围流体发生干涉融合形成的射流起到了强化换热的效果,换热效果最好的地方不是出现在平衡位置,而是涡对破碎、流体紊流度最强的地方。

关键词： 压电风扇 非定常流场 动网格 流动特性 换热特性 数值模拟

Abstract:

A two-dimensional numerical investigation of the unsteady flow characteristics caused by a piezoelectric fan is performed by using a moving-grid technique in order to further address the flow and heat transfer characteristics. The results are as follows: two strong vortices with opposite rotating directions are observed at the trailing edge of the fan (counter-clockwise on the top side and clockwise on the bottom side). The vortical structures show cyclical variations over time in size, location and disturbance range. The time-averaged velocity does not decrease monotonically with the increase of the distance between the fan tip and the measured location. The maximum velocity appears at the position where the distance from the fan tip equals to the amplitude, and this position is also the location of the vortex core when the vortex reaches the maximum size. The vortices interfere and fuse with the surrounding fluid and form a jet in the process of development and movement, which produces an enhanced heat transfer effect on the heated wall. The lowest temperature as well as the peak convective heat transfer coefficient does not appear at the neutral position of the heated wall, but at the location corresponding to where the value of turbulent density is the largest.

Keywords: piezoelectric fan unsteady flow moving-grid flow characteristic heat transfer characteristic numerical simulation

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