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安装角对压气机叶栅气动噪声特性的影响

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Influence of Stagger Angle on Aerodynamic Sound Performance of Compressor Cascade

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摘要 基于大涡模拟(LES)和边界元方法对轴流压气机叶栅湍流流场以及流场诱导的噪声进行计算,在不同叶栅安装角下研究来流攻角和来流雷诺数对叶栅气动噪声产生、辐射的影响。研究表明:来流雷诺数不变时,同一安装角下,随着来流攻角从-5°~20°变化,叶栅监测曲线上的声压级先减小后增大,在0°来流攻角下声压级达到最小。安装角为45°时,外场总声压级随来流攻角的分布与30°安装角变化趋势相近。但安装角为60°时,总声压级的变化则明显变缓。在0°来流攻角下,总声压级比安装角为30°和45°时增加了近6 dB,但在其他正来流攻角下,变化并不明显。叶栅的最小声压值出现在弦线方向附近,安装角改变时,最小声压级出现的位置也不同。安装角不变,随着来流雷诺数的增大,叶栅表面的分离减小,损失降低。但叶栅表面的压力脉动随着来流雷诺数的增大而增大,使外场辐射噪声增加。

关键词: 压气机叶栅 安装角 来流攻角 来流雷诺数 大涡模拟 气动噪声

Abstract: The turbulent flow through an axial compressor cascade and the sound induced by the flow are computed based on a large eddy simulation(LES) model and the boundary element method. The influence of the freestream angle of attack and Reynolds number on sound generation and radiation in the cascade at different stagger angles are analyzed. The results indicate that the total sound pressure level first decreases, then increases when the stagger angle and Reynolds number are constant while the angle of attack changes from -5? to 20?. The minimum sound pressure level appears at the angle of attack of 0?. At stagger angle of 45?, the total sound pressure level of the cascade changes varying with angle of attack, the trend is similar to that of the stagger angle of 30?. However, at the stagger angle of 60?, the total sound pressure level changes more gently. At the angle of attack of 0?, the sound pressure level increases about 6 dB comparing with the case of the stagger angle of 30癮nd 45?. At other positive angles of attack, the changes are not obvious. The minimum sound pressure level appears at the direction of the cascade chord. The positions of the minimum sound pressure level vary with change of stagger angles. With a constant stagger angle, surface separation and flow loss decrease with the increase of the Reynolds number. However, the surface pressure fluctuation of cascade and the far-field radiation sound increase.

Keywords: compressor cascade stagger angle freestream angle of attack freestream Reynolds number large eddy simulation aerodynamic sound

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