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对称翼型低雷诺数小攻角升力系数非线性现象研究

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摘要 采用Rogers发展的三阶Roe格式，求解非定常不可压N-S方程，时间方向为二阶精度双时间步方法，数值模拟了对称翼型SD8020低雷诺数(Re=40000, 100000)条件下，流场层流分离涡结构和升力系数随攻角的变化. 同试验比较证明了数值模拟的正确性. 通过对数值模拟时均化流场结果的详细分析，发现对称翼型在小雷诺数0o攻角附近出现的层流分离泡，其内部结构和演化规律都不同于经典层流分离泡模型，从而提出了一种后缘层流分离泡模型. 并应用该模型对对称翼型小攻角低雷诺数流场特性以及升力系数非线性效应的形成机理进行了研究和解释.

关键词 低雷诺数,对称翼型,小攻角,非线性,后缘层流分离泡

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Study of the nonlinear lift coefficient of the symmetrical airfoil at low reynolds number near the 0o angle of attack

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Abstract

The nonlinear effect of the lift coefficient of the symmetrical airfoil near the 0° angle of attack occurs at low Reynolds number. It may be disadvantageous for control. The 3rd order Roe scheme developed by Rogers was used to solve the unsteady incompressible Navier-Stokes equations, in the temporal direction the 2nd order two-step method was accepted, to numerically simulate the flowfield laminar separation vortex structure and the lift coefficient of the symmetrical airfoil SD8020 at low Reynolds number ($Re=40\,000$, 100\,000) at different angle of attack. The correctness of the simulation was proved by comparing the present CFD results with the experiment. Through the analysis and study to the time-averaged result of the numerical simulations, the new trailing-edge laminar separation bubble model for the airfoil near the 0° angle of attack was described in this paper, which is different from the classical laminar separation bubble model both in the inner structure and the development with the angle of attack. And this model was used to study and explain the mechanisms of nonlinear effect of the lift coefficient of the symmetrical airfoil at low Reynolds number at low angle of attack.

Key words low Reynolds number symmetrical airfoil small angle of attack nonlinear effect trailing-edge laminar separation bubble

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