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可压缩多介质粘性流体和湍流的大涡模拟

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Large eddy simulation for the multi-viscosity-fluid and turbulence

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摘要 在可压缩多介质粘性流体动力学高精度计算方法MVPPM(multi-viscous-fluid piecewise parabolicmethod)基础上,引入Smagorinsky和Vreman亚格子湍流模型,采用大涡数值模拟方法求解可压缩粘性流体NS(Navier-Stokes)方程,给出适用于可压缩多介质流体界面不稳定性发展演化至湍流阶段的计算方法和二维计算程序MVFT(multi-viscosity-fluid and turbulence)。在2种亚格子湍流模型下计算了LANL(Los Ala-mos National Laboratory)激波管单气柱RM不稳定性实验,分析了气柱的形状、流场速度以及涡的特征,通过与LANL实验和计算结果的比较可知,Vreman模型略优于Smagorinsky模型,MVFT方法和计算程序可用于对界面不稳定性发展演化至湍流阶段的数值模拟。

关键词： 流体力学 大涡模拟 Navier-Stokes方程 界面不稳定性 亚格子涡粘模型

Abstract： Based on the multi-viscous-fluid piecewise parabolic method,the Smagorinsky and Vreman subgrid eddy viscosity models were employed to the Navier-Stokes equations. A two-dimensional computational code MVFT(multi-viscosity-fluid and turbulence) was developed for computing the multi-viscosity-fluids and the turbulent induced by the fluid interface instability. By applying the developed MVFT code,numerical computations were conducted by the Smagorinsky and Vreman subgrid eddy viscosity models,respectively to simulate the Richtmyer-Meshkov instability experiment of a shock-accelerated heavy gas cylinder in LANL. The heavy gas column shapes,the flow field velocities and the vortex properties were analyzed and compared with the existent experimental and calculated results. It is indicated that the Vreman subgrid eddy viscosity model is superior to the Smagorinsky's in this simulation. The developed MVFT method and code are suitable for simulating the interface instability and turbulence mixing complex process.

Keywords： fluid mechanics large eddy simulation Navier-Stokes equation interface instability subgrid eddy viscosity model

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