CFD 100 Series

An introduction to Computational Fluid Dynamics

Lecture 03:

Navier-Stokes Equations: Unsteady diffusion

1.1
有限差分法 Finite Difference Method
控制方程

$$\frac{\mathrm{d}^2 T}{\mathrm{d}^2 x} = H(T - T_\infty)$$

- 空间项：中心插分

$$\frac{\partial u}{\partial t} = \mu \frac{\partial^2 u}{\partial x^2} + S \rightarrow \frac{\partial u}{\partial t} = \mu \frac{\partial^2 u}{\partial x^2}$$

- 时间项：一阶向前插分
- 空间项：中心插分

1.1
有限差分法 Finite Difference Method
控制方程的离散

$$\frac{\partial u}{\partial t} \ ?$$

$$u_i^{n+1} = u_i^n + \Delta t \frac{\partial u}{\partial t}\Big|_i^n + \frac{\Delta t}{2}\frac{\partial^2 u}{\partial t^2}\Big|_i^n + \cdots$$

$$\frac{\partial u}{\partial t}\Big|_i^n = \frac{u_i^{n+1} - u_i^n}{\Delta t} + \mathcal{O}(\Delta t)$$

$$\frac{\partial^2 u}{\partial x^2} \ ?$$

$$\frac{\partial^2 u}{\partial x^2}\Big|_i^n = \frac{u_{i+1}^n - 2u_i^n + u_{i-1}^n}{\Delta x^2} + \mathcal{O}(\Delta x^2)$$

$$\frac{\partial u}{\partial t} = \mu \frac{\partial^2 u}{\partial x^2}$$

$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = \mu \frac{u_{i+1}^n - 2u_i^n + u_{i-1}^n}{\Delta x^2}$$

1.1

有限差分法 Finite Difference Method

控制方程的离散

$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = \mu \frac{u_{i+1}^n - 2u_i^n + u_{i-1}^n}{\Delta x^2}$$

$$u_i^{n+1} = u_i^n + \mu \frac{\Delta t}{\Delta x^2} \left(u_{i+1}^n - 2u_i^n + u_{i-1}^n\right)$$