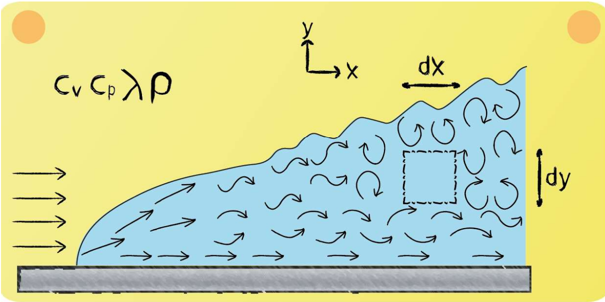
Lecture 1 - Question 10



Give the enthalpy balance to derive the first part of the energy equation. Assume two-dimensional steady state flow. Neglect kinetic and potential energy. Furthermore the control volume has the dimensions dx dy and dz and the velocities are described by u, v and w. Assume ρ, c_p, c_v, and λ to be constant.

Energy balance:

$$0 = \dot{H}_x(x) - \dot{H}_x(x+dx) + \dot{H}_y(y) - \dot{H}_y(y+dy)$$

Energy fluxes:

$$\dot{H}_x(x) = \rho \cdot c_p \cdot u \cdot T \cdot dy \cdot dz$$

$$\dot{H}_x(x+dx) = \rho \cdot c_p \cdot u \cdot T \cdot dy \cdot dz + \rho \cdot c_p \cdot \frac{\partial u \cdot T}{\partial x} dx \cdot dy \cdot dz$$

$$\dot{H}_y(y) = \rho \cdot c_p \cdot v \cdot T \cdot dx \cdot dz$$

$$\dot{H}_y\left(y+dy\right) = \rho \cdot c_p \cdot v \cdot T \cdot dx \cdot dz + \rho \cdot c_p \cdot \frac{\partial v \cdot T}{\partial y} dx \cdot dy \cdot dz$$

The total energy of a flowing fluid stream is the sum of the enthalpy, kinetic energy and potential energy. Since the potential and kinetic energy are neglected, the total energy equals the enthalpy. Since ρ, c_p, η and λ are constant, the total energy and thus the enthalpy and can be described as $H = m \cdot c_p \cdot T$.