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TEP4156 Formula sheet

$$\frac{\partial u_i}{\partial x_j} = \dot{\varepsilon}_{ij} + \dot{\Omega}_{ij}$$

$$\dot{\varepsilon}_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right)$$

$$\dot{\Omega}_{ij} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_j} - \frac{\partial u_j}{\partial x_i}\right)$$

$$(\dot{\vec{\Omega}})_k = \frac{1}{2}\epsilon_{ijk}\dot{\Omega}_{ij}$$

$$\dot{\vec{\Omega}} = \frac{1}{2}\vec{\nabla}\times\vec{u}$$

Continuity

$$\frac{D\rho}{Dt} + \rho\vec{\nabla}\cdot\vec{u} = 0$$

Momentum conservation

$$\rho\frac{Du_i}{Dt} = \frac{\partial \sigma_{ij}}{\partial x_j} + \rho f_i$$

$$\rho\frac{DE}{Dt} = \frac{\partial}{\partial x_j}(\sigma_{ij}u_i) + \rho f_i u_i - \frac{\partial q_k}{\partial x_k}$$

Total energy

$$E = e + \frac{1}{2}u_i u_i$$

$$\sigma_{ij} = -p\delta_{ij} + \sigma'_{ij}$$

Energy equation

$$\rho\frac{De}{Dt} + p\frac{\partial u_k}{\partial x_k} = \sigma'_{ij}\frac{\partial u_i}{\partial x_j} - \frac{\partial q_k}{\partial x_k}$$

Enthalpy equation

$$\rho\frac{Dh}{Dt} - \frac{Dp}{Dt} = \sigma'_{ij}\frac{\partial u_i}{\partial x_j} - \frac{\partial q_k}{\partial x_k}$$

$$\sigma'_{ij}\frac{\partial u_i}{\partial x_j} \geq 0$$

$$q_k = -k\frac{\partial T}{\partial x_k}$$

$$\sigma'_{ij} = \mu\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} - \frac{2}{3}\delta_{ij}\frac{\partial u_k}{\partial x_k}\right) + \mu_B\delta_{ij}\frac{\partial u_k}{\partial x_k}$$

$$\mathrm{Re}\to 0: \quad \vec{\nabla}p = \mu\vec{\nabla}^2\vec{u}$$

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = U\frac{dU}{dx} + \nu\frac{\partial^2 u}{\partial y^2}$$

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \frac{k}{\rho c_p}\frac{\partial^2 T}{\partial y^2}$$

Displacement thickness

$$\delta^* = \int_0^\infty \left(1 - \frac{u}{U}\right)dy$$

Momentum thickness

$$\theta = \int_0^\infty \frac{u}{U}\left(1 - \frac{u}{U}\right)dy$$

$$\psi(x,y) = \sqrt{\frac{2}{m+1}\nu x U}\, f(\eta)$$

$$\eta = y\sqrt{\frac{m+1}{2}\frac{U}{\nu x}}$$

$$f''' + ff'' + \frac{2m}{m+1}(1 - f'^2) = 0$$

$$\frac{d\theta}{dx} + \left(2 + \frac{\delta^*}{\theta}\right)\frac{\theta}{U}\frac{dU}{dx} = \frac{C_f}{2}$$