



Compressible Flow TME085

Basic Concepts

Specific Heat

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Specific Heat Relations

For thermally perfect and calorically perfect gases

$$\begin{aligned}C_p &= \frac{dh}{dT} \\C_v &= \frac{de}{dT}\end{aligned}\tag{1}$$

From the definition of enthalpy and the equation of state $p = \rho RT$

$$h = e + \frac{p}{\rho} = e + RT\tag{2}$$

Differentiate Eqn. 2 with respect to temperature gives

$$\frac{dh}{dT} = \frac{de}{dT} + \frac{d(RT)}{dT}\tag{3}$$

Inserting the specific heats gives

$$C_p = C_v + R\tag{4}$$

Dividing Eqn. 4 by C_v gives

$$\frac{C_p}{C_v} = 1 + \frac{R}{C_v}\tag{5}$$

Introducing the ratio of specific heats defined as

$$\gamma = \frac{C_p}{C_v}\tag{6}$$

Now, inserting Eqn. 6 in Eqn. 5 gives

$$C_v = \frac{R}{\gamma - 1}\tag{7}$$

In the same way, dividing Eqn. 4 with C_p gives

$$1 = \frac{C_v}{C_p} + \frac{R}{C_p} = \frac{1}{\gamma} + \frac{R}{C_p} \quad (8)$$

and thus

$$C_p = \frac{\gamma R}{\gamma - 1} \quad (9)$$