

From first law :  $Q = \Delta U + W$

$$nC_p \Delta T = nC_v \Delta T + nR \Delta T$$

dividing by  $(n \Delta T) \Rightarrow C_p = C_v + R$

or  $C_p - C_v = R$  Mayer's formula

Heat supplied ( $Q$ ) is partly utilised in  $\Delta U$  and  $W$ .

$$\frac{\Delta U}{Q} = \frac{nC_v \Delta T}{nC_p \Delta T} = \frac{C_v}{C_p} = \frac{1}{\gamma}$$

$$\Rightarrow \Delta U = \frac{Q}{\gamma}$$

Work done  $W = Q - \Delta U = Q - \frac{Q}{\gamma} = Q \left(1 - \frac{1}{\gamma}\right)$

$$W = Q \left(1 - \frac{1}{\gamma}\right)$$

For monoatomic :  $\gamma = \frac{5}{3} \Rightarrow \Delta U = \frac{3}{5} Q, W = \frac{2}{5} Q$

diatomic :  $\gamma = \frac{7}{5} \Rightarrow \Delta U = \frac{5}{7} Q, W = \frac{2}{7} Q$

polyatomic :  $\gamma = \frac{4}{3} \Rightarrow \Delta U = \frac{3}{4} Q, W = \frac{1}{4} Q$

# Chemical Engineering Thermodynamics Lecture Notes

**Shasha Hu**



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