PROPERTIES OF GASES

Equation of State

For a perfect gas: $pv = RT$

where p is pressure, N/m^2, Pa, or kPa

v is specific volume, m^3/kg

T is absolute temperature, ° K

R is the gas constant, J/kgK or kJ/kgK and $R = \mathscr{R}/M$

where $\mathscr{R}$ is the Universal Gas Constant = 8.3144 kJ/kmole K

M is the molecular weight, e.g. for air M_{air} = 28.96 kg/kmol, R_{air} = 0.2871 kJ/kgK.

Other Properties

At moderate temperatures and pressures the properties internal energy and enthaply are assumed to be independent of pressure.

$u = u(T, M)$ or for a particular gas $u = u(T)$

and $h = h(T, M)$ or $h = h(T)$

specific heats:

$c_v = du/dT$, $c_p = dh/dt$, and $c_p / c_v = \gamma$

since $h = u + pv = u + RT$, then $dh/dT = du/dT + R$. Thus $c_p = c_v + R$ and

$c_p - c_v = R$, or $R = c_p(\gamma - 1)/\gamma$.

Second Law

$Tds = dh - v\,dp$

$\therefore\ ds = dh/T - v\,dp/T = dh/T - R\,dp/p$

for an isentropic process $ds = 0$

$\therefore\ dh/T = R\,dp/p$.

This expression may be integrated to give

$$\int_{T_1}^{T_{2s}} c_p \frac{dT}{T} = R * \ln \frac{p_2}{p_1}$$

For the special case where the specific heats remain constant this equation may be written as:

$$\frac{T_{2s}}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{R}{c_p}} = \left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}}$$