Power Input Factor

The power input factor takes into account of the effect of disk friction, windage, etc. for which a little more power has to be supplied than required by the theoretical expression. Considering all these losses, the actual work done (or energy input) on the air per unit mass becomes

$$w = \Psi \sigma U_2^2 \qquad (7.1)$$

where Ψ is the power input factor. From steady flow energy equation and in consideration of air as an ideal gas, one can write for adiabatic work *w* per unit mass of air flow as

$$w = c_p(T_{0_2} - T_{0_1}) \qquad (7.2)$$

where T_{0_1} and T_{0_2} are the stagnation temperatures at inlet and outlet of the impeller, and c_p is the mean specific heat over the entire temperature range. With the help of Eq. (6.3), we can write

$$w = \Psi \sigma U_2^2 = c_p(T_{0_2} - T_{0_1}) \qquad (7.3)$$

The stagnation temperature represents the total energy held by a fluid. Since no energy is added in the diffuser, the stagnation temperature rise across the impeller must be equal to that across the whole compressor. If the stagnation temperature at the outlet of the diffuser is designated by T_{0_3} , then $T_{0_3} = T_{0_2}$. One can write from Eqn. (7.3)

$$\frac{T_{0_2}}{T_{0_1}} = \frac{T_{0_3}}{T_{0_1}} = 1 + \frac{\Psi \sigma U_2^2}{c_p T_{0_1}} \qquad (7.4)$$

The overall stagnation pressure ratio can be written as

$$\frac{p_{0_3}}{p_{0_1}} = \left(\frac{T_{0_{3s}}}{T_{0_1}}\right)^{\frac{\gamma}{\gamma-1}}$$

$$= \left[1 + \frac{\eta_c (T_{0_3} - T_{0_1})}{T_{0_1}}\right]^{\frac{\gamma}{\gamma-1}} \qquad (7.5)$$

where, $T_{0_{3s}}$ and T_{0_3} are the stagnation temperatures at the end of an ideal (isentropic) and actual process of compression respectively (Figure 7.1), and η_c is the isentropic efficiency defined as

$$\eta_c = \frac{T_{0_{3s}} - T_{0_1}}{T_{0_3} - T_{0_1}} \qquad (7.6)$$

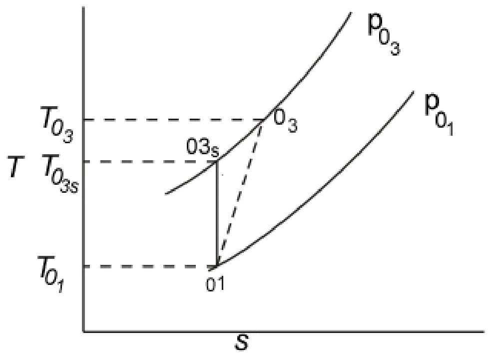

Figure 7.1 Ideal and actual processes of compression on T-s plane