Chapter 17

Compressible Flow

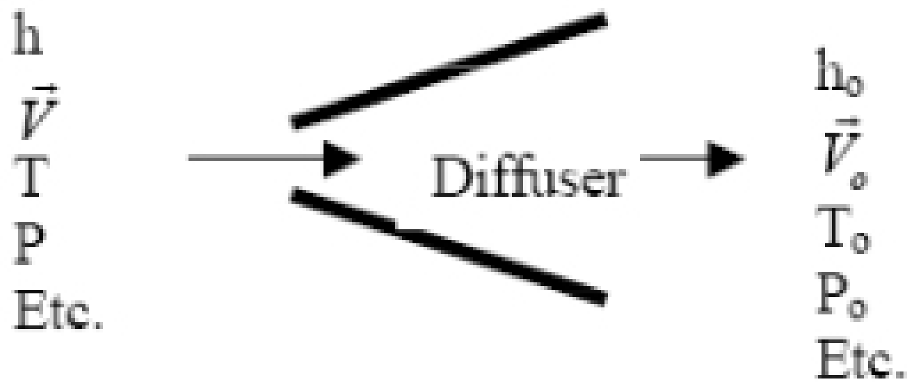
Study Guide in PowerPoint

to accompany

Thermodynamics: An Engineering Approach, 8th edition
by Yunus A. Çengel and Michael A. Boles

Stagnation Properties

Consider a fluid flowing into a diffuser at a velocity $\vec{V}$, temperature *T*, pressure *P*, and enthalpy *h*, etc. Here the ordinary properties *T*, *P*, *h*, etc. are called the static properties; that is, they are measured relative to the flow at the flow velocity. The diffuser is sufficiently long and the exit area is sufficiently large that the fluid is brought to rest (zero velocity) at the diffuser exit while no work or heat transfer is done. The resulting state is called the stagnation state.



We apply the first law per unit mass for one entrance, one exit, and neglect the potential energies. Let the inlet state be unsubscripted and the exit or stagnation state have the subscript o.

$$q_{net} + h + \frac{\vec{V}^2}{2} = w_{net} + h_o + \frac{\vec{V}_o^2}{2}$$

Since the exit velocity, work, and heat transfer are zero,

$$h_o = h + \frac{\vec{V}^2}{2}$$

The term h_o is called the stagnation enthalpy (some authors call this the total enthalpy). It is the enthalpy the fluid attains when brought to rest adiabatically while no work is done.

If, in addition, the process is also reversible, the process is isentropic, and the inlet and exit entropies are equal.

$$s_o = s$$

The stagnation enthalpy and entropy define the stagnation state and the isentropic stagnation pressure, P_o. The actual stagnation pressure for irreversible flows will be somewhat less than the isentropic stagnation pressure as shown below.