Static and Stagnation States

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Errata

I don’t proof read, so who knows!

lol

Definitions

A static state corresponds to the conditions you would measure if you moved with the fluid. (e.g. if you were able to "saddle-up" a small fluid particle and take a ride)

A stagnation state is a "reference state" which corresponds to the conditions that would exist if the fluid were brought to zero velocity and zero potential.

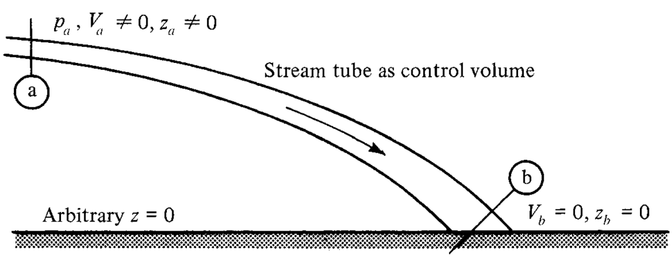
Stagnation process

To yield a consistent stagnation state, we must lay out the process by which the fluid would be brought to its stagnation state. The main characteristics of this process are as follows...

1. No energy exchange ($Q = W = 0$)
2. No losses

From the above 2 points we can see that the stagnation process is isentropic as well.

Stagnation enthalpy equation



Consider the above diagram, where fluid at (a) is brought to (b) through the stagnation process. Applying the energy equation, we see that

$$h_a + \frac{v_a^2}{2} + gz_a + q = h_b + \frac{v_b^2}{2} + gz_b + w_s$$

Removing the terms which are 0, the equation simplifies to

$$h_a + \frac{v_a^2}{2} + gz_a = h_b$$

Note that conditions at (b) represent the stagnation state corresponding to the static state of the fluid at (a). Hence, we call the enthalpy at (b) the stagnation enthalpy of (a).

$$h_{0a} = h_a + \frac{v_a^2}{2} + gz_a$$

In general,

$$h_0 = h + \frac{v^2}{2} + gz$$

With gases changes in potential are usually neglected, so we finally arrive at

$$h_0 = h + \frac{v^2}{2} \tag{1}$$

Variables

h_0	Stagnation or total enthalpy (per unit mass)