EXACT Analysis

Exact Analysis of the Carburettor :- (with Compressibility of air into consideration)

Section A-A → Point 1 — (At the inlet of the carburettor)

Section B-B → Point 2 → (Venturi Throat)

» Applying Steady flow energy Eqⁿ to section A-A & B-B §

① » Assuming unit mass flow of air ($m = 1\,kg$)

$$q - w = (h_2 - h_1) + \frac{1}{2}(C_2^2 - C_1^2)$$

Where,

② » Assuming an adiabatic flow $q = 0$ & $W = 0$

③ » ~~Assuming~~ $C_1 \approx 0$

$$C_2 = \sqrt{2(h_1 - h_2)} = \sqrt{2\Delta h}$$

Δh → Adiabatic Enthalpy change

④ » Assuming air to behave as ideal gas, $h = c_p T$

$$C_2 = \sqrt{2C_p(T_1 - T_2)}$$

⑤ » Assuming the flow to be Isentropic (1-1 to 2-2)

$$① \quad \boxed{C_2 = \sqrt{2C_p T_1\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}}$$

C_{da} → Co-eff of discharge for venturi (contraction of stream & fⁿ)

Z - Height of the nozzle exit above the level of fuel in the float chamber

Mass Flow-rate of air at Venturi Throat :

$$② \quad \boxed{m_{a_{Th}} \overset{= \rho_2 A_2 C_2}{=} \frac{A_2 P_1}{R\sqrt{T_1}}\sqrt{2C_p\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}}$$

From

$$m = \rho_1 A_1 C_1$$
$$= \rho_2 A_2 C_2$$

$$③ \quad \boxed{m_{a_{Actual}} = C_{da} \times m_{a_{Th}}}$$

or

$$\frac{P_1}{\rho_f} - \frac{P_2}{\rho_f} = \frac{C_f^2}{2} + gZ$$

$$C_f = \sqrt{2\left[\frac{P_1 - P_2}{\rho_f} - gZ\right]}$$

$$④ \quad \boxed{m_{f_{Th}} = \rho_f A_f C_f} = A_f\sqrt{2\rho_f(P_1 - P_2 - gZ\rho_f)}$$

Applying Bernoulli's Thⁿ & fuel is incompressible.