BOMBA $\quad W = Q\,(P_g + \rho g h - P_a)$

LIQUIDO $\quad \dfrac{dV}{dt} - Q + Q_b = 0 \Rightarrow \boxed{A\,\dfrac{dh}{dt} = Q - Q_b}$

BOQUILLA $\quad P_g + \rho g h = P_a + \frac{1}{2}\rho \dfrac{Q_b^2}{A_b^2}\ ; \ \boxed{P_g - P_a + \rho g h = \frac{1}{2}\rho\dfrac{Q_b^2}{A_b^2}}$

$$\boxed{A\,\frac{dh}{dt} = \frac{W}{P_g - P_a + \rho g h} - A_b\sqrt{\frac{2\,(P_g - P_a + \rho g h)}{\rho}}}\ ; \quad \begin{matrix} t=0 \\ h=0 \end{matrix}$$

VOLUMEN DE CONTROL EN GAS

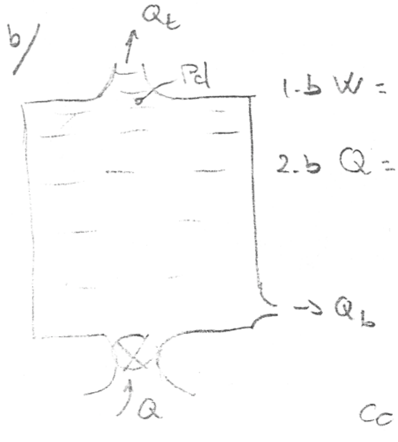
$$\frac{d}{dt}\left(V_g\,\rho_g\right) = -G\ ; \quad G = \rho_g\, a_g\, A_t\left[\left(\frac{P_g}{P_a}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]^{1/2}\left(\frac{P_g}{P_a}\right)^{-\frac{\gamma-1}{2\gamma}}\left(\frac{2}{\gamma-1}\right)^{1/2}$$

$$\frac{P_g}{\rho_g^{\gamma}} = \frac{P_a}{\rho_a^{\gamma}} \qquad = \sqrt{\gamma\,\rho_a P_a}\; A_t\left(\left(\frac{P_g}{P_a}\right)^{\frac{\gamma-1}{\gamma}} - 1\right)^{1/2}\left(\frac{2}{\gamma-1}\right)^{1/2}$$

$$\boxed{\frac{d}{dt}\left(V_g\left(\frac{P_g}{P_a}\right)^{1/\gamma}\right) = -\sqrt{\gamma\,\frac{P_a}{\rho_a}}\;A_t\left(\left(\frac{P_g}{P_a}\right)^{\frac{\gamma-1}{\gamma}} - 1\right)^{1/2}\left(\frac{2}{\gamma-1}\right)^{1/2}} \quad \begin{matrix} t=0 \\ P=P_a \end{matrix}$$

ESTADO FINAL a/ $\quad P_{gf} = P_a \Rightarrow \dfrac{W}{\rho g h_f} = A_b\sqrt{2 g h_f} \Rightarrow h_f = \left(\dfrac{W}{\rho A_b\, g^{3/2}}\right.$

b/



1.b $\quad W = Q\,(P_d + \rho g h - P_a)$

2.b $\quad Q = Q_b + Q_t\ ; \quad Q_b = \sqrt{\dfrac{2}{\rho}\,(P_d + \rho g h - P_a)}\;A_b \qquad$ 3.b

$Q_t = \sqrt{\dfrac{2}{\rho}\,(P_d - P_a)}\;A_t \qquad$ 4.b

Con 1.b, 2.b, 3.b y 4.b determinamos $Q, Q_b, Q_t,$