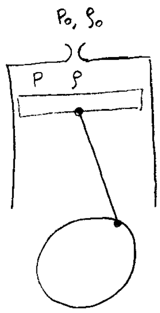

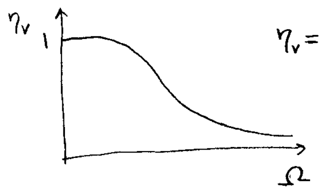

$$\eta_v = \frac{V_{ext}\rho_0}{Q\rho_F} \quad \frac{\rho_A}{\rho_0} = \frac{\rho_A}{\rho_0}(1+\alpha) - \alpha$$

MASA QUE ENTRA $(1+\alpha)Q\rho_F - \alpha Q \rho_0$

$$V = Q\left[\alpha + \operatorname{sen}\left(\frac{t}{t_A}\frac{\pi}{2}\right)\right],$$

CONTINUIDAD: $\frac{d}{dt}\int_{V_c} \rho\, dV + \int_{\Sigma_c} \rho(\bar{v}-\bar{v}_c)\cdot\bar{n}\, d\sigma = 0 \rightarrow \boxed{\frac{d}{dt}\rho V = G}$ $\qquad t=0,\ \rho=\rho_0,\ p=p_0$

ENERGIA: $\frac{d}{dt}\left[\int_{V_c}\rho e\, dV\right] + \int_{\Sigma_c}\rho\left(e+\frac{v^2}{2}\right)(\bar{v}-\bar{v}_c)\cdot\bar{n}\, d\sigma = -\int_{\Sigma_c} p\,\bar{v}\cdot\bar{n}\, d\sigma \rightarrow \frac{d}{dt}(\rho e V) = G h_0 - p\frac{dV}{dt} \rightarrow \boxed{\frac{d}{dt}(pV) = \gamma G\frac{p_0}{\rho_0} - (\gamma-1)p\frac{dV}{dt}}$

$$G = \rho_0 a_0 A_s\left(\frac{2}{\gamma-1}\right)^{1/2}\left(\frac{p}{p_0}\right)^{1/\gamma}\left[1-\left(\frac{p}{p_0}\right)^{\frac{\gamma-1}{\gamma}}\right]^{1/2} \quad \text{SI } p > p_{BS}$$

$$G = \rho_0 a_0 A_m\left(\frac{\gamma+1}{2}\right)^{-\frac{\gamma+1}{2(\gamma-1)}} \quad \text{SI } p < p_{BS}$$

DONDE p_{BS} SE OBTIENE DE SOLUCIONAR

$$\frac{A_s}{A_m} = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{2(\gamma-1)}}\left(\frac{\gamma-1}{2}\right)^{1/2}\left(\frac{p_0}{p_{BS}}\right)^{\frac{\gamma+1}{2\gamma}}\left[\left(\frac{p_0}{p_{BS}}\right)^{\frac{\gamma-1}{\gamma}}-1\right]^{-1/2}$$

UTILIZANDO COMO VARIABLES ADIMENSIONALES $\tau = \frac{t}{t_A}$, $\bar{\rho} = \frac{\rho}{\rho_0}$, $\bar{V} = \frac{V}{Q}$, $\bar{p} = \frac{p}{p_0}$ EL PROBLEMA SE REDUCE A INTEGRAR

$$\bar{V} = \alpha + \operatorname{sen}\left(\frac{\pi}{2}\tau\right) \qquad \bar{G} = \frac{G}{\rho_0 a_0 A_m}$$

$$\frac{d(\bar{\rho}\bar{V})}{d\tau} = \frac{\bar{G}}{\Omega} \quad (1) \qquad \bar{\rho}(0) = 1$$

$$\frac{1}{\gamma}\bar{V}\frac{d\bar{p}}{d\tau} = \frac{\bar{G}}{\Omega} - \bar{p}\frac{d\bar{V}}{d\tau} \quad (2) \qquad \bar{p}(0) = 1$$

ECS. DESACOPLADAS. INTEGRANDO (2) OBTENGO $\bar{p}(\tau)$ Y POR TANTO $\bar{G}$. INTEGRANDO (1) OBTENGO $\bar{\rho}_A = \bar{\rho}(1)$ Y POR TANTO $\boxed{\eta_v = \bar{\rho}_A(1+\alpha) - \alpha = \frac{1}{\Omega}\int_0^1 \bar{G}\, d\tau}$

LA SOLUCION DEPENDE DEL REGIMEN DE GIRO A TRAVES DEL PARAMETRO

$$\Omega = \frac{Q/(a_0 A_m)}{t_A}$$

$Q/(a_0 A_m) \rightarrow$ TIEMPO CARACTERISTICO DE LLENADO CON TOBERA BLOQUEADA.

$t_A \rightarrow$ TIEMPO DISPONIBLE PARA ADMISION

$$(3)\begin{cases} \bar{G} = \frac{A_s}{A_m}\left(\frac{2}{\gamma-1}\right)^{1/2}\bar{p}^{1/\gamma}\left[1-\bar{p}^{\frac{\gamma-1}{\gamma}}\right]^{1/2} & \text{SI } \bar{p} > \bar{p}_{BS} \\ \bar{G} = \left(\frac{\gamma+1}{2}\right)^{-\frac{\gamma+1}{2(\gamma-1)}} & \text{SI } \bar{p} < \bar{p}_{BS} \end{cases}$$

SI $\Omega \ll 1$ (NUMERO BAJO DE RPM)

$(2) \rightarrow \bar{G} \simeq 0 \rightarrow \boxed{\bar{p} = 1} \rightarrow$ LA PRESION EN EL CILINDRO SE MANTIENE IGUAL A LA EXTERIOR DURANTE EL PROCESO DE ADMISION.

$(1)-(2) \rightarrow \frac{d}{d\tau}(\bar{\rho}\bar{V}) = \frac{d\bar{V}}{d\tau} \rightarrow \boxed{\eta_v = \bar{\rho}_A(1+\alpha) - \alpha = 1+\alpha-\alpha = 1}$

SI $\Omega \gg 1$ (ALTO NUMERO DE RPM)

$$\Omega = \frac{\rho_0 Q}{\rho_0 a_0 A_m t_A} \gg 1$$

EN ESTE LIMITE LA MASA QUE ENTRA DURANTE EL PERIODO DE ADMISION $\sim \rho_0 a_0 A_m t_A$ ES DESPRECIABLE FRENTE A LA MASA QUE CABE $\rho_0 Q$

$(2) \rightarrow \bar{p}\bar{V}^\gamma = \alpha^\gamma$ EVOLUCION ISENTROPICA DE LA PRESION EN EL CILINDRO

$(1) \rightarrow \eta_v = \frac{1}{\Omega}\underbrace{\int_0^1 \bar{G}\, d\tau}_{f(\alpha)}$, $\bar{G} = f(\tau,\alpha)$ A TRAVES DE (3) $\boxed{1 > \bar{p}_{BS} \geq 0.528}$

$\tau_{BS} = \frac{2}{\pi}\operatorname{arcsen}\left[\alpha\left(\bar{p}_{BS}^{-1/\gamma}-1\right)\right] \sim \alpha$

COMO $\alpha \ll 1$ LA TOBERA ESTA CASI SIEMPRE BLOQUEADA Y TENEMOS $\eta_v \simeq \left(\frac{\gamma+1}{2}\right)^{-\frac{\gamma+1}{2(\gamma-1)}}\Omega^{-1}$

$$\boxed{\tau_{BS} \leq 0.368\alpha}$$

SI $\frac{A_s}{A_m} = 3$, $\alpha = 0.1$, $\bar{p}_A = \left(\frac{\alpha}{1+\alpha}\right)^\gamma$

$\bar{p}_{BS} = \frac{1}{1.027} = 0.9737$, $\bar{V}_{BS} = \alpha\,\bar{p}_{BS}^{-1/\gamma} = 0.1019$,

$\bar{p}_{OCS} = \frac{1}{2.65} = 0.377$, $\bar{V}_{OCS} = 0.2$

$\bar{p}_{AD} = \frac{1}{21.2} = 0.0472$, $\bar{V}_{AD} = 0.886$

$\tau_{BS} = \frac{2}{\pi}\operatorname{arcsen}(\bar{V}_{BS}-\alpha) = 0.00122$

$\tau_{OCS} = 0.0638$

$\tau_{AD} = 0.576$

$\bar{\tau}_1 = 0.03$, $\bar{V}_1 = 0.147$, $\bar{p}_1 = 0.583 \rightarrow$ OC NORMAL. $\rightarrow \frac{p_{02}}{p_0} = 0.63$, $M_{OC} = 2.2$, $\frac{A}{A_m} = 2.005$

$\bar{\tau}_2 = 0.2$, $\bar{V}_2 = 0.410$, $\bar{p}_2 = 0.139 \rightarrow$ OC. OBLICUA EN SALIDA $\rightarrow \frac{\bar{p}_2}{\bar{p}_{AD}} = 2.94$, $M_{N_{OC}} = 1.63$, $\beta = \operatorname{arcsen}\left(\frac{M_{N_{OC}}}{2.65}\right) = 38$, $\delta = 17$

$\bar{\tau}_3 = 0.7$, $\bar{V}_3 = 0.991$, $\bar{p}_3 = 0.040 \rightarrow$ EXPANSION $\rightarrow M_1 = 2.65$, $M_2 = 2.75$ $\quad \nu(2.75) - \nu(2.65) = 2.16°$