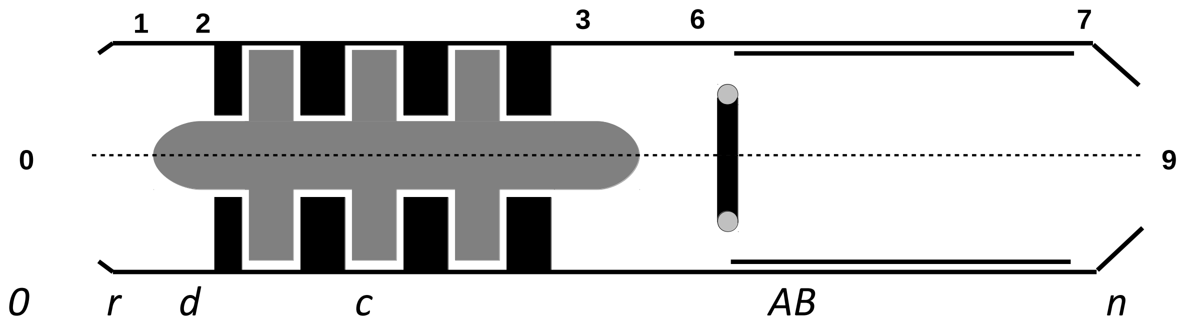
Modelo de Fan Híbrido Marciano (Fan elétrico mais pós-queimador bipropelente)
"Mars motorjet"



$$R_c = \frac{\gamma_c - 1}{\gamma_c} c_{pc}$$

$$R_{AB} = \frac{\gamma_{AB} - 1}{\gamma_{AB}} c_{pAB}$$

$$a_0 = \sqrt{\gamma_c R_c T_0}$$

$$V_0 = a_0 M_0$$

Difusor:

$$\tau_r = 1 + \frac{\gamma_c - 1}{2} M_0^2$$

$$\pi_r = \tau_r^{\frac{\gamma_c}{\gamma_c - 1}}$$

$$\pi_d = \pi_{dmax}\, \eta_r$$

$$\tau_{\lambda AB} = \frac{c_{pAB} T_{t7}}{c_{pc} T_0}$$

$$\tau_{\lambda P} = \frac{c_{pP} T_{tP}}{c_{pc} T_0}$$

Compressor (Electric FAN):

Razão de compressão de cada estágio do compressor (π_{ce}) do FAN e o número de estágios (n_e).

$$\pi_c = \pi_{ce}^{n_e} \qquad \tau_c = \pi_c^{(\gamma_c - 1)/\gamma_c e_c}$$

$$\eta_c = \frac{\pi_c^{(\gamma_c-1)/\gamma_c} - 1}{\tau_c - 1}$$

Potência elétrica requerida, onde η_e é a eficiência do motor elétrico e seu controlador:

$$\dot{W} = \frac{1}{\eta_e}\dot{m}_0 c_{pc}(T_{t3} - T_{t2}) = \frac{1}{\eta_e}\dot{m}_0 c_{pc} T_0 \tau_r \tau_d (\tau_c - 1)$$

Tubeira, na seção de saída:

$$\frac{P_{t9}}{P_9} = \frac{P_0}{P_9}\pi_r \pi_d \pi_c \pi_{AB} \pi_n$$

$$c_{p9} = c_{pAB} = \frac{(\dot{m}_0 c_{pc} + \dot{m}_P c_{pP})}{(\dot{m}_0 + \dot{m}_P)} = \frac{(c_{pc} + f_{AB} c_{pP})}{(1 + f_{AB})} \cong c_{pc}$$

$$R_9 = R_{AB}$$

$$\gamma_9 = \gamma_{AB}$$

Condições de saída do gerador de gás (*subscrito P*), resultado da queima de combustível e oxidante, injetados no pós-queimador (*subscrito AB*).

$$\dot{m}_9 c_{pAB} T_{t7} = \dot{m}_0 c_{pc} T_{t3} + \dot{m}_P c_{pP} T_{tP}$$

$$(\dot{m}_0 + \dot{m}_P) c_{pAB} T_{t7} = \dot{m}_0 c_{pc} T_{t3} + \dot{m}_P c_{pP} T_{tP}$$

$$(\dot{m}_0 + \dot{m}_P) c_{pAB} T_{t7} = \dot{m}_0 c_{pc} T_{t3} + \dot{m}_P c_{pP} T_{tP}$$

$$(1 + f_{AB})\frac{c_{pAB} T_{t7}}{c_{pc} T_0} = \frac{T_{t3}}{T_0} + f_{AB}\frac{c_{pP} T_{tP}}{c_{pc} T_0}$$

$$f_{AB} = \frac{\tau_r \tau_d \tau_c - \tau_{\lambda AB}}{\tau_{\lambda AB} - \tau_{\lambda P}}$$

$$\frac{T_9}{T_0} = \frac{T_{t7}/T_0}{T_{t9}/T_9} = \frac{T_{t7}/T_0}{\left(\frac{P_{t9}}{P_9}\right)^{(\gamma_9-1)/\gamma_9}}$$

$$M_9 = \sqrt{\frac{2}{\gamma_9 - 1}\left[\left(\frac{P_{t9}}{P_9}\right)^{(\gamma_9-1)/\gamma_9} - 1\right]}$$

$$\frac{V_9}{a_0} = M_9\sqrt{\frac{\gamma_9 R_9 T_9}{\gamma_c R_c T_0}}$$

$$\frac{F}{\dot{m}_0} = a_0\left[(1 + f_{AB})\frac{V_9}{a_0} - M_0 + (1 + f_{AB})\frac{R_9}{R_c}\frac{T_9/T_0}{V_9/a_0}\frac{1 - P_0/P_9}{\gamma_c}\right]$$

$$S = \frac{f_{AB}}{F/\dot{m}_0}$$

$$\eta_P = \frac{2V_0(F/\dot{m}_0)}{a_0^2[(1 + f_{AB})(V_9/a_0)^2 - M_0^2]}$$

$$\eta_T = \frac{a_0^2[(1 + f_{AB})(V_9/a_0)^2 - M_0^2]}{2f_{AB}h_{PR}} \qquad \eta_0 = \eta_P\eta_T$$

Para determinação da *Vazão Mássica de Saída* utilizando-se o parâmetro de fluxo de massa e sabendo a área de saída (A_9):

$$MFP_9 = \frac{M_9\sqrt{\gamma_9/R_9}}{\{1 + [(\gamma_9 - 1)/2]M_9^2\}^{(\gamma_9+1)/[2(\gamma_9-1)]}}$$

$$\dot{m}_9 = MFP_9\frac{A_9 P_{t9}}{\sqrt{T_{t9}}}$$

$$\dot{m}_9 = \dot{m}_0(1 + f_{AB}) \Longrightarrow \dot{m}_0 = \frac{\dot{m}_9}{(1 + f_{AB})}$$