Données:

> *restart*

Point d'adaptation (Z = 22000 m):

Caractéristiques de l'air:

> $T_a := 218.65;\ P_a := 4000;$

$$T_a := 218.65$$
$$P_a := 4000 \tag{1.1.1}$$

Nombre de Mach de vol:

> $Ma := 2.2;$

$$Ma := 2.2 \tag{1.1.2}$$

Paramètres moteurs:

Débit d'air:

> $m_a := 25$

$$m_a := 25 \tag{1.2.1}$$

Rapport de compression:

> $\tau_c := 6$

$$\tau_c := 6 \tag{1.2.2}$$

Température devant turbine:

> $T_{o4} := 1250$

$$T_{o4} := 1250 \tag{1.2.3}$$

Température de post-combustion:

> $T_{o5p} := 1500$

$$T_{o5p} := 1500 \tag{1.2.4}$$

Différents rendements:

Diffuseur d'entré:

> $\eta_d := 0.87$

$$\eta_d := 0.87 \tag{1.3.1}$$

Compresseur:

> $\eta_c := 0.88$

(1.3.2)

$$\eta_c := 0.88 \tag{1.3.2}$$

Chambre de combustion:

> $\eta_{ch} := 0.98$

$$\eta_{ch} := 0.98 \tag{1.3.3}$$

Turbine:

> $\eta_t := 0.93$

$$\eta_t := 0.93 \tag{1.3.4}$$

Tuyère d'éjection:

> $\eta_R := 0.97$

$$\eta_R := 0.97 \tag{1.3.5}$$

Post-combustion:

> $\eta_{pc} := 0.98$

$$\eta_{pc} := 0.98 \tag{1.3.6}$$

Caractéristiques thermodynamiques :

Chaleur spécifique de l'air:

> $C_p := 1008.7$

$$C_p := 1008.7 \tag{1.4.1}$$

Chaleur spécifique des gaz:

> $C_{pg} := 1354.9$

$$C_{pg} := 1354.9 \tag{1.4.2}$$

Chaleur spécifique du fuel:

> $C_{pf} := 2000$

$$C_{pf} := 2000 \tag{1.4.3}$$

Température du fuel:

> $Tf := 303$

$$Tf := 303 \tag{1.4.4}$$

Pouvoir calorifique du fuel:

> $Q_R := 43920000$

$$Q_R := 43920000 \tag{1.4.5}$$

Rapport des chaleurs massiques de l'air:

> $g := 1.4$

$$g := 1.4 \tag{1.4.6}$$

Rapport des chaleurs massiques des gaz:

> $gg := 1.315$

$$gg := 1.315 \tag{1.4.7}$$

Pertes:

Pertes Mécaniques :

> $DPm := 0.05$

$$DPm := 0.05 \tag{1.5.1}$$

Pertes dans la chambre de combustion :

> $DPch := 0.045$

$$DPch := 0.045 \tag{1.5.2}$$

(1.5.3)

Conditions amonts:

> $q_a := \sqrt{(\mathrm{g}-1)\cdot C_p\cdot T_a}\cdot Ma$

$$q_a := 653.4440801 \tag{2.1}$$

> $\rho_a := \dfrac{\mathrm{g}\cdot P_a}{C_p\cdot(\mathrm{g}-1)\cdot T_a}$

$$\rho_a := 0.06347702044 \tag{2.2}$$

> $P_{oa} := P_a\cdot\left(1+\dfrac{(g-1)\cdot Ma^2}{2}\right)^{\frac{g}{g-1}}$

$$P_{oa} := 42770.84404 \tag{2.3}$$

> $T_{oa} := T_a\cdot\left(1+\dfrac{(g-1)\cdot Ma^2}{2}\right)$

$$T_{oa} := 430.3032000 \tag{2.4}$$

> $\rho_{oa} := \dfrac{P_{oa}\cdot g}{C_p\cdot(g-1)\cdot T_{oa}}$

$$\rho_{oa} := 0.3448889406 \tag{2.5}$$

Entrée diffuseur:

> $q_1 := q_a$

$$q_1 := 653.4440801 \tag{3.1}$$

> $P_{o1} := P_{oa}$

(3.2)

$$P_{o1} := 42770.84404 \quad (3.2)$$

> $T_{o1} := T_{oa}$

$$T_{o1} := 430.3032000 \quad (3.3)$$

> $\rho_{o1} := \rho_{oa}$

$$\rho_{o1} := 0.3448889406 \quad (3.4)$$

Sortie diffuseur - Entrée compresseur:

> $P_{o2} := P_a \cdot \left(1 + \frac{(g-1)\cdot Ma^2 \cdot \eta_d}{2}\right)^{\frac{g}{g-1}}$

$$P_{o2} := 33939.52104 \quad (4.1)$$

> $T_{o2} := T_{oa}$

$$T_{o2} := 430.3032000 \quad (4.2)$$

> $\rho_{o2} := \frac{g \cdot P_{o2}}{C_p \cdot (g-1) \cdot T_{o2}}$

$$\rho_{o2} := 0.2736762794 \quad (4.3)$$

Sortie compresseur - Entrée chambre de combusttion:

> $Wc := \frac{C_p \cdot T_{o2} \cdot \left(\tau_c^{\frac{g-1}{g}} - 1\right)}{\eta_c}$

$$Wc := 3.297327761\ 10^5 \quad (5.1)$$

> $Pc := Wc \cdot m_a$

$$Pc := 8.243319402\ 10^6 \quad (5.2)$$

> $P_{o3} := \tau_c \cdot P_{o2}$

$$P_{o3} := 2.036371262\ 10^5 \quad (5.3)$$

> $T_{o3} := T_{o2} \cdot \left(1 + \frac{\left(\tau_c^{\frac{g-1}{g}} - 1\right)}{\eta_c}\right)$

$$T_{o3} := 757.1920433 \quad (5.4)$$

$$\rho_{o3} := \frac{g \cdot P_{o3}}{C_p \cdot (g-1) \cdot T_{o3}}$$

$$\rho_{o3} := 0.9331617768 \tag{5.5}$$

Sortie chambre de combustion - Entrée turbine:

$$P_{o4} := P_{o3} \cdot (1 - DPch)$$

$$P_{o4} := 1.944734555\ 10^5 \tag{6.1}$$

$$\rho_{o4} := \frac{gg \cdot P_{o4}}{C_{pg} \cdot (gg-1) \cdot T_{o4}}$$

$$\rho_{o4} := 0.4793561176 \tag{6.2}$$

$$mf := \frac{m_a \cdot (C_{pg} \cdot T_{o4} - C_p \cdot T_{o3}) - C_{pf} \cdot Tf}{Q_R \cdot \eta_{ch} - C_{pg} \cdot T_{o4}}$$

$$mf := 0.5475512320 \tag{6.3}$$

$$f := \frac{mf}{m_a}$$

$$f := 0.02190204928 \tag{6.4}$$

$$\tau_d := \frac{1}{\left(1 - \frac{C_p \cdot T_{oa} \cdot \left(\tau_c^{\frac{g-1}{g}} - 1\right)}{\eta_c \cdot \eta_t \cdot C_{pg} \cdot (1+f) \cdot T_{o4} \cdot (1 - DPm)}\right)^{\frac{gg}{gg-1}}}$$

$$\tau_d := 2.756486454 \tag{6.5}$$

$$Wt := \left(C_{pg} \cdot \eta_t \cdot T_{o4}\right) \cdot \left(1 - \tau_d^{\frac{1-gg}{gg}}\right)$$

$$Wt := 3.396481426\ 10^5 \tag{6.6}$$

$$Pt := Wt \cdot (m_a + mf)$$

$$Pt := 8.677178323\ 10^6 \tag{6.7}$$

Sortie turbine - Entrée tuyère:

$$P_{o5} := \frac{P_{o4}}{\tau_d}$$

(7.1)

$$P_{o5} := 70551.21030 \quad \textbf{(7.1)}$$

$$> T_{o5} := T_{o4} \cdot \left(1 - \eta_t \cdot \left(1 - \tau_d^{\frac{1-gg}{gg}}\right)\right)$$

$$T_{o5} := 999.3186636 \quad \textbf{(7.2)}$$

$$> \rho_{o5} := \left(gg * P_{o5}\right) / \left(C_{pg} \cdot (gg - 1) \cdot T_{o5}\right)$$

$$\rho_{o5} := 0.2175246237 \quad \textbf{(7.3)}$$

Sortie tuyère:

$$> P_6 := P_a$$

$$P_6 := 4000 \quad \textbf{(8.1)}$$

$$> T_6 := T_{o5} \cdot \left(1 - \eta_R \cdot \left(1 - \left(\frac{P_6}{P_{o5}}\right)^{\frac{gg-1}{gg}}\right)\right)$$

$$T_6 := 517.3933119 \quad \textbf{(8.2)}$$

$$> \rho_6 := \frac{gg \cdot P_a}{C_{pg} \cdot (gg - 1) \cdot T_6}$$

$$\rho_6 := 0.02382029508 \quad \textbf{(8.3)}$$

$$> P_{o6} := P_a \cdot \left(1 - \eta_R \cdot \left(1 - \left(\frac{P_a}{P_{o5}}\right)^{\frac{gg-1}{gg}}\right)\right)^{\frac{gg}{1-gg}}$$

$$P_{o6} := 62446.60840 \quad \textbf{(8.4)}$$

$$> T_{o6} := T_{o5}$$

$$T_{o6} := 999.3186636 \quad \textbf{(8.5)}$$

$$> \rho_{o6} := \frac{gg \cdot P_{o6}}{C_{pg} \cdot (gg - 1) \cdot T_{o6}}$$

$$\rho_{o6} := 0.1925363851 \quad \textbf{(8.6)}$$

$$> me := m_a + mf$$

$$me := 25.54755123 \quad \textbf{(8.7)}$$

$$> q_6 := \sqrt{2 \cdot C_{pg} \cdot T_{o5} \cdot \eta_R \cdot \left(1 - \left(\frac{P_a}{P_{o5}}\right)^{\frac{gg-1}{gg}}\right)}$$

$$q_6 := 1142.769145 \quad \textbf{(8.8)}$$

> $Po := m_a \cdot \left((1+f) \cdot q_6 - q_a \right)$

$$Po := 12858.85127 \quad (8.9)$$

Poussée et consommation spécifiques:

> $Fma := \frac{Po}{m_a}$

$$Fma := 514.3540508 \quad (9.1)$$

> $Cs := \frac{3600 \cdot mf}{Po}$

$$Cs := 0.1532939758 \quad (9.2)$$

Différents rendements:

> $\eta_{th} := \frac{(1+f) \cdot {q_6}^2 - {q_a}^2}{2 \cdot f \cdot Q_R}$

$$\eta_{th} := 0.4717219311 \quad (10.1)$$

> $\eta_p := \frac{2 \cdot Po \cdot q_a}{m_a \cdot \left((1+f) \cdot {q_6}^2 - \left({q_a}^2 \right) \right)}$

$$\eta_p := 0.7406916372 \quad (10.2)$$

> $\eta_g := \eta_{th} \cdot \eta_p$

$$\eta_{1.4} := 0.3494004894 \quad (10.3)$$

Combustion dans la tuyère de ralonge:

> $P_{o5p} := P_{o5}$

$$P_{o5p} := 70551.21030 \quad (11.1)$$

> $\rho_{o5p} := \frac{gg \cdot P_{o5p}}{C_{pg} \cdot (gg-1) \cdot T_{o5p}}$

$$\rho_{o5p} := 0.1449176109 \quad (11.2)$$

> $mfp := \frac{\left(m_a + mf \right) \cdot C_{pg} \cdot \left(T_{o5p} - T_{o5} \right)}{\left(\eta_{pc} \cdot Q_R \right) + \left(C_{pf} \cdot Tf \right) - \left(C_{pg} \cdot T_{o5p} \right)}$

$$mfp := 0.4164524452 \quad (11.3)$$

> $fp := \frac{mfp}{m_a + mf}$

$$fp := 0.01630107095 \quad (11.4)$$

Sortie tuyère de rallonge:

> $P_{6p} := P_a;$

$$P_{6p} := 4000 \quad (12.1)$$

> $T_{6p} := T_{o5p} * \left(1 - \eta_R * \left(1 - \left(P_{6p} / P_{o5p}\right)^{(gg-1)/gg}\right)\right);$

$$T_{6p} := 776.6191066 \quad (12.2)$$

> $\rho_{6p} := \left(gg * P_{6p}\right) / \left(C_{pg} * (gg - 1) * T_{6p}\right);$

$$\rho_{6p} := 0.01586937696 \quad (12.3)$$

> $P_{o6p} := P_{6p} * \left(1 - \eta_R * \left(1 - \left(P_{6p} / P_{o5p}\right)^{(gg-1)/gg}\right)\right)^{gg/(1-gg)};$

$$P_{o6p} := 62446.60840 \quad (12.4)$$

> $T_{o6p} := T_{o5p};$

$$T_{o6p} := 1500 \quad (12.5)$$

> $\rho_{o6p} := \left(gg * P_{o6p}\right) / \left(C_{pg} * (gg - 1) * T_{o6p}\right);$

$$\rho_{o6p} := 0.1282701354 \quad (12.6)$$

> $q_{6p} := \sqrt{2 * C_{pg} * T_{o5p} * \eta_R * \left(1 - \left(P_{6p} / P_{o5p}\right)^{(gg-1)/gg}\right)};$

$$q_{6p} := 1400.077692 \quad (12.7)$$

> $Pp := \left(\left(m_a + mf + mfp\right) * q_{6p} - \left(m_a * q_a\right)\right);$

$$Pp := 20015.52035 \quad (12.8)$$

Poussée et consommation spécifiques:

> $Fmap := \left(Pp / m_a\right);$

$$Fmap := 800.6208140 \quad (13.1)$$

> $Csp := 3600 * (mf + mfp) / Pp;$

$$Csp := 0.1733861112 \quad (13.2)$$

Différents rendements:

> $\eta_{thp} := \dfrac{\left(\dfrac{(m_a + mf + mfp) \cdot q_{6p}^2}{2} - \dfrac{m_a \cdot q_a^2}{2}\right)}{(mf + mfp) \cdot Q_R}$

$$\eta_{thp} := 0.4749796519 \quad \textbf{(14.1)}$$

> $\eta_{pp} := (Pp * q_a) / ((m_a + mf + mfp) * q_{6p}^2/2 - (m_a * q_a^2/2));$

$$\eta_{pp} := 0.6503681820 \quad \textbf{(14.2)}$$

> $\eta_{gp} := \eta_{thp} * \eta_{pp};$

$$\eta_{gp} := 0.3089116527 \quad \textbf{(14.3)}$$

>

Gains:

> $Gp := (Pp - Po) / Po;$

$$Gp := 0.5565558641 \quad \textbf{(15.1)}$$

> $Gcs := (Csp - Cs) / Cs;$

$$Gcs := 0.1310693085 \quad \textbf{(15.2)}$$

>