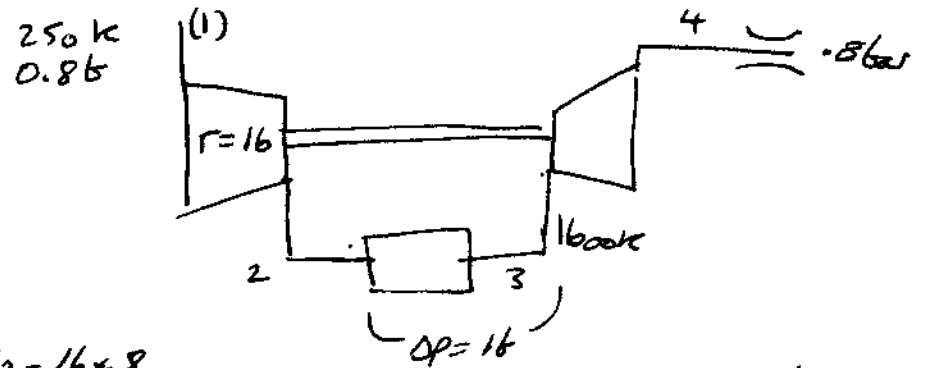
Q7 2001



$p_2 = 16 \times 8$

$p_2 = 12.8$ bar

$p_3 = 12.8$ bar

$T_2' = 250 \times 16^{\frac{\gamma-1}{\gamma}}$ $\quad \gamma = 1.39$

$T_2' = 250 \times 16^{.280} = 544.2\,K$

$\eta_{is} = 0.88 = \dfrac{544.2 - 250}{T_2 - 250}$ $\quad T_2 = 584.3K$

$P(in) = mC_p\Delta T = 1 \times 1.03(584.3 - 250)$

$P(in) = 344.3\ kJ/kg$

TURBINE $\quad P(out) = mC_p\Delta T = P_{in}$

$344.3 = 1 \times 1.19 \times (1600 - T_4)$ $\quad T_4 = \underline{1310.67K}$

THIS IS THE ACTUAL TEMP

$\eta_{is} = 0.9 = \dfrac{1600 - 1310.7}{1600 - T_4'}$ $\quad T_4' = 1278.6K$

$\dfrac{T_4'}{T_3} = \left(\dfrac{P_4}{11.8}\right)^{\frac{\gamma-1}{\gamma}} = \dfrac{1278.6}{1600} = 0.8 = \left(\dfrac{P_4}{11.8}\right)^{0.248}$

$P_4 = 11.8 \times 0.8^{1/.248} = 11.8 \times .398 = \underline{4.76bar}$

NOZZLE $\Gamma = \frac{P_4 \uparrow}{P_1 \downarrow} = \frac{4.7 \uparrow}{0.8 \uparrow} = 5.875 = 0.17$

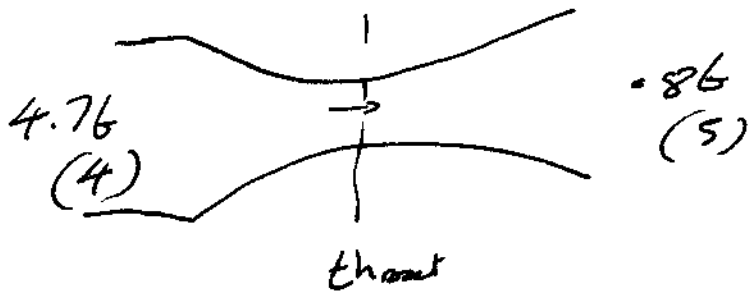
If the nozzle is choked

$$\Gamma_c = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{2}{1.34+1}\right)^{\frac{1.34}{0.34}} = (.855)^{3.94}$$

$\Gamma_c = 0.5386$ $\quad p = .5386 \times 4.7 =$

Hence nozzle is choked

Exit velocity is sonic Looks like A Conv/Div NOZZLE



$$C_p T_4 = C_p T_5 + \frac{u^2}{2}$$

$$T_5' = T_4 \left(\frac{4.7}{.8}\right)^{\frac{\gamma-1}{\gamma}} = 1310.67 \left(\frac{1}{5.875}\right)^{.254}$$

$$= 836.3K$$

$\eta_{1,5} = 0.92 = \frac{1310.67 - T_5}{1310.67 - 836.3}$

$T_5 = 874.3K$

$1.14 \times 10^{-3} \times 1310.67 = 1.14 \times 10^{-3} \times 874.3 + \frac{u^2}{2}$

$u = 997.5$ m/s

Momentum Thrust

$$F = \dot{m}\,\Delta V$$
$$= 1020 \times (997.5 - 250)$$
$$= 74.75\,kN$$