

3.8

$$C_F = \left[ \frac{2r^2}{r+1} \left( \frac{2}{r+1} \right)^{\frac{r+1}{r-1}} \left\{ 1 - \left( \frac{P_e}{P_c} \right)^{\frac{r-1}{r}} \right\} \right]^{\frac{1}{2}} + \left( \frac{P_e}{P_c} - \frac{P_a}{P_c} \right) \frac{A_e}{A^*}$$

$$\frac{A^*}{A_e} = \left( \frac{r+1}{2} \right)^{\frac{1}{r-1}} \left( \frac{P_c}{P_e} \right)^{\frac{r}{r-1}} \left[ \frac{r+1}{r-1} \left\{ 1 - \left( \frac{P_e}{P_c} \right)^{\frac{r-1}{r}} \right\} \right]^{\frac{1}{2}}$$

here

$$r = 1.22$$

$$P_c = 50 \text{ atm} \quad P_{SL} = 1 \text{ atm}$$

$$P_a = P_{SL} e^{-\frac{h}{7000}} = e^{-\frac{h}{7000}} \text{ atm}$$

will have 3 cases

1) design for 10,000 m

$$P_e = (P_a)_{10000} = e^{-\frac{10000}{7000}}$$

2) design for 20,000 m

$$P_e = (P_a)_{20000} = e^{-\frac{20000}{7000}}$$