5.19 CONSIDER A TURBOFAN:

$\gamma = 1.4$, $T_0 = 215\ K$, $C_p = 1000\ \frac{J}{kg \cdot K}$, $h = 4.43(10)^7$

$\tau_\lambda = 7$, $\tau_{\lambda_{AB}} = \tau_{\lambda_{AB}} = 8$, $\pi_c = 15$, $\pi_{c'} = 2.0$, $M_0 = 2.5$

a) FIND α^*, $\frac{F}{\dot{m}_c + \dot{m}_f}$, S^* (ASSUME AFTERBURNERS OFF)

FROM EQ. 5.94 IN OATES:

$$\alpha^* = \frac{1}{\tau_{c'} - 1}\left[\frac{\tau_\lambda}{\tau_r}(1 - \tau_t^*) - (\tau_c - 1)\right]$$

WHERE

$$\tau_t^* = \frac{1}{\tau_r \tau_c} + \frac{1}{4\tau_\lambda}\left[(\tau_r \tau_{c'} - 1)^{1/2} + (\tau_r - 1)^{1/2}\right]^2$$

$$\tau_r = 1 + \frac{\gamma - 1}{2}(2.5)^2 = 2.25 \qquad \tau_c = 15^{\frac{\gamma-1}{\gamma}} = 2.168 \qquad \tau_{c'} = 2.0^{\frac{\gamma-1}{\gamma}} = 1.22$$

$$\tau_t^* = \frac{1}{(2.168)(2.25)} + \frac{1}{4(7)}\left[((2.25)(1.22) - 1)^{1/2} + (2.25 - 1)^{1/2}\right]^2$$

$$\tau_t^* = 0.417$$

$$\alpha^* = \frac{1}{1.22 - 1}\left[\frac{7}{2.25}(1 - 0.417) - (2.168 - 1)\right] = \underline{\underline{2.94}}$$

AT THIS BYPASS RATIO:

$$a_0 = \sqrt{\gamma R T} = \sqrt{1.4(287)(215)} = 293.92\ \frac{m}{s}$$

$$\frac{F}{\dot{m}_c + \dot{m}_f} = \frac{293.92}{1 + 2.94}\left\{\left[\frac{2}{\gamma - 1}\frac{7}{(2.25)(2.168)}\left((2.25)(2.168)(0.417) - 1\right)\right]^{1/2} - 2.5\right.$$

$$\left. + 2.94\left(\left[\frac{2}{\gamma - 1}\left((2.25)(1.22) - 1\right)\right]^{1/2} - 2.5\right)\right\} = \underline{\underline{116.24}}\ \frac{N \cdot s}{kg}$$

$$f^* = \frac{(1000)(215)}{4.43(10)^7}\left(7 - 2.25(2.168)\right) = 0.0103$$

$$S^* = \frac{f(10)^6}{(1 + \alpha)\left(\frac{F}{\dot{m}_c + \dot{m}_f}\right)} = \frac{0.0103(10)^6}{(1 + 2.94)(116.24)} = \underline{\underline{22.49}}\ \frac{m_f}{N \cdot s}$$

b) FIND $\frac{F}{\dot{m}_c + \dot{m}_f}$ AND S^* FOR THE CONDITIONS ABOVE PLUS AFTERBURNING:

(1) CORE AB:

USING THE GENERAL EQN. FOR AN AB TURBOFAN:

$$\frac{F}{\dot{m}_c + \dot{m}_f} = \frac{293.92}{1 + 2.94}\left\{\left[\frac{2}{\gamma - 1}\frac{8}{(2.25)(2.168)(0.417)}\left(2.25(2.168)(0.417) - 1\right)\right]^{1/2} - 2.5\right.$$

$$\left. + 2.94\left[\left[\frac{2}{\gamma - 1}\left(2.25(1.22) - 1\right)\right]^{1/2} - 2.5\right]\right\}$$

$$\frac{F}{\dot{m}_c + \dot{m}_f} = \underline{\underline{294}}\ \frac{N \cdot s}{kg}$$

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