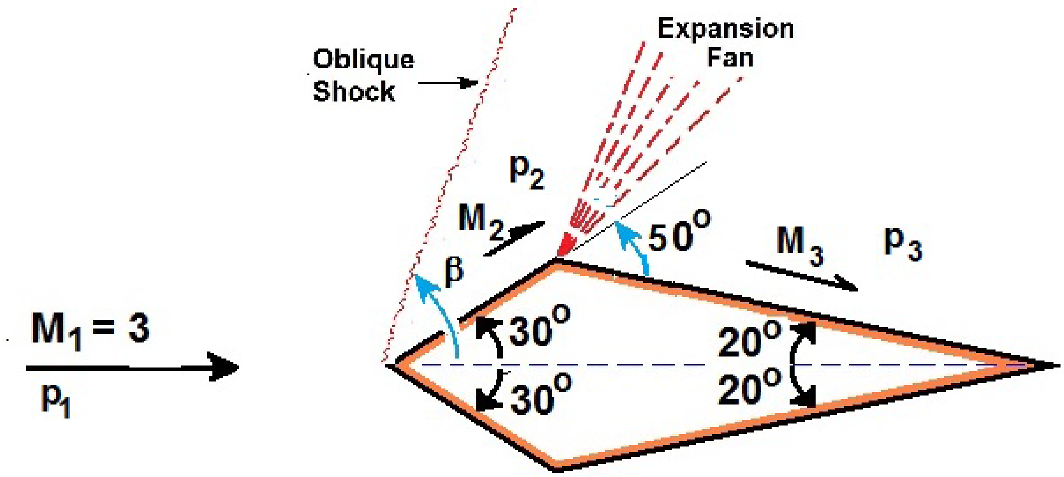
Solution to Problem 352F:



From the oblique shock graph for $M_1 = 3$ and $\theta = 30°$, we learn that $\beta = 52°$ and therefore $M_1 \sin\beta = 2.364$. Then using the normal shock wave table we find $M_2 \sin(\beta - \theta) = 5.28$ and so $M_2 = 1.41$ and $p_2/p_1 = 6.35$.

Then shifting attention to the Prandtl-Meyer fan at the shoulder, from the Prandtl-Meyer function table, $\nu(1.41) = 9.25°$, and since the angle of turn is $50°$, it follows that $\nu(M_3) = 59.25°$ and therefore from the Prandtl-Meyer function table, $M_3 = 3.55$. Moreover, from the isentropic flow table

$$\frac{p_2}{p_{02}} \; = \; 0.310 \quad \text{and} \quad \frac{p_3}{p_{02}} \; = \; 0.012 \tag{1}$$

where p_{02} is the reservoir pressure for regions 2 and 3 (not equal to p_1). It follows that

$$\frac{p_3}{p_2} \; = \; 0.039 \quad \text{and} \quad \frac{p_3}{p_1} \; = \; 0.248 \tag{2}$$

Denoting the frontal projected area by A the drag is $(p_2 - p_3)A$ and the drag coefficient, C_D, becomes

$$C_D \; = \; \frac{2p_1}{\rho_1 u_1^2}\left[\frac{p_2}{p_1} - \frac{p_3}{p_2}\frac{p_2}{p_1}\right] \; = \; \frac{2}{\gamma M_1^2}\left[\frac{p_2}{p_1} - \frac{p_3}{p_2}\frac{p_2}{p_1}\right] \tag{3}$$

and therefore

$$C_D \; = \; \frac{2}{1.4 \times 9}\,(6.35 - 6.35 \times 0.039) \; = \; 0.969 \tag{4}$$