

PROBLEM 12.71

PROBLEM: The airplane, at constant speed, is shown with its air streamlines and its lift coefficient C_L and drag coefficient C_D indicated. The free stream flow is also indicated.

Given: Conditions for the flow, lift coefficient, drag coefficient, wing area, free stream velocity. Find an equation relating the lift-to-drag ratio.

Assumptions: 1. A constant velocity.

Relationships: The lift coefficient is defined by $C_L = \frac{L}{\frac{\rho}{2} V_\infty^2 A}$ and the drag coefficient is defined by $C_D = \frac{D}{\frac{\rho}{2} V_\infty^2 A}$. There is no change in circulation.



Relationship: The lift-to-drag ratio is

$$\begin{aligned} \frac{L}{D} &= \frac{C_L \left(\frac{\rho}{2} V_\infty^2 A \right)}{C_D \left(\frac{\rho}{2} V_\infty^2 A \right)} = \frac{C_L}{C_D} \left[\frac{\frac{\rho}{2} V_\infty^2 A}{\frac{\rho}{2} V_\infty^2 A} \right] \\ &= \frac{C_L}{C_D} \quad \text{Eq. 1} \end{aligned}$$

The lift-to-drag ratio is related to the lift-to-drag ratio by

$$\begin{aligned} \frac{L}{D} &= \frac{C_L}{C_D} \left(\frac{\rho}{2} V_\infty^2 A \right) \left(\frac{1}{\frac{\rho}{2} V_\infty^2 A} \right) \\ &= \frac{C_L}{C_D} \quad \text{Eq. 2} \end{aligned}$$

Eq. 1: The change in lift-to-drag ratio is related to the change in lift-to-drag ratio by

$$\frac{L}{D} = \frac{C_L}{C_D} \left(\frac{\rho}{2} V_\infty^2 A \right)$$

Eq. 2: The change in lift-to-drag ratio is related to the change in lift-to-drag ratio by

$$\begin{aligned} \frac{L}{D} &= \frac{C_L}{C_D} \left(\frac{\rho}{2} V_\infty^2 A \right) \\ &= \frac{C_L}{C_D} \left(\frac{\rho}{2} V_\infty^2 A \right) \left[\frac{\frac{\rho}{2} V_\infty^2 A}{\frac{\rho}{2} V_\infty^2 A} \right] = \frac{C_L}{C_D} \left(\frac{\rho}{2} V_\infty^2 A \right) \\ &= \frac{C_L}{C_D} \quad \text{Eq. 3} \end{aligned}$$

$$\frac{L}{D} = \frac{C_L}{C_D} \quad \text{Eq. 4}$$

1. For part (a), the lift-to-drag ratio is constant.

Fundamentals Of Thermodynamics 5th Edition Solution Manual

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