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Thermodynamics | (6th Edition)

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Chapter 17, Problem 26P

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Problem

The Airbus A-340 passenger plane has a maximum takeoff weight of about 260,000 kg, a length of 64 m, a wing span of 60 m, a maximum cruising speed of 945 km/h, a seating capacity of 271 passengers, maximum cruising altitude of 14,000 m, and a maximum range of 12,000 km. The air temperature at the cruising altitude is about -60°C . Determine the Mach number of this plane for the stated limiting conditions.

Step-by-step solution

Step 1 of 3

Given data

Maximum Speed of airbus

$$\begin{aligned} V_{\max} &= 945 \text{ km/h} \\ &= 945 \times \frac{1000}{3600} \text{ m/s} \\ &= \frac{945}{3.6} \text{ m/s} \\ &= 262.5 \text{ m/s} \end{aligned}$$

Air temperature $T = -60^{\circ}\text{C}$

$$\begin{aligned} &= -60 + 273 \\ &= 213 \text{ K} \end{aligned}$$

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Step 2 of 3

{From tables of Ideal-gas specific heats of various common gases}

Specific heat ratio $k = 1.4$ Gas constant $R = 0.287 \text{ kJ/kg}\cdot\text{K}$

Assume air has ideal gas behavior at specified conditions

Speed of sound in air at 213 K

$$\begin{aligned} c &= \sqrt{kRT} \\ c &= \sqrt{1.4 \times 287 \times 213} \text{ m/sec} \\ c &= \sqrt{85583.4} \text{ m/sec} \\ c &= 292.55 \text{ m/s} \end{aligned}$$

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We know Mach number $Ma = \frac{V_{max}}{c}$

$$Ma = \frac{262.5}{292.55}$$

$$Ma = 0.897$$

The speed of airplane is subsonic because $Ma < 1$

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Chapter 17, Problem 107P

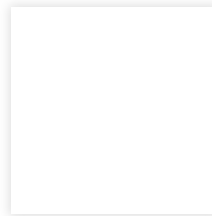
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Chapter 17, Problem 134P

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