Thermodynamics | (6th Edition)

Chapter 17, Problem 26P | 1 Bookmark | Show all steps: ON

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 crusing 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

$$V_{max} = 945 \text{ km/h}$$

$$= 945 \times \frac{1000}{3600} \text{ m/s}$$

$$= \frac{945}{3.6} \text{ m/s}$$

$$= 262.5 \text{ m/s}$$

Air temperature $T = -60\ ^0C$

$$= -60 + 273$$

$$= 213 \text{ K}$$

Comment

Step 2 of 3

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

Specific heat ratio $k = 1.4$

Gas constant $R = 0.287 \text{ kJ/kg.K}$

Assume air has ideal gas behavior at specified conditions

Speed of sound in air at 213 K

$$c = \sqrt{kRT}$$

$$c = \sqrt{1.4 \times 287 \times 213} \text{ m/sec}$$

$$c = \sqrt{85583.4} \text{ m/sec}$$

$$c = 292.55 \text{ m/s}$$

Comment

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

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

$$\boxed{Ma = 0.897}$$

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

Comment

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Recommended solutions for you in Chapter 17

Chapter 17, Problem 107P

Compressed air from the compressor of a gas turbine enters the combustion chamber at T1 = 550 K, P1 = 600 kPa, and Ma1 = 0.2 at...

See solution

Chapter 17, Problem 134P

Using the EES software and the relations in Table A-33, calculate the one-dimensional normal shock functions for an ideal gas...

See solution

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