Solutions Manual

Internal Combustion Engines:
Applied Thermosciences
(Fourth Edition)

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June 1, 2020

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Chapter 1

Introduction to Internal Combustion Engines

1.1) Compute the mean piston speed, bmep (bar), torque (Nm), and the power per piston area for the engines listed in Table 1.2.

Engine	Bore (mm)	Stroke (mm)	Cylinders	Speed (rpm)	Power (kW)
Marine	136	127	12	2600	1118
Truck	108	95	8	6400	447
Airplane	86	57	8	10500	522

Table 1.2 Engine Data for Homework Problems

a)

$$\overline{U}_p = 2Ns$$

$$\begin{aligned}\overline{U}_p &= 2{\cdot}2600\frac{\text{rev}}{\text{min}} \cdot \frac{\text{min}}{60\text{s}} \cdot 0.127 = 11.01\,\text{m/s} \\ &= 2{\cdot}6400 \cdot \frac{1}{60} \cdot 0.095 = 20.27\,\text{m/s} \\ &= 2{\cdot}10{,}500 \cdot \frac{1}{60} \cdot 0.057 = 19.95\,\text{m/s}\end{aligned}$$

b)

$$\begin{aligned}\text{bmep} &= \frac{2\dot{W}}{V_d N} = \frac{2\dot{W}}{n_c\left(\frac{\pi}{4}\right)(b)^2(s)(N)} \\ &= \frac{2 \cdot 1118}{12\left(\frac{\pi}{4}\right)(0.136)^2(0.127)\left(\frac{2600}{60}\right)} = 2.33 \times 10^3\,\text{kPa} = 23.3\,\text{bar} \\ &= \frac{2 \cdot 447}{8\left(\frac{\pi}{4}\right)(0.108)^2(0.095)\left(\frac{6400}{60}\right)} = 1.20 \times 10^3\,\text{kPa} = 12.0\,\text{bar} \\ &= \frac{2 \cdot 522}{8\left(\frac{\pi}{4}\right)(0.086)^2(0.057)\left(\frac{10{,}500}{60}\right)} = 2.25 \times 10^3\,\text{kPa} = 22.5\,\text{bar}\end{aligned}$$

c)

$$\begin{aligned}\tau &= \frac{\dot{W}}{2\pi N} \\ &= \frac{(1118)\,(1000)}{(2\pi)\left(\frac{2600}{60}\right)} = 4106.0\,\text{Nm} \\ &= \frac{(447)\,(1000)}{(2\pi)\left(\frac{6400}{60}\right)} = 667.0\,\text{Nm} \\ &= \frac{(522)\,(1000)}{(2\pi)\left(\frac{10500}{60}\right)} = 474.7\,\text{Nm}\end{aligned}$$

d)

$$\begin{aligned}\frac{\text{Power}}{\text{Piston Area}} &= \frac{\dot{W}}{n_c\left(\frac{\pi}{4}\right)(b)^2} \\ &= \frac{(1118)}{12\left(\frac{\pi}{4}\right)(0.136)^2} = 6413\,\text{kN/m}^2 \\ &= \frac{(447)}{8\left(\frac{\pi}{4}\right)(0.108)^2} = 6099\,\text{kN/m}^2 \\ &= \frac{(522)}{8\left(\frac{\pi}{4}\right)(0.086)^2} = 11{,}233\,\text{kN/m}^2\end{aligned}$$