

Thermodynamics II

Examples (Reciprocating Internal Combustion Engines)

1. A 2 stroke oil engine operates by an ideal diesel cycle with the condition at the beginning of compression at 100 kPa and 290 K. Compression ratio is 16 and heat is supplied for $1/8$ of the power stroke. Find
 - a. Maximum temperature of cycle
 - b. Air standard thermal efficiency
 - c. The power of the engine operating at 800 rpm with indicated mean effective pressure 83% of the theoretical value, 86% mechanical efficiency, 2 cylinders with 114 mm bore and 152 mm stroke.
2. A 4 stroke, 6 cylinder gas engine produces 5.2 kN.m of torque at 360 rpm. Bore and stroke are 270 mm and 350 mm respectively. Indicator diagrams for each cylinder are the same with 1590 mm² area, 60 mm length, and spring constant of 0.23 bar/mm. Volumetric ratio of fuel to air is 1:9 and the calorific value of the fuel is 18000 kJ/m³. Volumetric efficiency is estimated to be 80%. Find the mechanical efficiency and brake thermal efficiency.
(89.2%, 33.97%)
3. A V-8, 4 stroke petrol engine produces 186.5 kW at 4400 rpm. At this speed, the brake thermal efficiency and volumetric efficiency are estimated at 32% and 69% respectively. Taking the lower calorific value of the fuel as 44200 kJ/kg, free air condition as 1.013 bar and 15°C, and air to fuel ratio to be 12:1 by mass, find
 - a. Total displacement volume (total engine capacity)
 - b. Bore and stroke dimensions, given the stroke to bore ratio to be 0.8
(5.105 liters, 100.5 mm, 80.4 mm)
4. A 4 stroke, 5 cylinder diesel engine is fitted to a dynamometer with arm of R=80 cm length. Testing at speed N=480 rpm gives a load reading of W=5.6 kN. Free air condition is 1.013 b, 27°C. The bore and stroke are 260 mm and 320 mm respectively.
 - a. Find the brake mean effective pressure.
 - b. If the specific fuel consumption is 0.23 kg/kW.hr, what is the brake thermal efficiency? Take the lower calorific value of fuel as 43200 kJ/kg.
 - c. Find the volumetric efficiency, if the air-fuel ratio is 24.5 by mass
(6.62 b, 36.23%, 88.2%)