Agricultural and Biosystems Engineering, Iowa State University Spring 2007

Homework 1

Question 1: A tractor is traveling at 5 mph while pulling a ripper that exerts a force of 10000 lb.

(a). Calculate the drawbar power.

(b). If 65% of the power available at engine flywheel is available at the drawbar and the engine is operationg at 2000 rpm, determine the Engine Brake Power and torque required to pull this ripper under these conditions.

(c).If the mechanical efficiency of the engine is 0.75 and indicated thermal efficiency of the engine is 0.55, determine the fuel consumed operating 8 hours in the field under these conditions. (You may assume H_g = 19000 BTU/ lb fuel)

Question 2: An four-cycle engine is tested on a dynamometer. The engine is running at 2400 rpm and the load torque is 450 N.m. The engine consumes 25 liters/h of fuel. The fuel density is 836 kg/m^3 and the higher heating value of the fuel H_g is 45000 kJ/kg.

(a). Calculate the brake power.

(b). Determine the fuel equivalent power.

(c). Calculate the brake specific fuel consumption.

(d). Determine the brake thermal efficiency.

Question 3: An four cycle engine with a displacement of 10.455l produces 670 N.m of torque at a speed of 2100 rpm. A pressure transducer was used to measure the indicated mean effective pressure which was 1000 kPa.

(a). Calculate the indicated power.

(b). Calculate the brake power.

(c). Calculate the friction power.

(d). Determine brake mean effective pressure.

(e). Determine friction mean effective pressure.

(f). Consider if a two-cycle engine was used instead of the four-cycle engine. If the indicated mean effective pressure was identical at 2100 rpm. Would the two-cycle engine indicated power be twice or half that of the four-cycle engine? Give your reason.

(g). For the following parameters which can be physically measured and which can only be calculated from other measured parameters; indicated power, brake power, friction power, indicated mean effective pressure, brake mean effective pressure and friction mean effective pressure.

Question 4: During a test, a four-cycle engine with a displacement of 955 in^3, consumes 19 gal/h of diesel fuel while running at 2100 rpm, producing a torque of 870 ft.lb. Then a motoring dynamometer was used turn the engine at 2100 rpm, without the engine firing. The torque required to turn the engine was 165 ft.lb. Given that the fuel density was 7 lb/gal and the heating value of the fuel was 19500 BTU/lb.

(a). Calculate the fuel equivalent power.

(b). Calculate the indicated power.

(c). Calculate the brake power.

(d). Calculate the friction power.

(e). Calculate the indicated thermal efficiency, the mechanical efficiency and the brake thermal efficiency.

(f). Determine Brake Specific Fuel Consumption.

Question 5: An four-cycle engine with a displacement of 5.866l, consumes 19 kg/h of fuel and 413 kg/h of air running under full load at 2400 rpm. The ambient density of air during the test was 1.22 kg/m^3

(a). Calculate the theoretical air consumption.

(b). Determine the volumetric efficiency.

(c). The Air to Fuel Ratio.

(d). If you had to guess, do you think this is naturally aspirated (no turbo charger) or turbo charged engine? Explain your reason.

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Question 6

Consider the dual cycle shown in the figure below. Given:

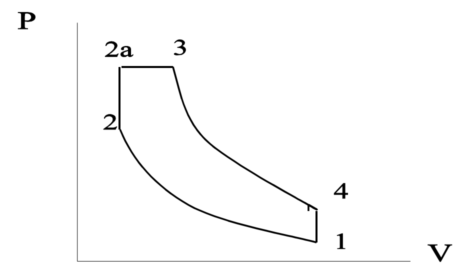
k=1.4,

Cv = 0.719 kJ/kg.ºK

T1 = 25C

P1 = 101 kPa

Engine Compression Ratio = 15:1



The injection cycle of this diesel engine is such that 500 kJ/kg of energy is added under constant volume and 1000 kJ/kg of additional fuel energy added between point 2a and point 3.

a). Calculate the temperatures and pressures at all points in the cycle.

b). Determine fuel cutoff ratio.

c). Determine the net work for the cycle.

d). Calculate the indicated thermal efficiency for the cycle.

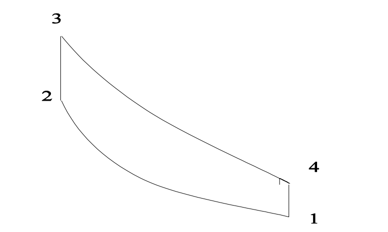
Question 7 Consider the standard Otto cycle shown with the following conditions:

P1 = 101 kPa T1 = 25 C

P2 = 1540 kPa

P3 = 8100 kPa

k= 1.4 Cv = 0.719 kJ/kg.ºK



Apparent Molecular Weight Air = 29

a). Calculate compression ratio for the engine to the nearest integer value.

b). Calculate the all unknown temperatures and pressure at points in the cycle.

c) Determine the energy input into the cycle under constant volume process 2-3

d). Determine the net work per unit mass of air for the cycle

e). Calculate the indicated thermal efficiency for the cycle.