16.050 Thermal Energy

Recitation #7 – Fall 2002

Problem 1:

An ideal dual combustion cycle, or dual cycle, consists of the following 5 processes (plus the intake and exhaust strokes):

1 => 2 Adiabatic and reversible compression
2 => 3 Constant volume heat addition
3 => 4 Constant pressure heat addition
4 => 5 Adiabatic and reversible expansion
5 => 1 Constant volume heat rejection

State 1 for a dual combustion engine is P_1=1 bar and T_1=330 K; r=18; at the end of the constant volume combustion process, P_3=75 bar; r_c=1.5. Assume 1 kg of perfect gas air is the working fluid with cp=1 kJ/kgK.

a) Sketch the P-V diagram for the cycle.
b) Find P, V, and T for states 1-5.
c) Determine the work output of the cycle.
d) Find the thermal efficiency of the cycle.

Problem 2:

The following device operates at steady-state and is well insulated. Air enters at one location and exits at another with a mass flow rate of 10 kg/s. Assuming perfect gas behavior and negligible potential energy effects, determine the direction of the air flow and the direction of the power flow. Determine the power in kW. Assume cp=1000 J/kgK for air. (Hint: it might be useful to initially assume directions of the different energy fluxes and then to check for consistency.)