Homework Assignment #6

1. Exactly .655 grams of rape methyl ester (form of biodiesel fuel) is burned in a bomb calorimeter like the one shown in the video. It has an energy equivalent of 2425 cal/C. The initial temperature was 20.122 C and the final temperature was 22.755 C. The correction factor for the heat of combustion of the fuse wire was 20 cal. Based on these data, determine the gross heat of combustion (higher heating value) in MJ/kg. How does this compare with #2 diesel fuel (42 MJ/kg)?

2. Sketch and label the following thermodynamic processes on enthalpy-temperature or internal energy-temperature diagrams (as appropriate). Use a separate diagram for each case. Clearly label reactant and product conditions on each diagram as well as the direction of the process path. For each process, specify (a) what initial conditions/inputs must be provided, (b) what resulting reaction quantity of interest can be calculated, (c) what thermodynamic constraints/assumptions apply, and (d) why you chose each diagram as well as why you drew each process path.

   CASE 1: reaction occurring within a bomb calorimeter
   CASE 2: reaction occurring in a highly conductive, non-insulated piston/cylinder
   CASE 3: reaction associated with ideal combustion event in an Otto engine
   CASE 4: reaction associated with ideal combustion event in a Diesel engine

3. Set up equations and describe the solution process you would use to determine fuel composition and equivalence ratio for an alcohol fuel given that the following exhaust dry gas fractions: CO2, CO, O2, H2, N2. Note that this is a rich mixture. Assume that exhaust gas temperature is known and show how the water-gas shift reaction helps you close the system of equations.

4. Explain the various trends in concentration of each species in Figure 3-10 (N2, O2, NO, CO2, CO, H, OH, H2, and H2O. In particular, discuss impacts of equivalence ratio and temperature as well as chemical reaction between different species.

5. Prepare a Powerpoint deck of 6-8 slides about your literature review project. Begin with a title slide that has a specific and descriptive title for your presentation. Include an introductory slide on why you selected this topic/why you find it interesting. Walk through your inquiry questions providing slides with appropriate titles, bullets/talking points, and graphics (including attribution of sources for these graphics). Conclude the package with a summary of insights gained and a complete listing of your sources. Submit this package as a PDF.