## Hydrogen Fuel Cell Problems

1) Explain why the hydrogen fuel cell vehicle is not as efficient as the reported "tank to wheel" efficiencies would suggest.

   Hydrogen must be produced, stored, and transported. None of these processes are 100% efficient and will thus have energy losses. These losses are due to heat and leaking of hydrogen in the atmosphere. Additionally it takes power to produce hydrogen and power production is only 35% efficient.

2) Gasoline has an energy density of 34.2 MJ/L or 46.4MJ/kg, and liquid hydrogen 10.1MJ/L or 143MJ/kg. How much energy is in a 50L tank of gasoline? How much energy is in a 50L tank of hydrogen? How much larger would a tank of hydrogen need to be to have the same amount of energy? What is the mass of the 50L gasoline tanks and the hydrogen tank of equivalent energy?

   (50L) * (34.2MJ/L) = 1710MJ
   (50L) * (10.1MJ/L) = 505MJ
   (X) * (10.1MJ/L) = 1710MJ  X = 169L = 45gal
   (1710MJ) / (46.4MJ/kg) = 36.9kg
   (1710MJ) / (143MJ/kg) = 12.0kg

## Biofuel Problems

1) If one acre of land can yield 7,110 pounds of corn, which can be processed into 328 gallons of ethanol, what is the pounds of corn per gallon yield of ethanol? A flex-fuel SUV has a 25 gallon tank. Its sustainably-minded owner has decided to use E85 ethanol to fill the tank. How many pounds of corn were needed to produce the ethanol needed to fill the tank of this SUV?
   a. Pounds of corn per gallon yield of ethanol:

      7110 pounds corn/328 gallons ethanol = 21.7 pounds corn/gallon ethanol

      b. E85 is 85% ethanol; 25 gallons * .85 = 21.25 gallons of ethanol

         21.25 gallons of ethanol * 21.7 pounds corn/gallon ethanol = 461 pounds of corn

2) If 450 pounds of corn will provide enough calories to feed one person for one year, how long would the corn used to fill the tank of the SUV in the previous problem have provided caloric intake for one person? What ethical issues does this situation raise?

   1 yr/person/450pounds of corn * 461 pounds of corn = 1.02 yrs

**Electric Vehicle Problems**

1) The all-electric Tesla Roadster requires 0.177 kWh / mile. You commute 20miles per day, 5 days a week, and 50 weeks per year.

   a. How much energy is consumed commuting for a whole year?

   b. If power cost $0.12/kWh, how much does the Tesla cost to drive for a year?

   c. If your current car gets 30mpg and gas cost $3/gallon, how much would the same yearly commute cost?

   a. 0.177 kWh/mile * 20miles * 5days * 50weeks = 885kWh/yr

   b. 885kWh * $0.12/kWh = $106.20/yr

   c. 20mile * 250 days = 5000miles/yr  5000miles / 30mpg = 166.67gallons

   166.67 gallons * $3/gal = $500/yr

2) Considering what you know about the pros and cons of electric vehicles (energy requirements, range restrictions, emissions, recharge time, acceleration/performance, battery life, etc.) would you consider an electric vehicle for your next car purchase? Would you be willing to pay more upfront for electric, or how much cheaper would an electric vehicle need to be for you to buy it? Write a short paragraph explaining your decision and what factors most influence your opinion.

What do you consider to be the ethical choice for an engineer concerned about the environmental, societal, and economic impact of their decisions?