ME 18b, HW 7

Due Tuesday June 2, 2009 (accepted until 4 pm)

Note: This homework is due on a Tuesday not a Thursday

TAs for HW #7:
Dan Alvarez, Sunday 8-10 pm, SFL 229;
Mary Dorman, Monday 7-9 pm, SFL 331

Number of classes attended: _____

Hours spent on homework: _____

1. **Fuels and Combustion Processes** A sample of pine park has the following ultimate analysis on a dry basis, percent by mass: 5.6% H, 53.4% C, 0.1% S, 0.1% N, 37.9% O and 2.9% ash. This bark will be used as a fuel by burning it with 100% theoretical air in a furnace. Determine the air-fuel ratio on a mass basis.

2. Enthalpy of Combustion: On many weekends Ashley Force Hood drives her car for just 4.5 seconds. In her car, the engine turns at 8000 rpm and has a displacement of 500 in^3 and a compression ratio of 7.5. Because she likes a lot of power, she has a supercharger on the engine that raises the intake pressure on the cylinders to 5 atm. She prefers to burn nitromethane in the car claiming it provides more power than gasoline even though the enthalpy of combustion for nitromethane is about -10.5 MJ/kg while that of gasoline is about -44.5 MJ/kg. Find out why nitro gives more power than gasoline in this application by computing the following:

The mass flow rate of air for the engine in kg/sec

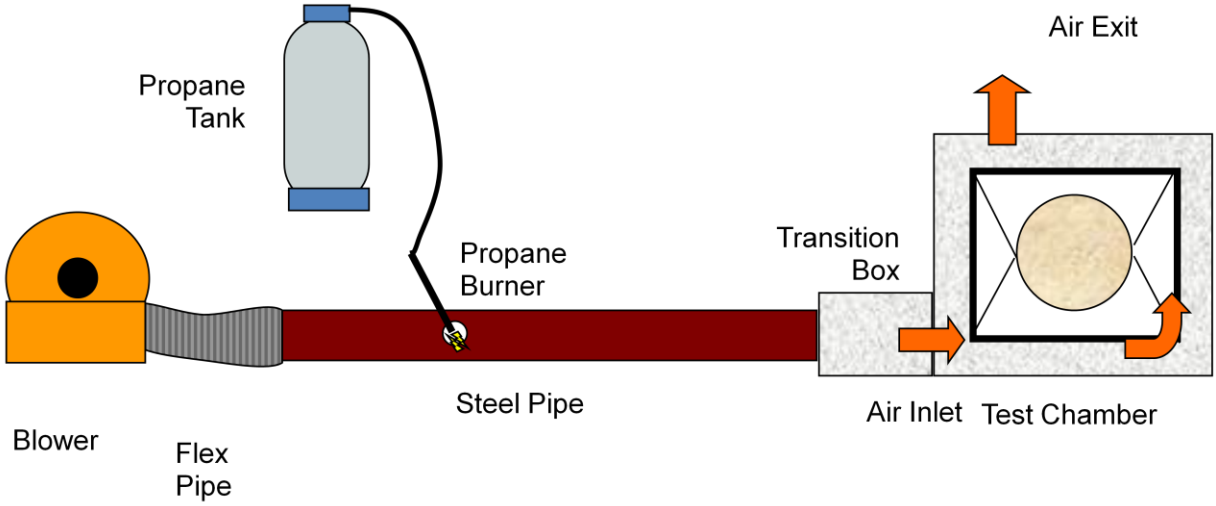
The theoretical air/fuel ratio for both nitromethane and gasoline.

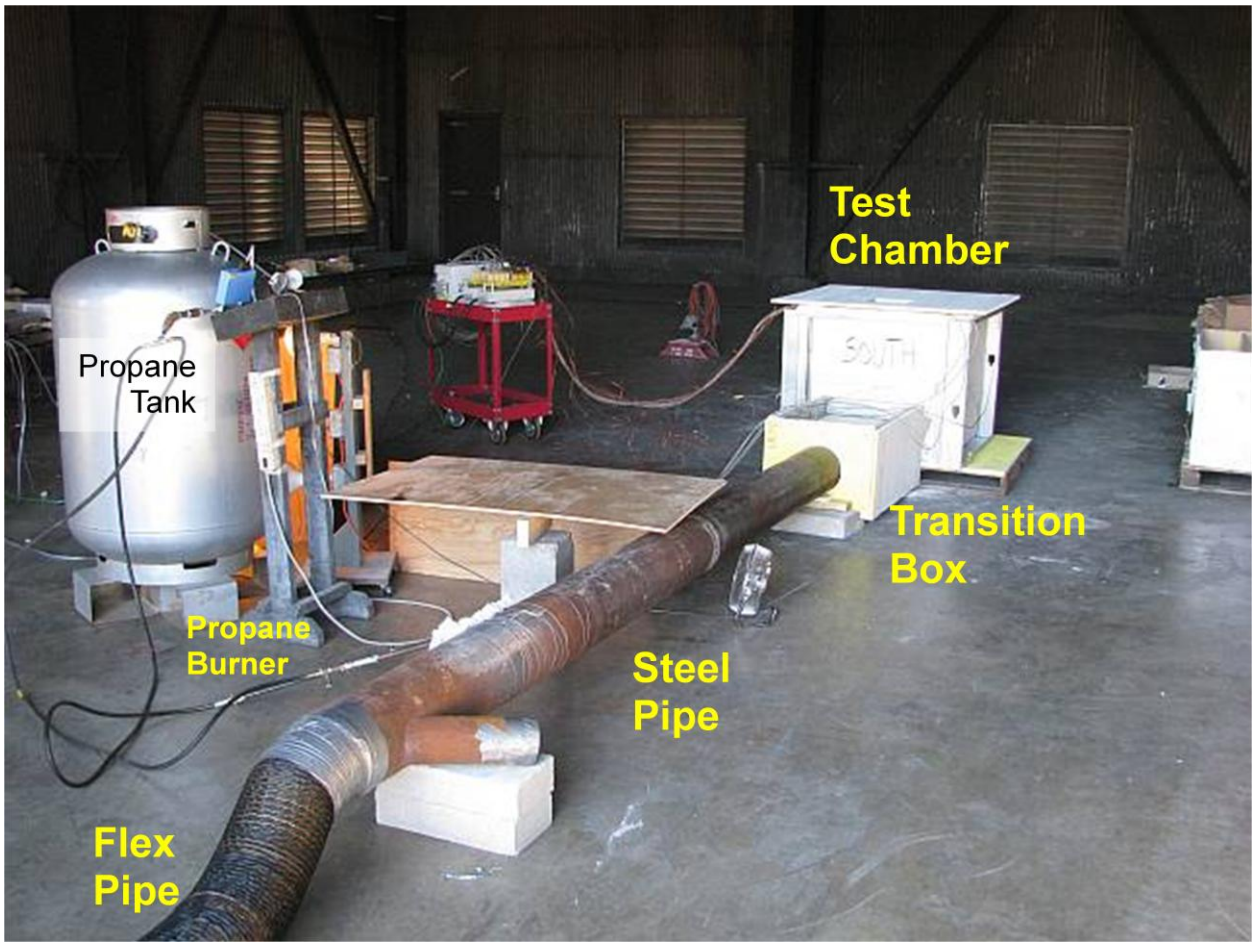
The mass of fuel burned on just one short weekend drive for both nitro and gasoline.

The amount of power produced by the engine assuming 30% of the heat gets used as work for both nitro and gasoline. You should give your answer in both MW and horsepower to give you a physical sense of scale.

So what do you think of Ashley's car?

3. A real life application: A few months ago, a custom built furnace was made to test a prototype Venus Lander thermal protection system. The furnace operated at 465°C. The heat source was provided by a propane burner. The air flow into the furnace was at 8 m^3/min. The average fuel flow rate was 62 standard liters per minute (nominally at 25°C and 1 atm pressure). Determine the excess air in the combustion process and the molar fractions of the products. What is the heat loss from the combustion products by the time they reach the furnace? The following page shows a schematic diagram and photo of the test set up.


Air Exit
Propane
Tank
Transition
Box
Propane
Burner
Steel Pipe
Air Inlet
Test Chamber
Blower
Flex
Pipe


Test
Chamber
Propane
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Steel
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Pipe