UCC501 Homework 2 Solutions

Yanan Xiao

`yxiao@masdar.ac.ae`

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1 Energy Scales, CO2 Emissions and Renewables

1.1 Energy Scales

- Natural gas consumption year 2012: in Billion Cubic Feet: 2235.169.

- For natural gases btu we have

$$1cf \rightarrow 1027Btu \tag{1}$$

source: `http://www.aga.org/KC/ABOUTNATURALGAS/ADDITIONAL/Pages/HowtoMeasureNaturalGas.aspx`, use MATLAB to convert units, we have

$$2012\ Yearly\ btu\ =\ 2235.169 * 10^9 * 1027 \tag{2}$$

Evaluate the equation we get $2.2955 * 10^{15}\ Btu$, divided by millions we get $2.2955 * 10^9\ MBtu$.

- From this unit conversion site `http://www.eia.gov/cfapps/ipdbproject/docs/units.cfm` we have

$$MTOE\ =\ MBtu * 0.02520 * 10^{-6} \tag{3}$$

Evaluate the above equation we have $57.8471 MTOE$

- Similarly we have $1MBtu = 1.05506*10^9 Joules$ and $1KWh = 3.6*10^6 Joules$, thus

$$2012\ Yearly\ GKWh = 2.2955*10^9*1.05506*10^9/(3.6*10^6*10^9) \quad (4)$$

Evaluate the above equation we have $672.7527\ GKWh$

1.2 CO2 Emissions

- Assume complete combustion, we have $2235.169\ Bcf$ natural gas burned in UAE for year 2012. Assume under normal temperature and pressure the natural gas is measured, we google the bold texts **natural gas density** and get the following:
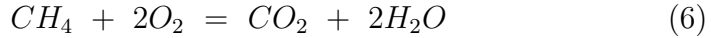
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Density
0.656 g/L at 25 C, 1 atm; 0.716 g/L at 0 C, 1 atm;
0.42262 g cm3; (at 111 K)
```

Since we assume normal density, we use $\rho = 0.656g/L = 656kg/m^3$. Thus we have the total mass of CO2 burned in year 2012

$$Mass\ of\ CH_4 = 4.1525*10^{13}kg \quad (5)$$

Since the background is complete combustion, from chemistry we have

$$CH_4 + 2O_2 = CO_2 + 2H_2O \quad (6)$$

and introduce a concept from chemistry, **molecular weight** we have

$$Mass\ of\ CO_2 = m_{CH_4} * \frac{M_{CO_2}}{M_{CH_4}} \quad (7)$$

where m_{CH_4} is the mass, the M_{CH_4} is the molecular weight. This equation is deducted by **carbon equilibrium** under complete combustion. Evaluate equation (7) we have $m_{CO_2} = 1.1419*10^{14}kg$

1.3 Renewables