12_11_2014

week 46: Economy

2.5

Suppose that coil-fired power plant burns lignite coal. Based on the energy content of lignite – brown coal (Table 2.1), estimate the CO_2 emissions in kg/GJ and compare your result with emission data in Table 2.2.

Assume that all the C in coal goes into CO_2, with only neglilible amount of creating CO.

Lignite: <46% of C (coal) ≈ 40%

Energy content in lignite: 5500-8300 Btu/lb = (12.8 - 19.3) MJ/kg

1 btu = 1055 J

1 lb = 0.45 kg

1 Btu/lb = 2.33 kJ/kg

C -> CO_2 (reaction in mol equivalent)

1 kmol C -> 1 kmol CO_2

(12 kg/kmol) C -> (44 kg/kmol) CO_2

0.08 kg C -> 0.02 kg CO_2

M(C) = 12 g/mol

M(O) = 16 g/mol

M(CO_2)=44 g/mol

CO_2 emission:

0.4 * 1/12.8 (kg/MJ) = 0.4 *78.1 kg/GJ = 31.2 kg/GJ

0.4 * 1/19.3 (kg/MJ) =0.4 *51.8 kg/GJ =20.7 kg/GJ

12 g/mol ….31.2 kg/GJ

44g/mol….x kg/GJ

x_{max}= (44g/mol /12 g/mol)*31.2 kg/GJ =114.4 kg/GJ (CO_2)

x_{min}=75.9 kg/GJ

x(average)= 95.1 kg/GJ (+/- 5 kg/GJ)

Table 2.2 : Emission from lignite power plant: 101 kg/GJ of CO_2

2.8

World proven natural gas reserves 1.9×10^{14} m^3. 1000 kg occupies a volume of 48700 ft^3 at atmospheric pressure, how does the amount trapped in hydrates (estimated as 6.4 e12 tons = 64 $\times 10^{14}$ m^3) compared to the proven reserves?

1 ft = 0.0283 m^3

48700 ft3/1000kg =1378 m3/1000 kg

World gas reserves in tones:

1.9×10^{14} m^3 t/1378 m^3 = 1.38×10^{11} t

2.11

Consider a power-plant having a fixed electrical power output 1000 MW. Show that if the efficiency of the plant were to increase from 33% to 50%, the amount of rejected heat (waste) per MW generated is halved.

η=efficiency= (power in– waste)/(power in)

η= Power out/Power in; Power in=> 0.33 = 1000 MW /x → 3030.3 MW

Solution:

if η= 33% waste 67%

if η= 50% waste 50%

0.67 waste/0.33 generated ≈ 2 MW waste/1 MW generated

0.5 waste/0.5 generated = 1 MW waste/ 1 MW generated

2.14

If your view of "fracking" (hydraulic fracturing) is that is that it is too risky to be pursued, look up some sources that support this view and, in a one page description, see if you can find any flaws in the arguments. Do the same if your view happens to be that fracking should be pursued.

Hydraulic fracturing

PRO

3x less price of natural gas

cheaper than wind, solar energy

CONS

leaching of liquid and chemicals -> drinking-water contamination

air pollution -> global warming

structural stability of that shale bedrock -> man-made earthquakes

costs of cleaning pollution

amount of water gone

Facts:

underground rivers that provide our drinking water - 20 to 100 m The gas-producing shale rock formations - 1000 to 1800 m that the well you drill to pump the water and released gas- sealed properly. (Density of CO_2 increases with depth)