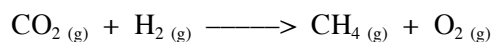


**CHEM 101 CONFERENCE: THE STOICHIOMETRY OF GREENHOUSE GASES
OCTOBER 24/25, 2007****What's for dinner, beef or rice? Which food has a lower impact on global methane emissions?**

1. Methane (CH₄) is produced in rice paddies according to the *unbalanced* reaction given below. In one square meter of land, researchers estimate that approximately 10 g of H₂ are available each day to react with an excess of carbon dioxide. How many grams of methane are released per day by a square meter of rice paddy?



2. Assuming that the growing season is 3 months long and that 3.5 metric tons of rice is cultivated per hectare, calculate the number of grams of methane released during the production of 1 kg of rice. Useful info: 1 metric ton = 1000 kg and 1 hectare = 10,000 m².
3. Cattle raised on feedlots in North America have an average mass of 415 kg and release approximately 37 kg of methane per head per year. If these cattle are butchered when they reach 2 years of age and 50% of their mass is suitable for human consumption, how many grams of methane are released during the production of 1 kg of beef?
4. Is more methane released during the production of 1 kg of rice or 1 kg of beef? How might your answer change if the comparison was made on a serving-by-serving basis rather than on a kg-by-kg basis?

So, what does cement production have to do with the global carbon cycle?

5. Production of cement represents a nontrivial source of CO₂ emissions in the US. Cement contains about 65% CaO (lime) by mass. Lime is produced by heating calcium carbonate, CaCO₃, to 2000°C. The other byproduct of the reaction is CO₂. In the year 2000, the US produced an estimated 90.60 million metric tons of cement. 1 metric ton = 1000 kg
- a) How many million metric tons of CO₂ are emitted from the production of this cement? How many Tg of C does this correspond to?
- b) Of course, heating the calcium carbonate to such high temperatures requires a tremendous amount of energy, 3100 kJ energy per kg CaO produced. Assume that this energy is provided by burning coal, which has a heat content of 35.2 kJ/g, and which contains 85% C by mass. How many more million metric tons of CO₂ and Tg of C are produced from the energy requirements of cement manufacture?

Is ethanol a cleaner burning fuel than gasoline?

6. The agricultural giant ADM, one of the corporate supporters of the News Hour with Jim Lehrer, often runs a short ad on PBS singing the virtues of "ethanol, a cleaner burning fuel..." From the point of view of greenhouse gas emissions, is ethanol (C₂H₅OH) a cleaner fuel than gasoline?
- a) Write a balanced reaction for the combustion of ethanol.
- b) In lecture, we calculated that burning 1.0 gallon of gasoline (octane, C₈H₁₈) releases 8200 g CO₂. If the heat content of octane is 47.7 kJ/g, how much energy is released when 1.0 gallon of octane is burned? The density of octane (C₈H₁₈) is 0.7025 g/mL.
- c) If the heat content of ethanol is 29.7 kJ/g, what mass of ethanol would need to be burned to produce the same amount of energy as burning 1.0 gallon of octane?
- d) How much CO₂ (in g) is produced from the combustion of this ethanol?