

1) Biogas generation efficiency from manure

Manure biomass is transformed to biogas by anaerobic digestion (in essence a slow hydrolysis).

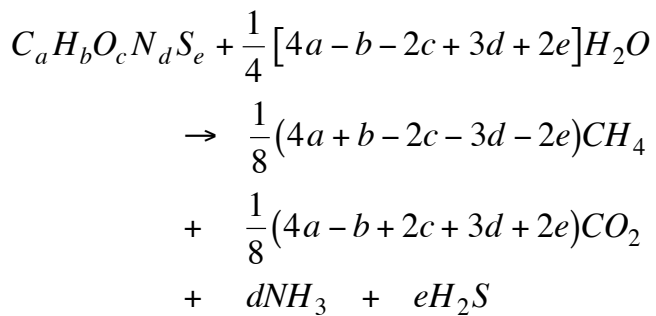
The manure's composition is, by weight (dry basis), 42% carbon, 6% hydrogen, 32% oxygen, 2.1% nitrogen, plus 18% of inorganics.

What will be the biogas composition ?

What is the energy balance of the process? I.e. how much energy is contained in the biogas compared with how much energy is contained in the manure?

(LHV CH₄ : 800 kJ/mole) (LHV NH₃ : 225 kJ/mole)

Hint: use the Buswell-Boyle formula :



2) Gasoline / Diesel replacement by inland bioethanol / biodiesel production ?

Inland mobility fuel use in Switzerland is ~5.1 Mtoe gasoline and ~2 Mtoe diesel per year.

(1 Mtoe = 1 mega-tonne oil equivalent = 42 PJ)

Assume we want to replace part of it by inland biofuel production and that we could dedicate 1000 km² of the Swiss territory (total: 41'000 km²) to sugar beet plantation and 1000 km² to rapeseed plantation (which are huge areas by the way).

Bioethanol (21.3 MJ / L) from sugar beet : yield 2500 L / ha (1 ha = 10'000 m² = 0.01 km²)

Biodiesel (33 MJ / L) from rapeseed : yield 700 L / ha (one notices that the lower yield with biodiesel is in part compensated by the higher LHV, compared to bioethanol).

How much (%) of imported gasoline and diesel fuel consumption could be replaced this way ?

If we were to dedicate instead 1000 km² of forest land (there is ~11'000 km² of forest in Switzerland) to bioethanol production (=>assume here renewable dry wood production of 20 ton / ha.yr, converting 3 kg wood to 1 kg ethanol), how much gasoline could we replace ? (ethanol density: 0.8 kg/L)

If we would instead convert this yearly available renewable wood quantity into methane (take wood-to-methane 70% energy efficiency yield) for mobility (gas vehicles) ? (Assume 16.7 MJ/kg dry wood)

Comment the results.