**Combustion theory exercises**

1. Calculate the energy released per unit mass (kJ / g) from the combustion of the following biofuels (biogas and bioethanol). Which is the better fuel? Use the values below.

∆Hf (CH4)(g) = -74,81 kJ/mol, ∆Hf (C2H5OH)(l) = -277,7 kJ/mol, ∆Hf (CO2)(g) = -393,15 kJ/mol, ∆Hf (H2O)(l) = -285,8 kJ/mol

1. Calculate the LHV of cyclopropane C3H6 (water vapor does not condense). Express the result in kJ/g.
2. Evaluate combustion of biogas (methane) on the climate. How much CO2 is produced in burning process. Express the result as compering masses m(CO2) / m(CH4) and compering energy g/kJ.
3. What different substances enter to the combustion process and what substances end up in the flue gases? Explain all substances in more detail. Fuel consists of C, H, S, H2O and λ> 1.

Fluegas

Combustion

Fuel

Air

1. Biogas contains 60 % CH4, 30% CO2 and 10% H2O. Density is 1,15 kg/m3. Calculate the fluegas volumes if 1 m3 of biogas burns when λ is 1,5 and combustion air RH is 40% and pressure ptot is 987,3 hPa and temperature is 22oC.
2. 5 kg woodchip is burned with air coefficient 1,5. The moisture content of the wood is 20%. The dry wood itself contains about 50 % carbon, 6 % hydrogen and 44 % oxygen. Smaller proportions are ignored. Total atmospheric pressure 1 bar, combustion air temperature 22 oC and relative humidity is 40 %.

a) How much air in m3 is needed for combustion (in NTP)?

b) How much dry flue gas (in NTP) is formed?

c) Total amount of flue gases?

1. The composition of a used fuel is: carbon 55 wt%, hydrogen 5,5 wt%, sulfur 0,2 wt%, oxygen 32,6 wt%, nitrogen 1,7 wt% and ash rest. The water content of the fuel during combustion is 45 % by weight. Combustion air is at a temperature of 285 K and pressure is 1 bar. The relative humidity of the air is 70 %. Calculate the theoretical amount of moist air required for combustion as well as the amounts of flue gas components generated when 1 kg of fuel burns and air coefficient is 1.