Teaching-learning materials compiled by the PARSEL consortium
as part of an EC FP6 funded project (SAS6-CT-2006-042922-PARSEL).

Cooperating Institutions and Universities within the PARSEL-Project:

For Teachers

Science in a Class of Its Own: Renewable Energy Sources – "My iPod Works with Energy from Bull Shit"

A Module for Science Instruction – especially Chemistry – for Grades 10 to 13

Module Content

In this module the students will deal with energy supply using biogas. First, the students will work on the essential theoretical background of the formation of biogas. It is produced by the process of anaerobic fermentation of plant or animal-based biomass (mainly liquid manure) in a biogas plant. During this process, the highly molecular organic substances contained in the biomass get broken down into less molecular substances. This is done by different bacteria in the anaerobic environment of the fermentation. After the approximately three week long fermentation process, the final product biogas has formed. It consists of 50-75% vol. of methane and of 25-45% vol. of carbon dioxide (further components under 1% vol.: water, hydrogen sulfide, nitrogen and oxygen).

The students have to recreate the processes in a biogas plant by carrying out an experiment and so creating biogas themselves. With a simple experimental setup, consisting of a plastic bottle filled with one of the starting substrates and a simple syringe, biogas forms after a few days in warm surroundings (cf. Wiederholt, Plempel 1995). Different starting substrates can be used: Horse dung, liquid manure from pigs, loppings and maize silage. In small groups, the pupils will vary combinations of the different substrates as well as different substrate ratios and amounts. These different starting combinations are noted down and after the mixture has rested for a few days, the amount of gas formed can be read off the syringe and noted down as well. The students are now urged to voice their opinions about the substrate combination and the amount of gas formed. To do so it is necessary to check the experimental setup exactly (hose seals tight?, ideal warmth?, oxygen in the setup?) The different results are compared with one another and used to interpret the "real" biogas production in biogas plants. To achieve optimum gas production the different starting substrates (mainly liquid manure) are mixed with so-called co-substrates (e.g. loppings, silages, grist).

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In further experiments, the heating value of different gaseous combustion substances (biogas, methane, natural gas from the mains) is determined, as well as the explosiveness of a methane-air-mixture.

Following the practical part of the module the manifold uses of biogas as a source of energy are focused on. In combustion plants, thermal energy is produced by combustion of biogas. Biogas can also be transformed into mechanical energy or into electricity in a combustion motor. In a thermal power station, biogas can be used to provide thermal as well as electrical energy. After purifying the biogas to increase the methane concentration it can be fed into the (natural) gas mains or can be used as fuel.

To conclude the module, the students are asked to perform a play about different aspects of energy supply using biogas. At the forefront of this exercise is a change of perspective which the students should undergo – because they are asked to act out the role of a "third party" whose position is to be underlined using plausible and convincing arguments. Having created the scenery and the roles for their play, the groups perform in front of their fellow participants. Finally, the presentations are discussed amongst the whole group.

References

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