Green Indicator

In this the 12th issue of Green Indicator we will have a look at a very promising development on the taming of sunlight. Researchers from Denmark and the US have successfully been able to use the energy from red light photons in the production of hydrogen gas from H^+-ions and with this solved half of the equation in producing hydrogen and oxygen from sunlight without going over an electricity intermediary. Interestingly they made the development by mimicking natural enzymes and translating this into the inorganic space. We will also summarize the different types of biofuels that are either produced or discussed at the moment.

/ Christian Hulteberg

Biofuels

There are a number of alternative fuels that are either discussed or actually produced in the world as of today. In this article, we will try to summarize these and perhaps also list some pros and cons with the various fuels. There are many attempts to classify these types of alternative fuels into generations, advanced etc. types of biofuels; we will stay away from that and only try to recap the types of fuels and their degree of maturity.

The leading alternative fuel based on quantity produced is ethanol, which is produced and used in a large part of the world as an alternative fuel. Indeed there are countries that have transformed most of their vehicle fleet to operate on the fuel; drawbacks include lower energy content and a marginal contribution to the diesel pool (mainly a gasoline type fuel). Ethanol may also come to play a part in the production of biodiesel, which leads to our next type of renewable fuel. Biodiesel is produced through the trans-esterification of triglycerides with an alcohol, most commonly methanol. The fuel, as with ethanol, can be used either as a low-blend component in the traditional diesel (or gasoline) or as a fuel on its own. Disadvantages with the fuel include limited shelf life due to microbial growth.

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Solar Fuel

Traditionally catalyst formulation has been something of a trial-and-error science, however with the use of elaborate calculation tools and methods, faster and perhaps better results may be achieved. In an on-line early publication in Nature Materials (Bioinspired molecular co-catalysts bonded to a silicon photocathode for solar hydrogen evolution) an American/Danish research collaboration has resulted in a new type of catalyst for the photon-assisted generation of hydrogen from water. By coupling a catalyst to a p-type silicon semi-conductor the red photons of solar light can be harvested and used for producing hydrogen gas from hydrogen ions with a molybdenum sulfide catalyst. With a more than 10% solar-to-hydrogen efficiency the system meets expected production targets.

The interesting part is, aside from the obvious cost reduction in changing from platinum to molybdenum, is the way the particular

Another alternative treatment of triglycerides includes hydrotreating in which hydrogen is reacted with the molecules to form alkanes, both long chain (from the fatty acids) and propane (from the glycerol). Drawbacks include the cost of hydrogen production as well as the need for isomerization of the long chain molecules to improve their diesel properties. On the flip-side, the fuel is high in energy content and contain no oxygenates.

The same can be said about fuels derived from synthesis gas (CO and H_2) in the form of diesel or gasoline. However, the production of these kinds of fuels from e.g. biomass is low compared to the production from triglycerides (not to mention coal). In the diesel pool using hydrogen derivatives of tall oil and other types of fatty acids can be included. Another much discussed source of fuel is algae, in which the same types of triglycerides used in transestrification and hydrotreating is produced, however the use of algae is rather an alternative source of feedstock than a type of fuel in itself.

Aside from the already mentioned fuels, butanol in different isomers is discussed quite often. The use of butanol has less of the drawbacks of ethanol, but produced via fermentation it is difficult to produce economically feasible. Another evergreen fuel is methanol, which should be included even though it is toxic, as well as the derivative of methanol dimethyl ether.

Through studying hydrogen producing enzymes a theoretical model of the enzyme functionality was devised. Based on the model, the enzyme functionality could be understood and similar, inorganic compounds suggested. The final choice to go with the molybdenum sulfide catalyst solves the first part of the problem; now the other half of the photo-electrochemical cell will be investigated, generating the oxygen from water.

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