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GENERATING ENERGY FROM BANANA PEEL

Relevant for: Science & Technology | Topic: Science and Technology- developments and their applications and effects in everyday life

Rich source: Dried banana peel has a hydrogen content of 5%, and 33% is carbon | Photo Credit: Getty Images

In the 1985 science fiction film *Back to the Future,* a flamboyant inventor modifies his car into a plutonium-powered time machine and travels back and forth in time. During a visit to the year 2015, he updates his engine so that it will now take any form of matter for generating energy — even a carrot or two tossed into the “tank” will do.

Well, 2015 has gone past us. Fusion-powered vehicles are still beyond the horizon. And we keep hoping for new and better ways of extracting clean energy from renewable sources. Such as carrots, or maybe bananas — which is indeed what has been achieved by a research group working at the Swiss Federal Institute of Technology in Lausanne (*Chemical Science*, 2022).

Their version of the banana split involved the splitting of biomass — banana peel, orange peel, coconut shells — by flashes of light emanating from a xenon lamp.

But before looking at this innovative approach, a few words about what makes hydrogen an attractive energy source. Storing large quantities of energy in a modest amount of space is a vital requirement, and hydrogen has an impressive energy storage capacity. While classifying fuels in terms of their energy value (also called heating value), the deciding elements are carbon, hydrogen and oxygen. Hydrogen has an energy value that is seven times that of carbon.

In the burning of wood, carbon and hydrogen are oxidised in a heat-generating reaction, the end products of which are carbon dioxide and water. The former is a greenhouse gas, contributing to global warming. Burning of hydrogen gives us only water and heat. A smarter way to harness the energy in hydrogen would be to generate electricity with it. This is achieved in a proton exchange membrane fuel cell where, in the presence of a metal catalyst, a hydrogen molecule is split into protons and electrons, with the electrons providing the current output.

Such fuel cells are now used to power a few light passenger transport vehicles in some parts of the world. Unlike electric cars, hydrogen-powered cars have a refuelling time of only about five minutes. Commercially available hydrogen-powered cars have fuel tanks that can carry 5-6 kg of compressed hydrogen, with each kilo providing a range of about 100 km (and emitting nine litres of water, mostly as steam).

The limited popularity of hydrogen as fuel is due to production and distribution restraints. It is safer to handle than domestic cooking gas.

Industrial-level quantities of Hydrogen gas are used in processes such as the production of ammonia for fertilizers. Over 90% of the world’s hydrogen is produced from fossil fuels.

This brings us back to the search for alternative sources of energy that do not tax the environment. Biomass is a catch-all term for organic waste material of plant and animal origin. It is a rich source of both hydrogen and carbon — our dried banana peel has a hydrogen content of 5%, and 33% is carbon. An important goal of all climate change-curbing protocols is to sequester as much carbon as possible — don’t let it become a gas.

The Swiss group uses pyrolysis, wherein organic matter is decomposed using small bursts of intense heat under inert conditions.

Flashes of irradiation from a xenon lamp provide the heat — a total of 15 milliseconds of irradiation are enough to heat the system to 600 degrees Celsius, and decompose a kilogram of banana peel powder — liberating 100 litres of hydrogen gas.

This short burst of photothermal energy also produces 330 grams of biochar, a solid residue that is rich in carbon.

It is worth noting here that if the biomass had been burnt, gaseous carbon would have escaped as carbon monoxide and carbon dioxide. Pyrolysis ensures that carbon remains sequestered as a solid.

Biochar has other uses too — apart from safekeeping carbon, biochar has several uses in agriculture.

Agricultural leftovers such as rice husk are a major source of biomass, and the biochar it forms has significant mineral content. Adding it to soil enriches plant nutrients.

The porous nature of biochar makes it suitable for remediation — the adsorption of toxic substances in polluted soils - thus reducing the potency of contaminants in the soil (*Annals Agric. Sci.,* 2019).

Biomass, be it from banana peel, or tree bark or poultry manure, thus improves air quality and adds value to agricultural produce — while setting in motion that emission-free car.

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