Sweet Success for Pioneering Hydrogen Energy Project

Posted on Wednesday 26th July 2006

Bacteria that can munch through confectionery could be a valuable source of non-polluting energy in the years ahead, new research has shown.

In a feasibility study funded by the Engineering and Physical Sciences Research Council, bioscientists at the University of Birmingham have demonstrated that these bacteria give off hydrogen gas as they consume high-sugar waste produced by the confectionery industry.

The hydrogen has been used to generate clean electricity via a fuel cell. Looking to the future, it could also be used to power the hydrogen-fuelled road vehicles of tomorrow. There is increasing recognition that, over the coming decades, hydrogen could provide a mainstream source of energy that is a safe, environmentally friendly alternative to fossil fuels.

This was a highly successful laboratory demonstration of bacterial hydrogen production using confectionery waste as a feedstock. An economic assessment undertaken by another partner, C-Tech Innovation Ltd, showed that it should be practical to repeat the process on a larger scale.

As well as energy and environmental benefits, the technique could provide the confectionery industry (and potentially other foodstuff manufacturers) with a useful outlet for waste generated by their manufacturing processes. Much of this waste is currently disposed of in landfill sites.

In this project, diluted nougat and caramel waste was introduced into a 5 litre demonstration reactor (although other similar wastes could be used). The bacteria, which the researchers had identified as potentially having the right sugar-consuming, hydrogen-generating properties, were then added.

The bacteria consumed the sugar, producing hydrogen and organic acids; a second type of bacteria was introduced into a second reactor to convert the organic acids into more hydrogen. The hydrogen produced was fed to a fuel cell, in which it was allowed to react with oxygen in the air to generate electricity. Carbon dioxide produced in the first reactor was captured and disposed of safely, preventing its release into the atmosphere.

Waste biomass left behind by the process was removed, coated with palladium and used as a catalyst in another project aimed at identifying ways of removing pollutants such as chromium (VI) and polychlorinated biphenyls (PCBs) from the environment. The reactors used by this parallel initiative also required hydrogen and this was supplied by the confectionery waste initiative too, further underlining the ‘green’ benefits offered by the new hydrogen production technique.

Professor Lynne Macaskie of the University of Birmingham’s School of Biosciences led the research team. “Hydrogen offers huge potential as a carbon-free energy carrier,” she comments. “Although only at its initial stages, we’ve demonstrated a hydrogen-producing, waste-reducing technology that, for example, might be scaled-up in 5-10 years’ time for industrial electricity generation and waste treatment processes.”

Dr David Penfold, microbiologist from the School of Biosciences, who has developed this technology, says, ‘The process has enormous potential. In theory, any waste can be used for hydrogen production as long as it contains sugars that the bacteria can utilise. This allows the possibility of using the process in countries which have a high sugar surplus. We have already received interest from countries with high levels of waste who are keen to make use of this technology.’

The team is now engaged in follow-up work which will produce a clearer picture of the overall potential for turning a wider range of high-sugar wastes into clean energy using the same basic technique.

Ends

Notes for Editors

The 15-month feasibility study ‘Biological Hydrogen Production from Crops and Sugar Wastes’ received EPSRC funding of nearly £24,000.

Bacteria can appear naturally in the environment or can be adapted into new forms in the laboratory. The bacteria used in this study were:

(i) An adapted form of a harmless strain of E. coli originally developed in Germany. The team used this organism to break down the confectionery waste.

(ii) Rhodobacter sphaeroides, a naturally occurring organism. This was used to turn the organic acids into hydrogen.

Fuel cells are devices that produce power by harnessing electrochemical reactions between (i) oxygen taken from the air and (ii) hydrogen. The only by-products are clean water and heat. Combined heat and power (CHP) units are the likely route forward for this technology, which is expected to find increasing application in the years ahead, initially in niche markets but then more widely as the units become more cost competitive. With the commercial supply of clean water decreasing, the water generated as a by-product could also find important uses.

Palladium is a soft, steel-white, tarnish-resistant, metallic element occurring naturally with platinum, especially in gold, nickel, and copper ores. Because it can absorb large amounts of hydrogen, it is used as a purification filter for hydrogen and a catalyst in hydrogenation.

The Engineering and Physical Sciences Research Council (EPSRC) is the UK’s main agency for funding research in engineering and the physical sciences. The EPSRC invests more than £500 million a year in research and postgraduate training to help the nation handle the next generation of technological change. The areas covered range from information technology to structural engineering, and mathematics to materials science. This research forms the basis for future economic development in the UK and improvements for everyone’s health, lifestyle and culture. EPSRC also actively promotes public awareness of science and engineering. EPSRC works alongside other Research Councils with responsibility for other areas of research. The Research Councils work collectively on issues of common concern via Research Councils UK. Website address for more information on EPSRC: www.epsrc.ac.uk/ <http://www.epsrc.ac.uk/>

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