Automobile fuel cells from sunflower oil

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Researchers in England have found a promising method for producing hydrogen from sunflower oil, a development that could lead to cleaner and more efficient hydrogen production for powering automobile fuel cells as well as homes, factories and offices.

Fuel cells show much promise for supplying the energy needs of the future, and their demand is growing with increasing use of the technology. But one of their drawbacks, experts say, is that the hydrogen required to run them generally comes from the burning of fossil fuels, which generate pollutants such as carbon monoxide and greenhouse gases like carbon dioxide and methane.

"Producing hydrogen from sunflower oil could provide a more environmentally-friendly alternative by reducing these pollutants while offering an abundant, low-cost and renewable resource that reduces dependence on foreign oil," says the study's lead researcher, Valerie Dupont, Ph.D., an energy engineer with the University of Leeds in England.

Dupont and her collaborators developed an experimental hydrogen generator that uses only sunflower oil, air and water vapor along with two highly-specialized catalysts — one nickel-based, the other carbon-based — that are alternatively used to store and then release oxygen or carbon dioxide while producing hydrogen intermittently. The new process does not involve the burning of any fossil fuels, they say.

The sunflower oil used is the same type found on grocery shelves. "We

would happily toss our salad with it," says the researcher, who adds that the process can also work with other types of vegetable oils.

In the prototype device, which can fit on a standard lab bench, water and oil are pumped into the unit and passed through a pre-heater to vaporize them. Through a process called steam reforming, the mixture is broken down in the presence of heat to generate carbon dioxide, hydrogen, methane and carbon monoxide.

The catalysts, which are key to the process, orchestrate a series of chemical maneuvers that ultimately result in an increased hydrogen yield. First, one of the catalysts (the nickel-based unit) absorbs the oxygen from the air and this interaction heats up the reactor bed of the device. Simultaneously, in the presence of heat, another catalyst (a carbon-based adsorbent) releases any carbon dioxide previously trapped in the device.

Once the reactor bed is hot enough and all the carbon dioxide has been released and expelled from the reactor, the mixture of vaporized oil and water are then fed into the reactor chamber. The heat from the reactor bed breaks down the carbon-hydrogen bonds in the vaporized oil. Water (steam) binds its oxygen to the carbon, releasing its hydrogen and yielding carbon monoxide. When carbon monoxide and water vapor are in the presence of each other, they tend to form carbon dioxide and hydrogen. This overall process results in a cyclical production of hydrogen, Dupont says, adding that the process can be modified to allow continuous hydrogen production.

In laboratory studies, the researchers achieved a hydrogen purity of 90 percent, which is more efficient than current hydrogen generators that only achieve a hydrogen purity of about 70 percent. The byproducts of the sunflower oil transformation, carbon dioxide and methane, are generated in roughly equal proportions, the researchers say.

"Currently the generator is heated electrically, but in the near future all the heat necessary to carry out the reaction of steam with oil vapor will come from the intake of oxygen on the nickel catalyst," Dupont says.

The experimental generator has not been used to supply hydrogen to any fuel cells yet, but a similar device could be refined to equip fuel stations with large-scale hydrogen supplies, which consumers can ultimately feed into the tanks of vehicles containing fuel cells, the researchers say.

Hydrogen is a key component of fuel cells, where it reacts with oxygen to generate electricity, with water as the main emission. Major automobile manufacturers are quickly developing fuel cell technology, but mass production of such vehicles is expected to be many years away, experts say. Fuel cells also can be used to provide electricity and heat to buildings.

Source: American Chemical Society