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Turning Carbon Dioxide into Fuel

Researchers are harnessing solar energy to convert carbon dioxide into carbon monoxide, which can be used to make fuels.

By Duncan Graham-Rowe

Could concentrated solar energy be used to reverse combustion and convert carbon dioxide back into gasoline? That's what scientists at Sandia National Laboratories (http://www.sandia.gov/Renewable_Energy/renewable.htm) , in Albuquerque, NM, aim to find out by building a novel reactor that can chemically "reenergize" carbon dioxide.

The device uses a two-stage thermochemical reaction to break down carbon dioxide to produce carbon monoxide, says Nathan Siegel, a senior member of technical staffat Sandia's Solar Technologies Department and one of the researchers developing the technology. "Carbon dioxide is a combustion product, so what we're doing is reversing combustion," he says. The carbon monoxide can then readily be employed to produce a range of different fuels, including hydrogen, methanol, and gasoline, using conventional technologies.

Within the Sandia reactor, invented by Sandia researcher Rich Diver, is a ring of a cobalt-ferrite ceramic material, which is essentially made up of iron oxide and cobalt. A parabolic solar concentrator directs sunlight onto the ceramic material, heating it to around 1,500 °C and causing it to give up oxygen.

As the ring continually rotates, the reduced material passes into a second, separate chamber containing carbon dioxide. Having given up its oxygen, the ceramic reacts with the carbon dioxide, stealing oxygen atoms off it. The result is the production of carbon monoxide. The process is continuous, so that the oxidized ceramic once again passes back into the solar chamber where it is again reduced. "It will work with either carbon dioxide to make carbon monoxide or with water to make hydrogen," says Siegel.

At least that's the theory. The Sandia group has carried out proof of principle demonstrations of various stages of the device but has yet to show that they all work together. The team is building a prototype that will be ready for testing by late spring. "It's 95 percent built," says Siegel.

The cobalt-ferrite ceramic was originally developed in Japan and is easy to produce. To maximize its effect, the material is constructed into a matrix of crisscrossing one-millimeter-diameter rods. This has the effect of producing a high surface area with which to react with the carbon dioxide.

By next June, the researchers expect to have the reactor's performance mapped out, and if it does as well as they expect, a practical version could be available within five years.

"At the moment, we are looking at getting carbon dioxide from industrial sources," says Siegel. The real potential, however, is to capture carbon-dioxide emissions and reuse them as fuel. "We're also looking at ways to pull carbon dioxide out of the air," he says. This would allow the reactor to be mounted anywhere, sucking up the atmospheric greenhouse gas and turning it into fuel. However, Siegel stresses, this is at a much earlier stage of development.

Despite the huge potential, there is currently very little research into finding ways to harness solar energy to produce carbon monoxide from carbon dioxide, says Siegel. But such technology deals with two problems directly: putting carbon dioxide to good use, and finding a way to make the best of the sporadic nature of solar energy. "It offers a way to store this solar energy and use it when you want it," he says.

It's excellent work and, in principle, scientifically quite possible, says Christian Sattler (http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-4074/6449_read-12526/sortby-lastname/) , of the Institute of Technical Thermodynamics at the German Aerospace Center, in Cologne. "The question is, at what efficiency?" he says. "How much energy does it take to carry out this reduction? It may be more efficient to use the solar energy for direct power production."
