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Scientists Use Sunlight to Make Fuel From CO2

By Chuck Squatriglia 01.04.08

Sandia researcher Rich Diver checks out the solar furnace which will be the initial source of concentrated solar heat for converting carbon dioxide to fuel. Eventually parabolic dishes will provide the thermal energy.
Photo: Randy Montoya / Sandia National Laboratories

Researchers at Sandia National Laboratories in New Mexico have found a way of using sunlight to recycle carbon dioxide and produce fuels like methanol or gasoline.

The Sunlight to Petrol, or S2P, project essentially reverses the combustion process, recovering the building blocks of hydrocarbons. They can then be used to synthesize liquid fuels like methanol or gasoline. Researchers said the technology already works and could help reduce greenhouse-gas emissions, although large-scale implementation could be a decade or more away.

"This is about closing the cycle," said Ellen Stechel, manager of Sandia's Fuels and Energy Transitions department. "Right now our fossil fuels are emitting CO2. This would help us manage and reduce our emissions and put us on the path to a carbon-neutral energy system."

The idea of recycling carbon dioxide is not new, but has generally been considered too difficult and expensive to be worth the effort. But with oil prices exceeding $100 per barrel and concerns about global warming mounting, researchers are increasingly motivated to investigate carbon recycling. Los Alamos Renewable Energy, for example, has developed a method of using CO2 to generate electricity and fuel.

S2P uses a solar reactor called the Counter-Rotating Ring Receiver Reactor Recuperator, or CR5, to divide carbon dioxide into carbon monoxide and oxygen.

"It's a heat engine," Stechel said. "But instead of doing mechanical work, it does chemical work."

Lab experiments have shown that the process works, Stechel said. The researchers hope to finish a prototype by April.

The prototype will be about the size and shape of a beer keg. It will contain 14 cobalt ferrite rings, each about one foot in diameter and turning at one revolution per minute. An 88-square meter solar furnace will blast sunlight into the unit, heating the rings to about 2,600 degrees Fahrenheit. At that temperature, cobalt ferrite releases oxygen. When the rings cool to about 2,000 degrees, they're exposed to CO2.

Since the cobalt ferrite is now missing oxygen, it snatches some from the CO2, leaving behind just carbon monoxide -- a building block for making hydrocarbons -- that can then be used to make methanol or gasoline. And with the cobalt ferrite restored to its original state, the device is ready for another cycle.

Fuels like methanol and gasoline are combinations of hydrogen and carbon that are relatively easy to synthesize, Stechel said. Methanol is the easiest, and that's where they will start, but gasoline could also be made.

However, creating a powerful and efficient solar power system to get the cobalt ferrite hot enough remains a major hurdle in implementing the technology on a large scale, said Aldo Steinfeld, head of the Solar Technology Laboratory at the Paul Scherrer Institut in Switzerland, in an e-mail.

He and Stechel said the technology could be 15 to 20 years from viability on an industrial scale.

The Sandia team originally developed the CR5 to generate hydrogen for use in fuel cells. If the device's rings are exposed to steam instead of carbon dioxide, they generate hydrogen. But the scientists switched to carbon monoxide, so the fuels they produce would be compatible with existing infrastructure.

Stechel said the Sandia team envisions a day when coal-fired power plants might have large numbers of CR5s, each reclaiming 45 pounds of carbon dioxide using reclamation technology currently under development and producing enough carbon monoxide to make 2.5 gallons of fuel. The Sunlight to Petrol process also raises the possibility that liquid hydrocarbon fuels might one day be renewable – provided CO2 reclamation reaches a point where the greenhouse gas can be snatched directly from the air. Such a process is being explored by Global Research Technologies and Klaus Lakner of Columbia University, among others.