A Rotating Solar Device

TAPPING SOLAR HEAT TO CREATE FUEL

BY SALVATORE SALAMONE

RESEARCHERS AT SANDIA NATIONAL Laboratories are building a prototype device that will use solar heating to split carbon dioxide into carbon monoxide and oxygen, and water into hydrogen and oxygen.

In theory, the device, dubbed the counter rotating ring receiver reactor recuperator, can clean the flue gases of a coal-fired plant, create hydrogen fuel for use in a variety of applications, and make the starting ingredients for a variety of liquid fuels such as gasoline, jet fuel, and methanol.

Co-researchers on the project are Jim Miller, Richard Diver and Nathan Siegel. They caution that this project is in the research stage and a commercial version is still 15 to 20 years off. However, the device's potential is fascinating in several ways.

"We see it as being very flexible. It takes thermal energy and converts it directly to chemical energy without the normal intermediate step of electrolysis," said Miller. And by creating chemical energy, the technique offers the potential to store energy more efficiently, too.

So what about the name? The prototype will consist of a stack of counter-rotating disks inside a small cylindrical container. The disks will be coated with a reactive, metallic oxide. And the device will sit at the focus of a solar collector or furnace.

Inside the device, as a disk turns, part of the disk enters a chamber where the coating is heated to trigger a reaction where oxygen is freed. As the disk turns another 180 degrees, that part that had experienced the first reaction enters another chamber where it is exposed to superheated steam. The disk's modified material and the water react to release hydrogen and return the material to its original state.

On another stack of disks, carbon dioxide is broken into carbon monoxide and oxygen. The carbon monoxide can then be combined with the hydrogen produced from the other stacks to create synthetic fuels.

Much of work to date has focused on two areas to improve the device's operation.

First, there was pure materials research to enable a more reasonable operating range. In particular, splitting water into hydrogen and oxygen or carbon dioxide into carbon monoxide and oxygen can be done thermally, but it would require extremely high temperatures. This is not especially useful – for example, it is not practical to heat water to that degree.

The team built on the work of others to lower the required temperature to generate hydrogen or turn carbon dioxide into carbon monoxide.

Second, even when added compounds lowered the reaction temperature to a more reasonable range, there was still the chance of other problems including melting – because the reactions still take place at high temperatures, just not as high as before – and consistency where there might be problems repeating the operation.

This led the team to explore substitutes such as compounds that included nickel, manganese, and cobalt. "We sought to manipulate the properties to make the reaction better thermally," said Miller.

They were able to come up with a combination of compounds that enable the reactions to take place at a lower temperature, to avoid melting, and to be more repeatable and sustainable.

The research team has already proven that the chemistry works repeatedly through multiple cycles without losing performance and on a short enough cycle time for a practical device. The lab expects the prototype to be completed this year.

"We just now have to do it all in one continuous working device," said Siegel.

A Sandia researcher assembles a prototype device intended to chemically reenergize carbon dioxide into carbon monoxide.
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