Sorbents capturing CO2 will make power plants cleaner

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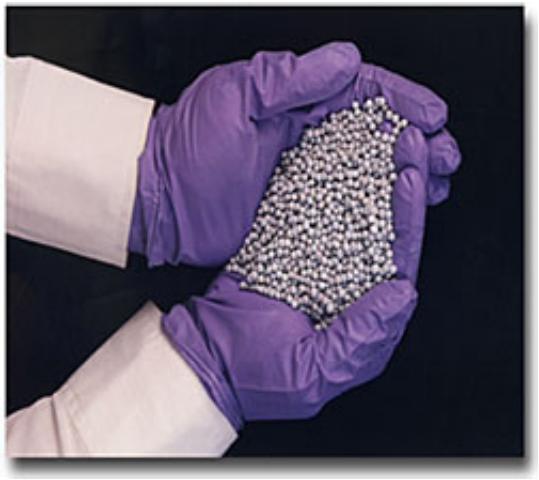

Scientist holding sorbents (pellets) in gloved hands.

When coal is used to generate electricity in power plants, carbon from the coal bonds with oxygen from air to make carbon dioxide (CO2). Due to concerns about how CO2 impacts global climate, scientists at DOE's National Energy Technology Laboratory are developing materials and processes to separate and capture it from power plants for permanent disposal. Ideally, the capture process will not create new waste materials, is quick and efficient, and the CO2 ends up as a high-pressure gas that can be transported in a pipeline to be injected into an oil field or a deep geologic formation.

Researchers at NETL are developing chemicals called sorbents that

absorb carbon dioxide after it is created in power plants. Some sorbents react with the CO2 to create solid materials; these solids can be easily separated from gases in the power plant. Once separated, the solid is chemically broken down into CO2 gas and the original sorbent chemical is recovered, and thus re-used to capture more CO2. Good sorbents have a high CO2 capture capacity and react relatively rapidly with CO2 at temperatures close to those in the power plant. Reversing the reaction to regenerate the sorbent and release the CO2 must also be efficient and the conditions cannot be too extreme.

Fortunately, there are literally millions of possible solid materials that could be used as sorbents, but identifying good ones is a bit like finding needles in a haystack, so NETL researchers use a combination of computer modeling and experiments to identify and test sorbents that will work in a power plant environment.

Computer programs can sort through mountains of thermodynamic data on materials reacting with carbon dioxide, and other programs can calculate those properties when they aren't available. Using these programs together, many new materials can be evaluated rapidly to narrow down the field to the most promising few. Using this methodology, researchers investigated a series of lithium silicates with different Li2O/SiO2 ratios and explored their CO2 capture properties. They found that adding SiO2 to decrease this ratio made CO2 capture more favorable at power plant operating temperatures. This work was described recently in Physical Chemistry Chemical Physics.

A magnesium hydroxide sorbent has recently been developed that can be used for carbon dioxide capture from coal gasification plant gas streams. These gas streams are at high pressures and relatively warm temperatures, and contain hydrogen and steam in addition to CO2. In the process, CO2 and Mg(OH)2 react to form magnesium carbonate at 150-250 °C and 380 psi, followed by breakdown of the magnesium

carbonate above 350 °C and regeneration of Mg(OH)2. Because the process can work at higher pressure, it takes significantly less energy to compress the CO2 to make it ready for pipeline transport. An analysis compared a theoretical integrated gasification combined cycle (IGCC) plant using the Selexol process, a competing CO2 capture method, with one using the proposed Mg(OH)2 process. Using the magnesium hydroxide sorbent, the plant required 62% less energy to compress the CO2, and the overall efficiency of the plant increased by 1%. U.S. Patent 8,470,276 has been issued on the new process.

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