Go Inside an Industrial Plant That Sucks Carbon Dioxide Straight Out of the Air

Source: technologyreview.com

Published: June 6, 2016

by Peter Fairley

Carbon dioxide emissions must decrease to nearly zero by 2040 if global warming by the end of this century is to be held to 2 °C. But we may well miss that target. A pilot plant started up last fall at Squamish, British Columbia, is testing a backup plan: sucking carbon dioxide directly out of the air.

Capturing ambient carbon dioxide is a tall order because, for all the trouble it causes, the greenhouse gas makes up just 0.04 percent of the air we breathe. The Squamish plant can capture one ton of carbon dioxide a day. Significantly reducing atmospheric carbon dioxide levels would require thousands of far larger facilities, each sucking millions of tons of carbon per year out of the air.

Carbon Engineering CEO Adrian Corless

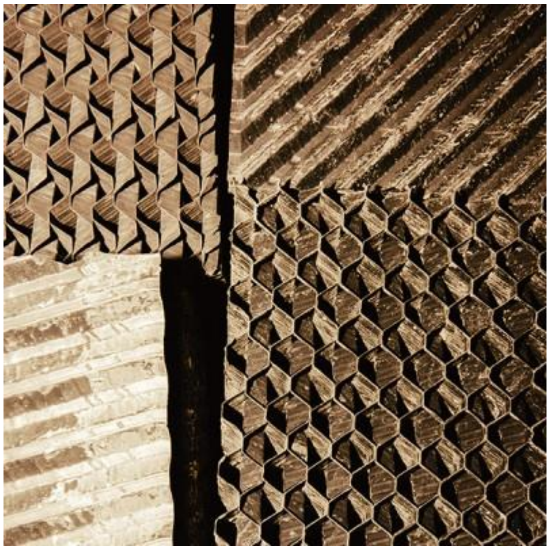
The plant is the brainchild of Calgary-based Carbon Engineering and its founder, Harvard University physicist David Keith. While some scientists have estimated that direct air capture would cost $400 to $1,000 per ton of carbon dioxide, Keith projects that large plants could do it for about $100 per ton.

“We’ve taken existing pieces of industrial equipment and thought about new chemistries to run through them,” says Adrian Corless, Carbon Engineering’s CEO. The company captures carbon dioxide in a refashioned cooling tower flowing with an alkali solution that reacts with acidic carbon dioxide. That yields dissolved carbon molecules that are then converted to pellets in equipment created to extract minerals in water treatment plants. And the plant can turn those carbonate solids into pure carbon dioxide gas for sale by heating them in a modified cement kiln.

In May the company closed on $8 million of new financing in Canadian dollars ($6.2 million in U.S. dollars) from investors including Bill Gates. Keith also hopes to start winning over skeptics. “Most people in the energy expert space think that air capture is not particularly credible,” he says. “There won’t be incentives and funding in a serious way for these technologies unless people believe that they actually work.”

Carbon dioxide is captured within the plant’s gas-liquid contactor, which is essentially a repurposed cooling tower. An alkaline solution in the contactor reacts with acidic carbon dioxide in air to enrich the capture solution with potassium carbonate.

The contactor contains 80 cubic meters of plastic packing whose three-dimensional honeycomb structure offers 16,800 square meters of surface area. The setup removes 75 to 80 percent of the carbon dioxide in the air.



Left: The capture fluid, now rich with carbon dioxide from the air, circulates to a 13-meter-tall reactor. Right: Calcium hydroxide is added to the capture fluid just before it enters the reactor, causing two products to be created inside. One is solid calcium carbonate containing the captured atmospheric carbon. The second, potassium hydroxide, flows back to the air contactor to capture more carbon dioxide.

As fluid moves up through the reactor, growing pellets of calcium carbonate spread out in a gradient, with the smallest pellets at the top. Pellets can be removed via these sample ports and analyzed in order to optimize the process.

The heaviest pellets settle at the bottom of the reactor and are periodically removed, washed to remove fine crystals and capture fluid, and dried. The finished product is solid grains of calcium carbonate that resemble a fine couscous.

Controlling the formation of calcium carbonate crystals is critical. Fine crystals serve as seeds for future pellets, ensuring the sustainability of the process. Too many fine crystals, however, produce a caustic sludge that's difficult to process.

Dried pellets are fed into the calciner, in which a 900 °C inferno of natural gas burning in pure oxygen roasts a rolling mass of calcium oxide. The calcium carbonate pellets spontaneously break down, producing more calcium oxide and releasing carbon dioxide gas.

Calcium oxide mixed with water regenerates calcium hydroxide for use in the pellet reactor.

Next up at Squamish: turning captured carbon dioxide (now vented back to the air) into a low-carbon transportation fuel. By reacting carbon dioxide with hydrogen, Carbon Engineering plans to synthesize a fuel with less than one-third the carbon content of conventional gasoline. Corless estimates the fuels will cost $4 to $6 per gallon, but he expects to fetch a premium in places such as California and the European Union, where mandates require fuel suppliers to reduce their carbon content annually. Ultimately, says Corless, fuel from air capture may prove crucial to break the fossil-fuel dependence everywhere.