Construction Begins on New Carbon-Capture Plant

The Texas plant claims that it will be the world's first commercial carbon dioxide mineralization plant, transforming the greenhouse gas CO2 into baking soda

Michael Parker, Scientific American, 10-3-13

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The term "carbon capture and storage" seems only to appear when shortly followed by "not commercially proven" or "in development". But construction has now begun on what will be the world's first commercial carbon dioxide mineralization plant, in which carbon dioxide greenhouse gas is transformed into baking soda.

Skyonic has been developing its patent-backed carbon capture process since 2004. The principle is to turn gaseous waste products including CO2 into valuable industrial chemicals that can be sold. The technology, Skymine, is a self-contained unit about the size of an articulated lorry, set up at power stations or industrial installations such as steelworks or petrochemical plants. Construction of the first commercial Skymine plant began this week alongside the Capital Aggregates cement works in San Antonio, Texas. When completed in 2014, it will capture around 83,000 tons of direct CO2 emissions and create around 160,000 tons of bicarbonate, preventing 300,000 tons of emissions in total.

The process is powered by using the heat in waste gases from industrial chimneys to generate electricity. First the carbon dioxide, sulphur dioxide, nitrogen oxides, and heavy metals like mercury are scrubbed from the waste gases. The latter are stored, and the CO2 enters absorption chambers where it is treated with sodium hydroxide – caustic soda – made from salt (sodium chloride, or NaCl) and water (H2O). The chemical reaction that occurs is: CO2 + H2O + NaCl —> NaHCO3 + H2 + Cl2.

Put another way, carbon dioxide, water and salt react to produce sodium bicarbonate (baking soda), hydrogen gas and chlorine gas. Hydrogen and chlorine gas have commercial uses themselves, or both can be easily dissolved in water to create hydrochloric acid (HCl), an important industrial solvent. Even the poisonous extracted mercury has value. "A few kilos of mercuric oxides in solid form is much better than spreading it about far and wide as aerosols in the air," Skyonic CEO and founder, Joe Jones said. "And we will sell that to other people who will mine it for rare earth minerals like yttrium, niobium, vanadium, many of which are highly prized per microgram."

The market for these products, and the products which they are used to manufacture, is enormous. "In North America alone the market for carbonates, soaps, limestone products used in making paper, cement, or fine chalks is with US$7.5 billion," Jones said. "Even if only about half of that is lucrative, we'll be able to drive down the price of carbon sequestration process to around US$20 per ton. The market will deliver the most sequestration at the least cost to society."

Also acting in Skyonic's favor are regulations that already require polluters to scrub out sulphur and nitrous dioxides that cause acid rain. Jones says his process can do it cheaper than the current commercial scrubbers that cost hundreds of millions of dollars, and millions more on annual maintenance. Even the baking soda, lime, and acid products can be created more cheaply from the carbon dioxide stream through Skymine than from traditional methods. New, tighter EPA regulations on power station emissions enacted recently may also drive interest in his technology – energy firms such as BP, ConocoPhilips, Luminant and Cenovus have already backed Skyonic to the tune of US$128m.

The question is, can this baking soda process save the planet from runaway climate change? Jones, himself a chemist, is realistic. “Skymine by itself cannot save the world, because the sodium-based product market by itself could only support 200-250 plants worldwide,” he said. But a second design, code named Skycycle, that will manufacture calcium-based products like chalks and limestones, might be able to.

“In this county alone there are more than a pentillion tons of limestone, that contain more CO2 than has or could be generated by all fossil fuels for all time,” Jones said. “Disposing of CO2 as solids has already been proven to work over very long, geological periods of time.”

Despite the straightforward chemistry, it’s the first attempt at mineralizing carbon in a way that is commercially viable and carbon negative. The method seen as more mainstream is to capture the CO2, transport and inject it in gaseous form into subterranean geological formations. The UK has a great number of these, Michelle Bentham, senior geoscientist at the British Geological Survey. “We have lots of suitable formations offshore, and lots of oil and gas fields, in which the gas and oil collects in the same way the CO2 would.”

The so-called reservoir rocks such as sandstone are filled with tiny holes known as pore spaces which are microns in size, into which the CO2 is forced, eventually bonding to the rock. While the technology required at each stage – scrub, capture, transport and inject – are well-established, commercial schemes have been held up by economic, not technical questions.

“There are still unanswered questions until we actually do it, but I have no doubt that carbon dioxide can be stored in that fashion,” said Bentham. A Norwegian drilling firm has been carrying out a similar process since the 1990s – stripping CO2 from oil and gas as it is extracted and then injecting millions of tons of it every year back under the North Sea.

Judith Shapiro, policy and communications manager for the Carbon Capture and Storage Association, a trade association, said the Skyonic project was promising, and demonstrated that there were different ways to going about capturing carbon. “But I’d say that scale and challenge of climate change is such that it’s unlikely the mineralization process would be sufficient,” she said.

For comparison, the US alone produced 5.5m tons of CO2 in 2008, compared to the estimated 83,000 tons Skymine would remove. “In terms of the time we have and volume we’re producing, it’s just not possible be able to mineralize that amount of carbon dioxide.”