New CO_2 applications

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The carbon dioxide (CO_2) industry expands organically, at around 3% annually in some markets. The best way to grow more rapidly in the industry is via the development and implementation of new and unique applications in a wide variety of markets.

CO_2 applications, of a traditional nature, are tried and true, such as many uses in food processing, beverage carbonation, and a range of industrial uses. On the other hand, new and green and often cryogenic applications help sustain the industry.

As for new or newer applications for the product, most of these are of an industrial nature, generally outside of the food and beverage demands. Food and beverage applications often account for 70% of all tonnage consumed in the merchant sector. There are also demands of a captive and sequestration nature, which in my view, are generally categorised outside of the merchant markets, such as large EOR (enhanced oil recovery) usage. There are many conceptual ideas for the application of CO_2 in industry, many of which have a green take, a form of sequestering CO_2 molecules in everyday products. There are other applications, which are relatively new to the industry, which are being applied and expanded in the markets, such as concrete dosing.

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On a long-term basis, given the global interest in reducing carbon emissions, concerns for climate change, and a warming globe, more applications are being developed all the time, many of which have been initially developed in academia, and have not been scaled up, or commercialised. Some of the technologies outlined in this article may plan to use subsidies in order to make them economically viable, at least for the short-term. Of so many technologies which claim to produce a fuel, chemical, plastic or recover flue gas cheaply, the longer term viable commercial results will speak for themselves. Of the technologies being announced all the time, some will eventually be commercialised, and take their place in the CO_2 and sequestration industries, while others will not.

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Applications

There have been a number of emerging technologies which are proposing the use of CO_2 in the production of various plastic and building materials, some of which could replace hydrocarbons in plastics, which is a truly green usage.

Further on this subject, the ultimate goal of successfully using CO_2 from flue gas to produce useful products, along with sequestration, would represent a double achievement. Some of the concepts below, could eventually yield true break throughs, when scaled up. The problem with flue gas over the years has been the very high cost of recovery and production into a viable CO_2 product which would meet required standards and specifications. Of course, the industry is often concerned with producing a CO_2 product which will meet the standards for use in soft drinks and food processing. Such applications which represent a high percentage the CO_2 merchant market in the US, are not those which sequester carbon dioxide, but use the BTU value, and perform via their physical properties to achieve results. Such CO_2 is eventually returned to the atmosphere. Some new or conceptual applications are as follows.

- Carbon nanotubes, via molten electrolysis, the process requires electric power for converting CO_2 into carbon fibres, or nanotubes. Such nanofibres could be used in carbon composites. Such composite materials are lightweight, alternatives to metal, to make a variety of products such as bicycles, one of which I have which is very light and rigid. Other products could be airplanes, and turbine wind blades. Such sources for the raw CO_2 for this process, could ideally be flue gas from a power plant, or other such stream, like a cement kiln.
- Concrete dosing with CO_2 is an outstanding way to create a form of sequestration, as well as strengthen the concrete via increasing the calcium carbonate content in the concrete. This is a relatively new application, now being used across the US, to a degree.
- Bioplastics – nanoparticles for plastics and building materials such as coatings and concrete is a possible sink for CO_2. In some cases, bioplastics have been developed among those in universities, where some technologies have moved to the field, and are looking to commercialise. One start-up combines CO_2 with by-product waste materials such as the products of coal and coke combustion, using fly ash, for example.
- Another technology with a start-up is in the field of bioplastics again, using flue gas as a CO_2 feedstock. This licensed technology is a California-based company under the name Newlight Technologies.
- Methanol is the product of a team looking to develop an artificial photosynthesis process to convert CO_2 into methanol. Of course methanol is a common solvent or industrial chemical, used as a fuel, and in a variety of personal and industrial products. Here is another example of a sequestered or converted CO_2 into a useful common solvent. A team in India under the name Breathe is working on this process.
- Chemicals and bio composite foam plastics. This is another take on recovered CO_2 for the production of ethylene glycol, methanol, and foam based plastics. In this case, natural materials such as sawdust, wood, and rice hulls are the backbone for such products.
- Enhanced geothermal systems (EGS), using CO_2 as a working fluid. Supercritical CO_2 could be utilised in these systems as a circulating heat exchange fluid. In this case, using the density difference between cold CO2 flowing down the injection wells, and the hot CO_2 traveling up these wells would eliminate a need for a circulating pump. Further, CO_2 could be used as a working fluid in supercritical power cycles. This application works well with compact turbo machinery.
- Polymer production, where CO_2 could be used as a feedstock via transformation of CO_2 into polycarbonates, using proprietary zinc catalysts.
- Transformation of CO_2 from power plant flue gas could be chemically transformed into industrial fuels and chemicals. Such a process, which is under development, would use renewable electricity to reduce CO_2 to CO. the carbon monoxide is a key product used in various industrial processes. The CO_2 would be fed into catalytic reactors which chemically transform CO_2 into fuels and chemicals which emit only oxygen. Some technologies like this, are being developed by university researchers.

Costs, scale-up and commercialisation

The above technologies are a few of those which have been discussed, developed and even implemented to a degree. The ultimate challenge is to move applications from the lab to a successful pilot project in the field, and scale up in order to make it economically feasible.

As with all other developments, industries and processes, such applications need to be competitive, as standalone, scaled-up technologies, or they would need to have ongoing subsidies in order to commercialise. I often think of most current day, proven technologies which have been used successfully, albeit expensively, to recover CO_2 from flue gas. The agent of choice over the years has been MEA (monoethanolamine) or a similar amine solvent in the front end of most commercialised plants, such as those which have operated by companies in the US like the AES Corporation. AES operated flue gas recovery operations from coal-fired cogeneration facilities for decades in the US, which were developed under now defunct energy laws which used the co-generated steam as a thermal host in the MEA process.

This subsidy essentially included the capital cost of the expensive CO_2 recovery plant in the cost of the power plant, thus considering the cost of CO_2 production to only be that of utilities, labour, and maintenance. With today's 45Q tax credits in the US, a significant number of companies are looking to recover CO_2 more cheaply, and/or apply the CO_2 in useful products. This is a form of subsidy which would provide a performance-based tax credit to power plants and industrial facilities which capture and store CO_2 which would have otherwise been emitted to the atmosphere.

The credit is linked to the installation and use of CO_2 recovery equipment on industrial sources, such as gas or coal power plants, or facilities which would directly remove CO_2 from the atmosphere. The recovered CO_2 would then be applied in products such as construction materials, biofuels, enhanced oil recovery (EOR), and sequestration into aquifers, for example. The value of the credit depends upon the type of CO_2 storage which results from the process. Eligibility for industrial facilities begins with 100,000 metric tons per year, including ethanol and fertiliser production. The value of the credit is now $35/ton for EOR, and $50/ton for CCS.

Of course, there is much more than EOR related to technologies and products which these developers hope to commercialise, such as fuels, plastics, and chemicals for industry. A technology developer recently had a discussion with me where they would use a cryogenic technology in part for the recovery of CO_2, where their liquid product could be sold to the markets; with the CO_2 source being power plant exhaust. This is another take on recovering CO_2 for various markets, and many more news releases and articles will appear on new or novel means of recovering CO_2, from primarily power plant flue gas; and the production of useful fuels, plastics, and chemicals which sequester or convert the CO_2 and thereby eliminate more carbon emissions.

There are many takes on technology, and desired products which could be produced should the technologies actually be scaled up successfully. Long-term, I believe some of these technologies will be scaled up both successfully and affordably. The Earth is our home, and there is no replacement; therefore a reduction in carbon emissions is key for the Earth to prosper. For the gas companies, all applications are important, as well as methods for sequestering CO_2 into useful products for everyday life. gw

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