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A 'green' perception of CO2 – when derived from biofuels and other sources

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Yes, carbon dioxide as a green chemical – however, what about the effects on the environment and economy?

Carbon dioxide is ever – more a green – natured agent when applied in a growing number of industries. Further, it is often difficult to think of carbon dioxide as a green chemical or gas, when at first blush, CO2 is indeed the greatest greenhouse gas by volume; not the worst of all heat trapping gases, but the greatest (by volume) when emitted. All of this is relevant to the industries which produce a CO2 by-product or flue gas; as well as those gas companies which recover, refine, and sell the product to the merchant markets.

By many accounts, CO2 atmospheric levels are in excess of 400 ppm, a record by modern standards, while noting CO2 levels have steadily risen since the beginning of the industrial revolution; however accelerated during the last number of years and decades. In the end, it is clear to see the often dire effects which climate change can take, as evidenced by melting glaciers and the shrinking artic ice. Perhaps the most daunting image happens to be the drowning of, and unlikely relocation of polar bears. Then, it is important to note since the 1960s, over some 40 years, CO2 atmospheric content has increased by a factor of 20%. This is indeed, truly unsustainable.

However, there is hope to turn the tide, or at least arrest the accelerated growth of carbon emissions, via many small steps; and major steps toward CO2 emissions reduction schemes. This can start with green CO2 applications from planting more green life, trees, and even more commercial greenhouse crops; to large ventures such as enhanced oil recovery (EOR) projects, which can truly sequester & recycle CO2. Many green CO2 applications are essentially well proven and are now essentially old technologies, which continue to work well. Ahead we go toward

developing additional green and environmentally friendly carbon dioxide uses in industry; as well as improved methods of sequestering the product.

Changes in the perception of applications – if even for economic reasons v. perceived green results are the motivating factor

The problem with CO2 sequestration and carbon reduction schemes is the lack of economic return for many purely sequestration projects, unless government funding or subsidies are guaranteed. Then, the challenge is to find projects which are truly green from a sequestration perspective, while they weather the test of economic returns. With this in mind, EOR may be on the top of the list, in terms of receiving potential and real economic returns from the application of carbon dioxide which achieves carbon sequestration as well. This represents incremental returns from the rater long – term investment in EOR, often running from years to many decades in duration. Otherwise unobtainable oil is recovered, plus CO2 is actually sequestered in the geological formations. Therefore, in some ways, CO2 emissions are essentially ‘taken off the table’. Of course, we have 45Q and the IRA; however today, with the turn away from science by politicians, all of this is at risk.

Then we also have the ongoing arguments surrounding absolute removal of carbon by-product into various modes of sequestration v. only displacing the CO2 into various markets via a wide range of uses in industry. Sequestration v. displacement of CO2 via applications is perhaps a matter of perception; however some of this is rather clear. It is truly clear to see applications which replace harmful, carcinogenic, and toxic agents such as various halogenated hydrocarbon compounds (such as ‘perc’ in dry cleaning environments) v. carbon dioxide, which is an excellent solvent, without the terrible legacy associated with dry cleaning operators developing cancer; which is common in the industry. When thinking in terms of economic gains received via certain green applications, the greatest example of this, perhaps, would be EOR applications, which have proven to be effective in recovery of oil as well as sequestering CO2; all dependent upon the geology of the well. Below, I am reviewing a number of common and proven green applications used in industry.

All of this is important to the readers of this article, particularly to the gas company professional, or those in science and business who can make the most of applying and sequestering the product; where markets can be enhanced by more use of the ‘green – related’ CO2 applications; both in terms of gaining more CO2 market share, and increasing revenues. Further, many of these new developments in industry essentially create new CO2 business from otherwise applications of solvents and chemicals of a noxious nature.

Green applications typical for carbon dioxide in industry

CO2 as a solvent – Supercritical extraction: Essential oil

extraction, decaffeination of coffee and tea – Of course supercritical extraction of essential oils has both food – related and for cosmetic applications. Flavoring agents, essential oils, and of course caffeine removal from coffee and tea are among the major applications for supercritical extraction. This has the benefit of eliminating sometimes hydrocarbon – based solvents from the process in lieu of a food grade CO2 which has no residue, and is harmless to the consumer. Products of this process can then be labeled ‘natural’. **Dry cleaning industry:** It has been said many of the dry cleaning industry’s long term workers who have used ‘perc’ for years, often end up with a variety of diseases including cancer and organ damage; however when applied in specially designed machines, CO2 is an excellent solvent, for a truly healthy dry cleaning environment, which also yields outstanding cleaning results from the process.

CO2 as an acid – Water treatment and Ph reduction: This is a long – lived and well proven application, which in many world markets dates back half a century; but has a long way to go in terms of use in public and private industrial settings. The application of CO2 is sometimes found in municipal water treatment plants. Many such municipal treatment plants in places such as the US Midwest and Southwest have particularly hard water. Often such plants use lime as one of the basic chemicals for the softening process; and CO2 is then often the logical and natural option for Ph reduction v. using other agents. Further, the application can be sought to help reduce calcium carbonate scale within the distribution system, where literally calcium scale can fully plug up the water lines. Then, the application is an environmentally friendly alternative to mineral acids (hydrochloric, sulfuric, and nitric), where CO2 by-products are benign carbonates and bicarbonates v. sulfur compounds from sulfuric, for example. In the end, this application should be explored fully in all industries which have effluent, or a need to reduce the Ph, which are otherwise being treated by other agents, such as mineral acids, and of course evaluate opportunities in municipal treatment systems. How much greener can we get than naturally purifying and reducing the Ph in the water we drink?

CO2 in a gaseous form for agricultural uses: Perhaps another very ‘natural’ form of CO2 usage in a ‘literally’ green (flower and plant growing) format would be the application of CO2 for greenhouse plant growth enrichment. In this context, of course, photosynthesis is enhanced with the CO2 content elevated from our current levels near or at 400 ppm to ~1,000 ppm; and the plant growth factor is estimated to be enhanced up to 50% with this treatment. Overnight, the application occurs, and in the years and decades past, greenhouses often used fossil fuel combustion flue gas to obtain some boost in CO2 content; but not very concentrated; with a noxious mix of gases v. pure CO2. Then, various projects worldwide have evaluated the use of CO2 by-product streams from traditional source production, such as ethanol. Also, during the high development days of US cogeneration projects, greenhouses served as a ‘thermal sink’ for the cogeneration flue gas. **Insect fumigation :** In lieu of using

various chemical agents for insect control in grain storage facilities, CO2 maintained at about 50% by volume in the atmosphere, for 4-7 days, generally in warmer climates over 60 degrees F, is an excellent means of eliminating chemical agent, and controlling insects; in a very green way. This application would be particularly interesting to buyers of grain products which are labeled ‘natural’ or language relating to being processed in a ‘green’ manner. **Algae farms**: As algae is an area with is being embraced more readily for applications in biodiesel, such as extraction of algae oil for biodiesel projects, CO2 is of course one of the raw ingredients required for algae growth. Everything from power project flue gas to merchant CO2 deliveries have been used in algae projects, which remain in early stages of development; when thinking of commercialization for large biodiesel projects. As a small usage requirement, CO2 is used from micro-bulk storage for algae growth; and algae can serve as a foodstuff for shrimp and seafood farms; then this seafood or their prodigy end up on our dinner tables. This is green CO2 usage found in an everyday food industry context.

The application for CO2 in the cannabis industry has been a component of such closed greenhouse enrichment; as well as the use for supercritical extraction of CBD oil. I understand today, perhaps due to politics and the perception of a saturated cannabis market, that some of this activity is flat. More than likely, growth will continue in these sectors in the future.

Bioplastics: There is the potential for development of bioplastics and utilize CO2 to replace hydrocarbons; and the long term potential outlook, in my view if bright, with respect to this subject. I feel this would be one of the most extraordinary green developments to occur in the future, is to bring such technologies to scaled-up reality; which in some cases are hoping for gaining traction by 2030. Companies such as Fortum Carbon 2x of Finland; and in the US, Newlight Technologies/Air Carbon, with their Thermoplastic material. This field holds significant promise.

Dry ice blasting: This of course has been promoted for some years as the logical, clean, and safe alternative to various forms of cleaning, from a menu of solvents, to sand, for example. Dry ice blasting inquiries from independent gas producers in developing countries continue to grow, where this has been the basis of new CO2 producer start-ups in some cases. Even though this represents a small percent of total CO2 sales, it is a means of selling and supplying a greater service which entails the use of the CO2. It represents far more than the price of the commodity as a unique and clean form of removing a wide variety of materials from many surfaces. The lack of leaving behind a mess is perhaps the greatest advantage found.

Enhanced fossil fuel yield: Under this heading, the most obvious, perhaps, is EOR, which achieves various tasks, primarily enhanced recovery and revenues from oil; and secondly, a viable form of sequestration. EOR project interest has literally exploded in North America. A very finite number of ethanol projects in the

US have their CO2 by-product delivered to EOR projects by pipeline; and many more such projects are under evaluation for possible development. Since oil and gas production in North America is significantly on the rise, plus the potential and true need to recover as much oil from otherwise depleted wells is now fostered more than ever, and some believers in climate change, more EOR developments will occur – a major driver is 45Q and the IRA.

There is also enhanced coal bed methane removal and replacement of such methane molecules with CO2; and over the years, both N2 and CO2 have been tested, and in some cases, utilized in this field.

Thinking of Canadian projects with interest in sequestration and government subsidies, going back a number of years, occurred in Saskatchewan, is Sask Power, which had work to sequester over 1 million metric tons of CO2 from a coal fired power plant, their 140 MW unit 3. The ultimate goal was to expand the Weyburn oil field, which delivered through a 40-mile pipeline the CO2 recovered via MEA technology. The pipeline, by Cenovus Energy, was the oil company expanding the EOR project. This represented real change from a greenhouse gas emitted from power production, both to enhance oil recovery and achieve CO2 sequestration all in one. Further, in my work spanning over 30 years consulting on CO2 sources, I always felt the CO2 from power plants, has been some of the best located raw CO2 gas for recovery. However, there is much work to do, in terms of developing federal help to subsidize such projects; and reduce airborne emissions. The CO2 from power plants represents, per some estimates, around 40% of all emissions. I have party to one 500 TPD new ethanol by-product ventures with CO2 by-product to the oilfields in the recent term; and this is truly gratifying.

Cleaner sources of energy are being halted in the US today; and we have to know, from a long term perspective, this is temporary. Biofuels are a large part of this equation, and should the Summit Energy Pipeline actually be consummated, constructed, and become operational to sequester the CO2 emissions of over 40 ethanol plants primarily in the Midwest; this a significant sum of CO2 being sequestered.

The Current appetite for CO2 projects has shifted: I believe many ethanol firms are ‘on the fence’ waiting for the outcome of the Summit Pipeline to go one way or the other, since due to a number of setbacks, such as South Dakota refusing to allow the line to cross their state; this may never occur – or perhaps it will, however, taking a very long time, most likely. Most of the traditional CO2 sources are generally ‘taken’, or otherwise unavailable for new merchant projects; options are few and far between for new CO2 merchant plants. One bright spot is biogas, which in some markets, is making headway, in terms of producing RNG; there are some efforts to utilize the CO2 product, in refined and liquefied form, and profit from the overall endeavor. Technologies from wood waste, and biomass are also candidates

for CO2 projects in some cases; based upon the nature of the project, and markets served. All new CO2 sources of course are driven by markets, economics, and location. There have been very few new CO2 sources developed in the US over the last two years, by the way. However, things change, technologies change and are developed, and new opportunities arise. Hopefully, there will be more CO2 recovery from projects which yield the product; and foster a greener and healthy environment.

Then, when looking at this, as well as other applications, isn’t all of this representative of changes for the greater good, and in favor of a green economy and environment; while using a gas which, by volume, has been the greatest offender? It is important for the CO2 suppliers to focus on green technologies, some of which will take business from ‘competing’ chemical agents used in industry v. only using CO2, and expand markets. This is more than perception alone; it is truly green in nature.

About the author:

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