CARBON DIOXIDE FROM AMMONIA PLANTS—AN EXCELLENT REVENUE SOURCE SERVING AN INTERESTING AND DIVERSIFIED MARKET

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Background

As of today, without the deployment of new merchant CO2 plants, there are about 23 standing CO2 plants, which are fed by ammonia by-product raw gas. This represents about 21% of the total number of ammonia plants serving the merchant sector. The total number of merchant CO2 plants is around 111 in the United States. Further, numerous additional CO2 plants are under consideration, or are possible, as facilities to be built alongside future ammonia ventures. Globally, the merchant CO2 market is over 20 million tons annually, and North America is over 10 million tons in merchant demand.

CO2 plants are required to liquefy and purify the commodity that is recovered from anhydrous ammonia sources, and other chemical and energy sources. Such liquid is used to satisfy the extraordinary CO2 market demands of a very diverse nature.

The lion's share of anhydrous ammonia is dedicated to the agricultural sector. However, there are other industrial applications found. The CO2 income stream is equally important to the ammonia venture, given that long-term revenues are often available, lasting for decades.

All ammonia and CO2 source ventures should take a fresh look at CO2 as an excellent opportunity for future revenue developments. Monetizing the CO2 is probably the primary reason for recovery and marketing the product. The second reason, of course, is environmental. Further, opportunities via tax credit-based sequestration are a good possibility. Whether such sequestration is via class VI wells, pipeline, or the manufacture of enhanced fuels, chemicals, and building materials, this is a way to monetize CO2 from ammonia plants. On a daily schedule, over 75 million tons of CO2 are emitted globally, of which some 66% of this greater estimate is not sequestered by natural means (oceans, soils, photosynthesis, etc.), and this value may be growing every day.

CO2 plant alongside raw gas source.

Applying anhydrous ammonia on the field.

Markets are key to making a commercial CO2 project work, unless the aim is some form of sequestration where carbon–based tax incentives make these efforts work economically. On the other hand, all of the approximate 23 CO2 plants from ammonia in the U.S. potentially have one form of a market or another,and revenues from the sale of CO2 to the right or best-suited markets can mean a steady stream of income for decades ahead. The need to bring in money from all viable by-products in an ammonia project is more important than ever, for long-term sustainability. Further, since the U.S. and global markets have consolidated so much, taking a strong look at directly entering the markets makes sense more than ever.

CO2 Market Opportunities—Should it be Wholesale Raw Gas or Direct Marketing to Consumers?

Some decades back, in the U.S., some of the source (i.e., ammonia, reformer/refinery) plant operators and owners were (and still are) the same parties who owned and operated the CO2 plant near the raw gas source operation. Today, only a very few independents that recover and market CO2 thrive in the U.S. as direct sales to consumers. As mentioned before, most of the CO2 independents have been acquired by the majors. As it goes for the time being, and the future, the time is right for new CO2 independents to rise and take advantage of market opportunities for the sale of CO2 direct to the markets. Since the emergence, and growth of the major gas companies, most of the raw CO2 has actually sold to the major corporate industrial gas refiners—which is also generally the marketing operation for the CO2 merchant.

What is needed today in North America are more direct CO2 marketing schemes. Direct sales from the ammonia plants to the markets can be found outside of the U.S. in some cases, and they prosper greatly from the CO2 revenue income.

One fact supporting direct sales of CO2 by the ammonia, or other CO2 sourcing firm to a limited merchant or niche market, is a large margin difference between the raw gas price to a refiner/gas company. In the U.S., raw gas prices range from $5 to $25/ton v. consumer market prices usually averaging around $90 to $120/ton—and in some higher priced markets with little regional competition, or no local supply, can be $200 to $300/ton. It will be necessary to evaluate the costs of production, distribution, and overhead, initially to consider wholesale raw gas sales or direct markets. Further, once markets are understood, and the costs and requirements for producing CO2 for the merchant trade is known, along with distribution, then potential risks for direct marketing can be properly evaluated. Numerous cases exist where a niche market or a specific region would make the most sense, in terms of directly marketing the commodity—and a true opportunity to produce much stronger revenues.

CO2 has a Wide Variety of Uses—and Always Growing

In developing economies, the lion's share of CO2 is dedicated to beverage carbonation, with some sold to welding shops and as a cylinder gas for fountain service or fire abatement. This was also the nature of the merchant or commercial CO2 markets in America some time back. Years ago, there was a great deal of CO2 which needed to be sold by the gas companies, and which was simply being vented by a large number of industries. This was an impetus for developing more markets for the product. What emerged ahead in due time was the application for CO2 liquid in food processing environments—this was largely the use of liquid, stored on site at a food plant and used for so-called IQF (or individually quick frozen). This involved laying out a food product to freeze well, and not stick together in a cryogenic freezer, and sending it on a straight thru, multiple pass, or spiral type configuration. Other freezers using CO2 exist, such as the tumble freezer, for products such as pizza toppings. CO2 liquid is injected into a blender or grinder, which uses the cold nature of this liquid, and is then 'flashed' at atmospheric pressures into a fine CO2 'snow.'

The nature of refrigeration and cryogenic freezing is often calculated by a BTU value that would have to be removed to achieve a temperature to simply cool, crust-freeze, or freeze completely. These values are calculated during planning stages in order to closely estimate CO2 usage, dwell time in a freezer, and freezer size. CO2 is delivered via insulated piping from storage vessels into the freezer, blender, grinder, etc. via insulated piping. However, sometimes the liquid CO2 is vaporized for a gas flush or a so-called modified gas environment—intended to preserve the food product, yield an improved appearance, and reduce the bacteria count. Such CO2 applications probably amount to 40% of the average developed economy's usage of the commodity at large—where some very large plants can use hundreds of tons of CO2 daily for food processing. Thus, if a plant is dedicating their CO2 product to a region that has many such food plants, this represents a captive market of sorts. Of course, the soft drink carbonation requirements for CO2 are straightforward, in terms of using CO2, and some breweries that do not recover sufficient CO2 via fermentation, may then require merchant product to supplement this need. Also, some large breweries use the gas to backpressure their systems rather than to actually directly enter their product. In many developed economies such as the U.S., the food and beverage applications for the product can be some 70% of all merchant product sold. This excludes captive use for making commodity or specialty chemicals, numerous industrial uses, enhanced oil recovery

Cryogenically frozen food.

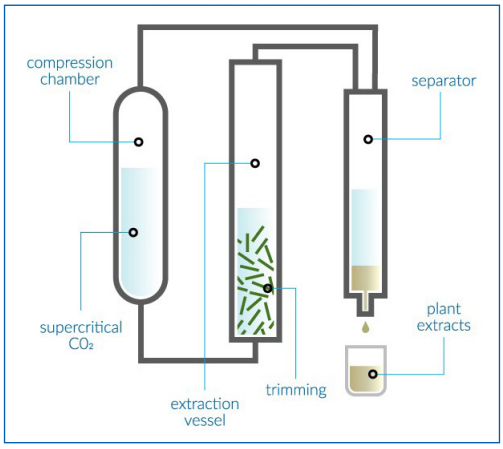
(EOR), and niche markets of a unique nature like recovering natural gas molecules from coal bed seams and replacing this natural gas with CO2.

The next broad sector, outside of food and beverage applications for CO2, would be a large industrial sector. In most cases, one grade of CO2 is produced at most merchant plants. This standard grade is a high-quality product, usually meeting beverage standards, and should the plant sell any product to the beverage industry, this is known as 'ISBT grade.' So, outside of a captive EOR application for CO2, the beverage grade will suit all parties. The only exception to this is a very small market, essentially a specialty 'USP-grade' version meeting pharmaceutical production and medical usage standards. This type of CO2 is used for respiratory stimulation in emergency rooms and similar settings. The USP grade is produced in specific plants, and is usually not the concern of smaller players, or even some of the major suppliers.

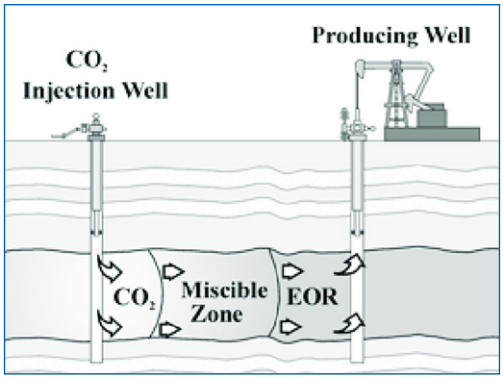
As for the industrial sector of CO2 markets, this includes the application of CO2 for water treatment—processes and municipal plants using the product in water softening plants, and for pH reduction. Carbonic acid is formed from CO2 and is a weak, environmentally friendly acid when in water and under given pressures and temperatures. The use of CO2 for pH reduction has also been a safe acid replacement material in the paper and pulp industries, as well as effluent from chemical plants, and food processing facilities—where an alkaline stream requires treatment. The incorporation of CO2 in fire extinguisher settings is as old as the industry happens to be. The same goes for the many uses of CO2 in cylinders for the welding and soda fountain industries, and similar small-usage requirements. CO2 has been popular in some metallurgical settings, as a stirring medium for large molten metal processes, and for use in some foundries as a coolant. The application of CO2 in rubber, rubberized belt, and some plastics manufacturing has been around for some time. CO2 can help control insects in sealed grain elevators, holds, and ships, and has been popular in warm climates in lieu of numerous chemical agents often considered harmful to health.

When in the form of dry ice, CO2 is popular in a wide variety of settings and sells for a price many times higher than a liquid product, generally speaking. Of course, dry ice is used in huge quantities food processing industry for food preservation and shipment. Dry ice has many uses as a portable coolant, which sublimates as it cools, and of course has a limited life. Dry ice has grown in popularity in so-called 'blast cleaning' applications whereby the product is manufactured or pressed to form very small 'rice-like' pellets, which are literally blasted under pressures, sometimes near 1,500 psig. Pellets are used in a wide range of settings to remove paint, grease, and ink—anywhere from printing presses to refineries, and beyond. This is an environmentally friendly application. The application is ever-growing in all types of markets.

Taking it even further, novel CO2 applications can include moving away from the old-time dry cleaning solvent 'perc' to CO2—pushing out a hazardous and environmentally unfriendly chemical from the scene. Other solvent applications include pressure extraction processing with CO2 (in lieu of hydrocarbons) to produce CBD, essential oils, and like substances. CO2 has been a choice v. water-based (oil and gas) 'frac' or fracturing applications, given the location, geology, etc. A whole separate niche market is EOR for recovering oil that would have not been recovered by primary means—this CO2 technology is usually described as secondary or tertiary oil recovery. This is specific to the oil-producing regions of the world, however, it could be a good opportunity for specific settings where a niche market could be created and served, usually for decades.



CO2 extraction of CBD oil from cannabis.



CO2 in enhanced oil recovery operation.

The uses for CO2 are growing all the time—and today, since carbon sinks and sequestration are hot topics, using CO2 in large greenhouse operations to enhance the growth of plants is a popular topic. It's not hard to imagine growing next-generation biofuels using CO2 usage for algae growth—a truly environmentally friendly carbon sink, which will grow indefinitely and is pertinent to

advancing renewable energies. Numerous applications are underway in test phases, which are diverse, and again, very environmentally friendly.

What to Do—Direct Markets or Wholesale Options?

Above, I have outlined some of the considerations for evaluating the costs and requirements to produce CO2 for the markets, and understanding the downstream requirements and costs surrounding direct sales to the markets. Of course, there is a huge difference between the selling prices of a delivered merchant product and the price to a refiner or gas company for a raw gas. With a full evaluation of markets, along with plant and operating costs, and requirements understood—then weighing this against raw gas sales, which usually will have to be negotiated up from the initial offer—will yield a sense of which direction one should take. It must be understood that the merchant CO2 industry is supplied by a very few, very large gas corporations, and there is an opportunity to look at direct sales to the markets, unlike any other time in recent decades. Practically all of the significant independents in the CO2 industry have been acquired by the majors, so there is room for new parties to enter the industry.

There are niche settings, or markets that are not served well by local production, or lack local production. These are excellent examples of such opportunities where an entity, for example, such as an ammonia producer could capitalize on marketing their CO2 directly to the consumers—and sometimes they can literally make a fortune. The first step is understanding in-depth the feasibility behind the direct market for the CO2, or wholesale—raw gas options.

ABOUT THE AUTHOR

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