CO_2 in manufacturing sector

When, where and why?

By Sam A. Rushing

I have previously discussed carbon dioxide (CO_2) utilisation in a wide range of applications, from healthcare to oil and gas applications, and everything in between.

The title of this piece, in terms of the manufacturing sector, can further be sub-categorised under industrial applications for the product, specifically as non-food and beverage and other applications which consume the commodity. On the other hand, soft drink and food processing are elements of manufacturing and home to the lion's share of the greater merchant market for CO_2.

Sources, production, and distribution

CO_2 supply in North America can be piped directly to captive destinations such as enhanced oil recovery (EOR) projects, including the highly successful Encana CO_2 flood taking place primarily in the Weburn Field, found largely in Saskatchewan, Canada. This is pipeline-fed CO_2 from the Dakota Gasification project in Beulah, North Dakota.

Industrial use of CO_2 in EOR is largely fed, on the other hand, from natural sources, primarily sourced in the US Jackson (Mississippi) dome, or the New Mexico Bravo Dome to mention other natural sources feeding EOR projects in the US middle south and southeast; and the (primarily) Texas oilfields. Further, the ExxonMobil gas separation plant in La Barge, Wyoming supplies CO_2 to Wyoming EOR projects. The 'when' component of these ventures is ever-present, and ongoing.

Other CO_2 sources, such as in Green River, Wyoming, involve pipeline-fed CO_2 direct to the production of sodium bicarbonate. In a similar way, one might consider the supply of CO_2 from the ammonia plant, as a nearby source to produce urea. Similarly, nearby sources of CO_2 can supply such a feedstock component to produce methanol.

The above examples are cases where the manufacture of chemicals, to enhance the production of oil, are delivered via pipeline for practical reasons, simply often due to large volumes. From a contract perspective, this represents security for the supplier of the CO_2 product to maintain and keep the account for a longer period compared to delivery via rail or truck, usually 1-5-year agreements. Therefore, in such cases, the easiest and most practical means of making deliveries that are economically feasibile and maintain a customer for often decades-long service, are the motivations behind pipeline supply scenarios.

The majority of merchant CO_2 is delivered via tractor/trailer, capable of up to 20-24 short tons per truck load. Railcars carry some product to large consuming destinations, such as to large food processing destinations, and pilot EOR demands, and larger chemical feedstock usage as well, in some cases where pipeline deliveries either are premature, or not feasible.

Railcar delivered product is often sent to depots for further distribution via truck. The term 'manufacturing' has a broad base, in my mind, from large oilfield and chemical demands to food processing and beverage manufacturing; and then the so-called 'industrial' merchant sector, which generally refers to non-food and beverage applications such as uses in welding, Ph reduction, greenhouse enrichment, cylinder repackaging, dry ice manufacturing, industrial heat reduction such as the manufacture of rubber and plastics and molten steel, then applications such as fire abatement, grain fumigation, concrete (sequestration), and much more. All of these destinations, under the 'where' component of this article, are widely diverse in nature.

Dry ice

With respect to dry ice, more and more, the demands are geared toward food processing. Rice-sized dry ice has become ever-popular among food processors, particularly poultry processors, when using the product in shipping boxed poultry.

As with the breakdown of 70/30% food and beverage versus industrial, a similar breakdown is probably realistic in the most prevalent food-related CO_2 consuming markets domestically. In any event, the 'why' component of dry ice is essentially the sublimation and resulting cooling effects provided.

The issue of producing one grade, generally the CGA grade 'I' used for beverage carbonation, is often the product which is made available for all applications delivered to the merchant market via truck and rail since, initially, various contamination incidents have occurred in the past, when beverage grade was mixed with an off-spec CO_2 (some in the past were an oilfield/frac grade) or industrial grade alone. If mixed with transports which also deliver to the food and particularly beverage sector, all efforts to yield the very pure beverage quality product would be eliminated. Therefore, today, it is a matter of course, to generally produce one grade, as grade' I' for beverage service, and deliver to all merchant customers – including so-called industrial consumers.

As it goes in the merchant industry, outside of pipeline delivered product, up to 70% of the CO_2 on average is sold to the food and beverage sector; of which probably 70% is for food processing, and the balance is beverage. Therefore there is usually one grade for all customers, unless a specific plant is only an industrial grade product (which is generally not the case any longer in North America since the era of CO_2 in frac service is not available today). The 'why' component of one grade for all represents uniformity, a reduction in contamination of grades, and further assurance of quality standards.

As for the industrial consumers of CO_2, over the years in the US for example, there have been large demand customers taking numerous truckloads or railcars for use as a chemical feedstock; or more commonly via over-the-road trucks delivered into merchant storage vessels, ranging from six tonnes in capacity to 120 tonnes. The industry has been working with merchant customers to enlarge storage capacities to truck load capable vessels, therefore at least 30 tonnes in capacity, where possible. Of course, this only makes sense where the demand can sensibly make use of larger storage vessels. Then, when the demand is small, it usually is handled by an independent CO_2 distributor or reseller, such as an independent carbonic gas dealer, a welding gas distributor, or even repackaged into microbulk units for delivery.

> **"With respect to dry ice, more and more, the demands are geared toward food processing"**

The manufacturing sector – where?

The manufacture at large, as defined, would represent CO_2 found virtually everywhere; a truly versatile product. In this respect, some of the welded metallic products found in home and industrial settings sometimes use CO_2 in the manufacturing process.

In terms of food production, from the CO_2 used in enrichment of beefsteak tomatoes to the grains baked into our breads, could have been fumigated with CO_2. Then, the chilled, or frozen food products found in everyday life, are sometimes treated with CO_2 – it is easy to see how versatile this commodity truly is. When I put this in perspective, it is amazing how a simple molecule, when taken as a gaseous or liquid product, can be used in a very wide variety of applications everywhere.

The 'where' behind this discussion is now found more in the developing world. One of my clients, a major independent African CO_2 firm, has entered the broader development of applications in industry, now working beyond a very narrow (previous) concentration of work serving the soft drink, dry ice, and cylinder gas customer base alone; is now moving into a more diverse food processing and industrial marketing scheme. A product of my working with this gas company in the development of applications, in terms of where the product is being sold, the company is moving further toward a ubiquitous place in the lives of those who sell and use products which are found everywhere.

This trend will continue in the developing world; logically as a matter of the need to sell out product from the plants which are being operated, and further to offer a complete portfolio to industry.

'When' CO_2 is sold, of course, ties into the 'where' aspect – that is everywhere possible in the developed markets and increasingly so in the developing world. Over time, the merchant CO_2 industry has sought a greater market for the product, perhaps with the greatest breakthrough some decades back when the product was first sold as a cryogen. This trend developed further in more food-related applications such as gas flush, rice ice production for food processing, supercritical extraction for spice production, and much more. The applications are becoming even broader as CO_2 is sequestered into concrete, as advanced biofuels use the product (at least theoretically) as chemical building blocks, and it is proven today in algae farms. As the planet heats up, more solutions will have to be sought, despite the anti-climate change tone in the US administration – otherwise dire consequences will result for all of mankind.

On a micro-scale, when thinking of 'the when factor', with respect to when the product is sold and utilised, one can take this in context with the distribution of product, and a rather finite amount of time when it will be stored on-site for consumption. Distribution is a rather fine art, that being the gas companies are always striving to improve their economics by delivering in the most efficient manner possible. This includes seeking improved storage capabilities among customers, and using electronic monitoring systems to signal when it is time to make the next delivery, for example.

> **70%**
> Up to 70% of CO_2 – on average – is sold to the food and beverage sector

As to 'why', with CO_2 in the manufacturing sector this returns to the ubiquitous nature of CO_2 in everyday life, where it is used in improving and processing everyday foods, in the manufacture of everyday products used, through to the oil and natural gas recovered and used for every day energy needs and, hopefully, further green applications in industry today – including viable forms of carbon sequestration. Simply put, why use CO_2 is to sustain and improve our everyday lives; for the CO_2 industry and the gas companies it is to sustain the industry and make a living.

In the end, the product is found via the manufacture of a wide range of products, and for use in services practically everywhere. This is more predominant in the developed world markets; the developing markets are now working toward a diverse sphere of CO_2 consumption.

ABOUT THE AUTHOR

Sam A. Rushing is President of Advanced Cryogenics, Ltd., and a chemist by background. The company is supported by decades of diverse professional CO_2 and cryogenic gas consulting expertise and merchant background. For consulting expertise and all forms of CO_2 and cryogenic equipment, Advanced Cryogenics is here to support your projects and add value to your bottom line.

+001 305 825 2597

rushing@terranova.net

www.carbondioxideconsultants.com