Carbon dioxide in the food processing business

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In the developed world markets, including North America, Europe, Japan, and many other regions, often the predominant range of applications for carbon dioxide (CO_2) is dedicated to a variety of food processing demands. When examining this through the lens of the North American market, it is generally estimated that 70-80% of the merchant market, that being non-captive usage, is dedicated to food and beverage applications at large.

The industry generally separates a variety of food processing applications from purely beverage-related usage, the latter being mostly beverage carbonation. Of this, 70-80% of the total merchant market (depending upon the regions selected), from 40-60% of this food and beverage market, covers a wide range of food applications, per se; and the balance is beverage-related. Beyond this 70 – 80% relating to food and beverage use for CO_2, would be a wide range of industrial uses for the product; which are expanding all the time. Some of the perhaps less traditional applications for CO_2 can also be grouped into overall food-related usage, which include uses in grain fumigation, supercritical extraction, and photosynthesis enhancement (greenhouse enrichment), for example. Without some of these very basic food (processing) related applications being accomplished, the feedstock for various food products would be less available; with perhaps a lesser quality too. An example might be greenhouse-grown crops or food products, enhanced via CO_2 greenhouse enrichment.

With supercritical extraction via CO_2 too, various essential oils, and spices are made more available. I found this application to be rather common in India, as per a client who indicated they were using CO_2 in extraction of spices and oils for food processing.

The use of CO_2 in grain fumigation is interesting, and represents a non-toxic means of repelling or eliminating insect proliferation in the grains which go into our basic food manufacturing; so this is a very basic application in the food sector. Therefore, the food sector, with respect to CO_2 usage, covers a very broad range of uses from the growth and processing of basic food commodities, to the chilling, refrigeration, shipping, and freezing of food products. This ranges from a very simple food item, to expensive and more complex food products being cryogenically frozen. In a way, the applications seem to be almost infinite as the industry fully applies its wares.

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When looking at beverage applications for CO_2, this sector has and is continuing to evolve, both from a beverage product type to deliveries and storage of the CO_2 for usage in beverage carbonation. In some developed markets, the majors such as Coca-Cola and Pepsi have become mature brands, which in some ways have reached their point of saturation. Further, these large corporate entities have already diversified well beyond carbonated beverages; and are continuing to do so. Further on the carbonated beverage front, some of the beverage majors are looking to reinvent themselves, via new product lines, and combining forces with non-traditional allies. The latter was recently demonstrated by the acquisition of Dr. Pepper/Snapple by Keurig, a major coffee pod and coffee machine manufacturer. This latest acquisition became one of the largest beverage deals, worth $19bn. With respect to some definitions, ‘beverage’ is considered part of the overall food industry; outside of the CO_2 industry’s usual definitions splitting food from beverages, they are generally intrinsically affiliated. When all of us sit down to a meal, there is usually a beverage which accompanies the meal itself, for example, even if it is tap water.

When considering food processing itself, over the years this industry has evolved, and worked to gain efficiencies, whereby the goal is to sell more CO_2 molecules to the customer, while enjoying healthy growth, and sustainability. I feel the sustainable part of this goal is very well entrenched, where in some markets, depending upon the application in food processing, the use as a refrigerant often competes with mechanical refrigeration, nitrogen, and glycol. When power is cheap, it is easier for mechanical refrigeration and nitrogen to compete, on a BTU removal basis alone; however, there are other factors which well favour carbon dioxide over other former means of refrigeration, such as the anaerobic/bacteria control aspect of the commodity.

As to the developing world markets, the long-term forecast for CO_2 usage is very bright, whereby as more industrial development, automation, and innovation take place, more opportunity will expand for CO_2 in a wide range of food processing applications – as it has over the years in the developed world markets. As I wrote earlier, my consulting work sometimes involves teaching clients and working to implement CO_2 applications in various developing world markets beyond what has generally been a predominant beverage carbonation, dry ice, and cylinder gas business. Such successes have been enjoyed with client companies in certain Latin American, Caribbean, African, and Middle Eastern markets. One such consideration has been to produce a high-quality meat product, cryogenically frozen, for export to well-paying customers with high quality demands, located in Dubai (UAE). As a food product prepared in Africa, this particular case has been a real success story.

The usage of CO_2 in a wide variety of food processing applications, from photosynthesis enhancement, to chilling and freezing applications, represents producing a higher-quality food product, with greater speed, than with previous methods.

Applications for carbon dioxide in the food sector

As I mentioned above, the food sector literally includes the usage of CO_2 from the very basic form of producing the food commodity, through to the cryogenic freezing of a high quality food product.

Beginning with the very basic applications in greenhouse enrichment, and grain fumigation, both have environmentally friendly takes with the application; whereby using CO_2 from a source such as a fermentation by-product for enrichment, represents a valuable carbon sink rather than simply venting the raw CO_2 to the atmosphere. Then with grain fumigation, this form of treating insect infestation leaves no chemical residue behind, thus a cleaner and safer way to fumigate grain. Downstream of these very basis applications, from the growth of the fruit or vegetable product, and fumigating the basic grains which are used in food manufacture, the following applications are predominant →

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in the food processing sector, primarily utilising CO_2 for the refrigeration value (predominantly meat-related). Of course, as a refrigerant, CO_2 can be used (whether this is dry ice, gaseous and liquid forms), on generally most food products which require some form of refrigeration. Many companies favour cryogens (including CO_2 and nitrogen) for higher-margin food products, which tend to be predominantly meat-related products.

In the US, major meat related firms, including Tyson Foods, Smithfield Foods, and Cargill, all have very significant demands for CO_2 in a variety of applications. Some of the major applications found in such processing plants include the following:

A) Solid – dry ice usage. Dry ice has become highly favoured in the processing of various poultry, meat and fish operations, which are applied in many points through the plant, and in transit to a further destination. This includes dry ice as ‘rice’ pellets are used for reducing temperatures during the blending and grinding of meat products, which is a major demand centre for dry ice. The commodity is also used in boxed/packaged raw, cut meat and poultry products, which sometimes include water-based ice as well. The CO_2 sublimates, and keeps the product cold, which further benefits from being surrounded by CO_2 gas, which helps retard aerobic bacteria; thus, more than refrigeration is obtained, to enhance freshness.

B) Gaseous – The use of modified atmosphere packaging (MAP) is another application for CO_2, often in conjunction with other gases, as a form of product freshness enhancement. This includes injection of the CO_2 containing gases into packaged products, which also purges atmospheric oxygen resulting in an anaerobic atmosphere, which retards spoilage and enhances freshness.

C) Liquid – The liquid application can be used in various forms, one of the most common and most interesting being cryogenic freezing via the use of freezers built for this application, which have a variety of configurations. Such configurations include straight-through tunnel freezers, multiple pass tunnel freezers, batch freezers, and spiral freezers. Higher margin product – including some berry, vegetable, meat, fish, and fabricated specialty products – travel through these machines with a specific residence period inside the machine, resulting in the desired amount of chilling upon exiting the freezers. These can include only chilling, or crust freezing, and core freezing these food products. Other applications include the use of liquid injected through the bottom or side of a blender/grinder to achieve temperature control of the heat generated during the process. This liquid, of course, is flashed into the blender as a snow product, from liquid, along with gases, all of which represent temperate control, bacteria reduction, and a better quality product emerging from these machines. Other applications inject from a liquid line, CO_2 snow into the machine which is blending/grinding the (usually) meat product. CO_2 vapour must be exhausted from the workspace in all cases, when using such machines, to ensure a safe workplace, and maintain reasonable atmospheric levels. Other applications for liquid in the food processing plant, include CO_2 snow injected manually or automatically via a machine, with or without a conveyor system, into boxed food products to maintain temperatures and quality, usually during transport to a further destination.

Global Co_2 food processing

The application for CO_2 on the global stage will continue to expand, of course, within the developed world markets, which hold from 40- 50% of the total merchant market volume in average markets, and growth is tied to corresponding growth in food industries which consume the commodity. All of which represent a bright future in the CO_2 industry.

If poultry becomes more predominant, as a matter of a healthier form of protein, CO_2 applications for this commodity should rise. Also, with specialty food products, there are also corresponding bright spots for growth via the application of CO_2 in food processing. The developing world markets also have a long-term bright future for CO_2 in food processing, which is somewhat tied to economic developments and the fostering of technologies, all of which are slated to occur over time.

For the gas companies, it is recommended to go back to basics, and look at the opportunities within the food industry for a wide range of uses, from the food basics, through the processing of higher end food products. Within existing plants served, it is further recommended that the gas company suppliers take a fresh look at all potential applications which have not been fulfilled; sometimes opportunities are not noticed right before our eyes.

The industry is resilient, and will continue to grow and find more improvements, innovations, and opportunities over time. This is a core part of the CO_2 merchant market which truly matters, and always will. gw

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