The market for dry ice

By Sam A. Rushing

Dry ice is unique, often thought of as a portable refrigerant and of course, physically unique in that it sublimates from a solid to a gas, while providing refrigeration value. The further by-product value, when applying dry ice in food processing applications, is a form of gaseous bactericide.

Of course, such a commodity requires constant ventilation, as it sublimates in the place of application or storage, which otherwise if applied improperly, can result in harm. Beyond the need for proper ventilation, it is dry ice's primary value – the very cold nature of the commodity – which can cause injury if there is direct contact with human skin and other living organisms. Over the years, the application of dry ice has morphed from certain industrial uses, such as food preservation/shipping applications to name a few, into a major form of temperature reduction in major food processing plants. Many plants have started with dry ice in service of food processing, then graduated to liquid carbon dioxide (CO_2), and sometimes reverted back to dry ice again. This change in the form of CO_2 usage, particularly in food processing environments, is driven by the demand onsite to do the job, compared with the capital or rental cost of a liquid system which could otherwise generate snow (or pellets).

> "Many plants have started with dry ice in service of food processing, then graduated to liquid CO_2, and sometimes reverted back to dry ice again..."

Often the demand changes radically from place to place in a plant, as well as the actual tonnage required; all leading to using dry ice shipped into the plant or generating a form of dry ice onsite. Dry ice has always been an important sector of the carbon dioxide industry and has been a major focus of companies as Airgas (Carbonic) in the US. Over the years, as mergers and acquisitions occur, beyond those companies such as Airgas seeking additional dry ice interests, the majors in the industry have generally maintained predominantly liquid in their portfolio, while dry ice specialists tend to specialise in dry ice; where the majors sell liquid to dry ice operations downstream, often adjacent to the liquid plant.

Sometimes the CO_2 and dry ice operations of some of these companies are integrated, where liquid is produced, and closely integrated dry ice operations operate within the same facility. This can be found with companies such as Continental Carbonic, now owned by MATHESON. At one time, EPCO Carbon Dioxide Products sold liquid to Continental Carbonic for its (predominantly dry ice) operations, well before Air Products acquired EPCO, and Continental became part of the MATHESON family.

The dry ice business can be labour intensive, sometimes much more than the liquid business, which also requires specialised boxes, bins, and pressing/extruding hardware to specifically generate whatever form of dry ice is required to do the job. In developed markets, it can often represent some 20% of the overall merchant demand; and in developing markets, this varies throughout but is probably less than 20% in some cases.

Developments in dry ice demand

Over the years, the demand for dry ice has grown significantly in the developed world markets. This growth has primarily been associated with the increased usage in food processing plants.

For the developing markets, where food processing plants of a significant size are less common, there is much less usage of the commodity and the product is then applied in the shipping of perishable products and uses for portable refrigeration. Dry ice usage in the US, for example, was once found to be predominantly used in shipping applications as a refrigerant; and uses as a refrigerant of a portable nature, plus some industrial usage.

Over time, dry ice has become the darling in the food industry, particularly with 'rice ice' – that being rice-sized 1/8" pellets, which mix well into various food products which are being ground, blended, and transported. In this respect, the poultry (and other meat industries) often request rice ice for their refrigeration needs. As was mentioned before, there is always the challenge with respect to ease of application, and efficiency, to evaluate the cost of a liquid system, which usually generates CO_2 snow rather than dry ice pellets of one size or another. Often, the point of application changes in various food plants, which make the feasibility for dry ice usage (particularly rice ice) the choice of products, from a strategic point of view, compared to an installed, and more rigid liquid system.

When I have worked in developing markets such as the Middle East, Latin America and Africa, dry ice has primarily been found as a form of portable refrigeration, for shipping demands, as well as small cooling needs. As food processing facilities are being developed, or are considering CO_2 applications in various forms, that being liquid to snow or dry ice delivered as in the developed markets, if the demand is initially small, dry ice will fit the need. As these plants enlarge, or their processing demand increases, as in the developed markets, CO_2 snow systems (if economically viable)

20%

The dry ice business can often represent 20% of overall merchant demand

may then be installed.

Some of the CO_2/dry ice producers in these developing markets worked to market the product to street vendors, and independent, small food operators and transporters, however the process of acceptance and affordability has been a significant hurdle to cross. In the countries which are predominantly beverage-related liquid markets, with perhaps small dry ice capabilities, the affordability issue is often the primary hurdle to cross – relatively speaking, the prices can be quite high in these markets.

As to dry ice demand, which has been popular and often profitable in the developed markets, at one time the airline catering firms were a popular market. Dating back a couple of decades or more, dry ice blocks were sliced and diced, and bagged, then the sliced dry ice – with specific dimensions – were inserted into the airline food service equipment, and thus refrigerating food products. Today, when such demands exist for dry ice, pellets or discs, pressed pieces make more sense. Today, often machines press specific sizes of discs, blocks, and pellets to supply such operations. The manual method of preparing such intricate sliced pieces of dry ice is very labour intensive, dangerous, and expensive to handle, and today in many cases mechanical refrigeration has replaced such dry ice demands onboard airlines.

Typically, what is found in large food processing operations, such a large poultry plants, are concurrent LCO_2 and dry ice demands, which serve several applications for temperature reduction, gas flushing, and pneumatic usage. Stationary applications for liquid, including usage in IQF (Individually Quick Frozen) operations, snow production, and gas flushing are often operational in a plant, while for dry ice, often rice pellets are applied in temperature reduction applications and for use in the transport of raw or cooked food products. What is sought by some processors is the ready availability of dry ice rice to fit into cracks and crevices of meat and poultry products.

As I see the dry ice demands in developed markets, these are highly linked to food processing and preservation, in fact this accounts for the lion's share of dry ice demands. In plants and processes which have used water-based ice, and colder temperatures, with no run-off sought, dry ice is often the perfect match and particularly so in the food industry. Of course, BTU removal capabilities are significantly higher with dry ice compared to water ice, and of course, there is no run off. Once again, however, there is the vital need to have adequate ventilation onsite. Then, beyond food preservation and refrigeration, there is some industrial use, and this is often specific to the region where dry ice is made available.

Application development

Over the years, the CO_2 industry has worked to develop more dry ice demands, such as blast cleaning with rice dry ice. The results behind marketing dry ice blasting over other forms of cleaning, such as sandblasting and solvent usage, are mixed. Dry ice blasting generally falls into specific region-based usage, such as the cleaning of industrial equipment, and usage in cleaning the hulls of ships and boats or for that matter, cleaning the façade of a building, or other infrastructures.

Some of the advantages behind dry ice blasting include a quality cleaning, often found in detailed cleaning of industrial machinery, or intricate items. The dry ice left behind sublimates, so large piles of sand, or significant run-off of solvents are not a problem – so it is a tidy process in this respect. Of course, there are cleaning and specialised dry ice blasting operations which own the blasting equipment, as well as the rice ice supplies, and offer transport capabilities to the job, which run the job and purchase the rice ice for the job.

The usage of dry ice in industrial settings can include any place where a portable refrigerant is required, such as shrink-fitting of metals, preserving core samples in oil and gas production, and applications to deflash rubber.

Small applications for dry ice can exist in medicine, one in the case for transport of tissue, organs, and blood. The use for removal of moles and warts and other skin imperfections has been discussed in literature, specifically for the dermatologist. Beyond its use as a refrigerant, from food to medical to industrial, there are of course applications sought for the sublimation value of the commodity. In such cases, places where a CO_2 gas is sought to achieve results include grain fumigation in certain grain storage facilities, insect control, and small usage in so-called 'fog' machines, used on stage. Places where dry ice is otherwise applied, include small markets such as homemade root beer and usage in mosquito traps – this has been found to be effective rather than using CO_2 cylinders under pressure.

> "Other usage can be in body shops for the removal of dents in car bodies, and deflashing of plastic and rubber parts manufacturing..."

Other usage can be in body shops for the removal of dents in car bodies, and deflashing of plastic and rubber parts manufacturing. Unique applications include 'green burials' and shipments of corpses across the battle line, such as in cases during the Iraq War. Of course, since photosynthesis is enhanced with CO_2 as a gas or liquid vaporized, sublimation of dry ice accomplishes similar results. In smaller settings, where LCO_2 from large storage or micro-bulk tanks is often too large, dry ice can accomplish the job – this includes temperature reduction, and some Ph reduction such as unclogging wells via dry ice. In the case of the latter, once dropped into the well, dry ice as CO_2 combines with water, producing a weak carbonic acid acting on the calcium carbonate formations which are blocking the waterway.

Other applications such as this can be devised. Unique applications include usage in cooling alcohol for the branding of cattle, and eradicating gophers and moles underground. Tests →

have occurred with cloud seeding for the enhancement of rain as well. Some rather obvious markets can include requirements to pressurise systems and vessels, for example, as well as use in cooling needs throughout many industrial processes, not mentioned before.

There is always the challenge, as mentioned earlier, to address adequate ventilation needs when applying or storing dry ice – this is critical to health and safety of the workforce. Further, the challenge with respect to sublimation is an age-old challenge, that being working to find ways to minimise sublimation, and thus sell more weight as a dry ice product, before it is delivered to the customer's dock. There are arrangements where the product is sold FOB shipping point, or production plant which is a strong advantage in favour of the supplier, however a challenge for the customer in terms of actual product received. Most customers expect dry ice to be sold, based upon what they receive. The CO_2 industry has sought to install pressing operations as close to demand centres as possible, thus reduce sublimation, thus improved margins for the producer and customer. Specialised boxes and containers are used, and being improved upon, to reduce sublimation.

As for the developed and developing world markets for dry ice, it would be who of the gas company or dry ice supplier to evaluate all existing temperature and CO_2 gaseous applications within existing customer's plants for new or expanded opportunities for dry ice. Where dry ice is not used, it would make sense to investigate applications where water-based ice can be partially or fully replaced by dry ice, given an enhanced refrigeration value, and the sublimated gas value, such as in food processing environments. Further, where smaller demands for a CO_2 product, and specifically results from the application of these products exist, dry ice may well fit the bill.

Over time, the dry ice market has grown significantly, in a sustainable manner, thanks largely to applications in the food industry. Since the food industry will continue to grow, as populations grow and as emerging economies develop, more automation, processing, and applications for these products will emerge. The future of dry ice and LCO_2 are strong and much of this is due to the basic need for 'all of us to eat'. gw

ABOUT THE AUTHOR

Sam A. Rushing is President of Advanced Cryogenics, Ltd, a global CO_2 consulting firm with decades of experience in both the consulting and merchant roles. Rushing is a chemist by background and provides a full menu of consulting work to the CO_2 industry, primarily, and for cryogenic gases as well. The company can also supply a full range of equipment to these sectors. For more information, contact:

Tel: +1 305 852 2597
Web: www.carbondioxideconsultants.com
Email: rushing@terranova.net

The key to dry ice – local supply

An insight from Butler Gas Products, originally published in May 2016.

Butler Gas Products, with headquarters in Pittsburgh, Pennsylvania, manufactures dry ice daily at its McKees Rocks facility. Dry ice is simply frozen carbon dioxide. Frozen directly from a gas to a solid at -109.3°F, dry ice does not melt; it sublimates back into its gaseous form. No mess, guaranteed.

Butler Gas Products is Pittsburgh's source for fresh dry ice. The key to buying high quality dry ice is purchasing it from a local supplier. Dry ice sublimates at a rate of approximately 10% every 24 hours, depending on environmental variables. If you're buying from an out-of-state supplier, you're paying for lost product. Butler Gas makes its dry ice in the morning and delivers it to customers that same day; fresh dry ice is also available for pick-up at every one of its locations.

Due to its extreme low temperature, dry ice is used in a variety of applications. Industrially, dry ice is used to shrink metal into tight fittings. Commercially, dry ice can be used in a number of projects – everything from removing old tile flooring to shipping frozen food products. In addition to its industrial and commercial uses, dry ice is ideal for creating a freezer away from home. Pack your cooler with dry ice for road trips, tailgating, concerts, and camping. When transporting dry ice in a cooler, always remember to keep it in a well-ventilated area; as the dry ice sublimates, you want to allow the carbon dioxide gas to escape.

Dry ice can also be used seasonally for special effects. To make a foggy punch bowl that's perfect for Halloween, you will need a large bowl for the dry ice, a smaller bowl for the punch, hot water, and dry ice. Throughout the entire process, do not let the dry ice come in contact with either bare skin or the punch. Using gloves, place a few handfuls of dry ice pellets into the larger bowl and fill it halfway with hot water. Add your punch to the smaller of the two bowls, making sure that the punch does not come in direct contact with the dry ice. Float the smaller bowl filled with punch in the larger bowl containing the dry ice/hot water mixture. To maintain the fog effect, periodically add more dry ice and hot water to the bottom bowl. For an extra Halloween kick, use a cauldron as the outer large bowl. Float the smaller punch bowl inside the cauldron. Remember, always wear gloves when handling dry ice! gw