

Liquid Nitrogen in Food

Making up 78% of the world's atmosphere nitrogen in its base form is part of life itself, our genes rely on nitrogen atoms, nitrogen forms part of amino acids and proteins which are the building blocks of all life. Indeed, nitrogen compounds from lightning or from mineral deposits were sufficient to get life started nearly 4,000,000,000 years ago. For thousands of years farmers have understood the basic benefits of nitrogen, (although non-specifically), through crop rotation and use of manure. As an inert gas it acts a perfect 'manager' for all kinds of chemical processes.

Perhaps the most profound effect of nitrogen however has occurred in the last 100 years. With the onset of industrial gas production man has be able to conquer cold. Production of Liquid Nitrogen (LN2) by gas companies for the food industry who in turn have used it to freeze and chill foods, has enabled longer storage of foods allowing far greater mobility for mankind. Human mobility away from the centers of food production, the process has enhanced population growth and spread around the globe throughout the 20th Century.

Liquid Nitrogen's use has not been restricted solely to the food industry however. It is used in many applications across a broad range of industries. Liquid Nitrogen (LN2) is best utilized in processes where extremely low temperatures or rapid rates of cooling are required. In many cases the use of Liquid Nitrogen (LN2) freezing, or Cryogenic freezing as it is known, is a preferred alternative to the use of Mechanical Freezing devices such as traditional refrigeration units. Cryogenic freezing has traditionally been attractive due to its low capital costs as units tended to be far smaller, and cheaper to produce. Companies have been able to gain large refrigeration capacity at little or even zero capital cost, simply by renting Cryogenic storage tanks from gas companies and buying Liquid Nitrogen (LN2) to suit demand.

Major players in the food industry have used Liquid Nitrogen (LN2) for freezing meats, fish, poultry, dairy and bakery products and many others such as pasta, prepared meals (microwave meals), fruit and vegetables. In some cases the very rapid freezing with Liquid Nitrogen (LN2) has very marketable benefits. Such as the prevention of crystal formation on food stuffs which causes cell damage to the product. Liquid Nitrogen (LN2) prevents oxygen from reaching the food's surface this denies bacteria the oxygen they need to grow and multiply. Where

mechanical freezers can cause dehydration of products cryogenic freezers can avoid any dehydration, which in turn provides producers with a better yield.

The gases food market sector organizations such as Praxair, BOC, Air Products, Air liquide, Linde Gas and Siad, all produce an extensive range of cryogenic freezers capable of handling most food products. The majority of equipment is made from stainless steel primarily to meet with international hygiene regulations but also so that they can withstand cryogenic temperatures, (Liquid Nitrogen is - 196°C), and not fracture or become brittle. The spiral freezer type offers the largest capacity, a mesh belt, on which the food is placed, spirals vertically within the freezer box allowing a large capacity for a relatively small floor space.

Another popular design is the Tunnel freezer. These are straight tunnels in which are house multiple decks of conveyor belts, often three, situated above one another. These initially immerse the product in liquid nitrogen to achieve rapid crust freezing before it is carried onto conventional trays. Also popular has been the immersion freezer, which, as the name suggests, dips the product into the Liquid Nitrogen (LN2). More recent developments include fluidized bed freezers and impingement freezers that achieve high heat transfer rates by subjecting the product to high velocity gas movement. All of these types of freezer, apart from

the immersion freezer, are versatile enough to run on both Liquid Carbon Dioxide (LCO2) and Liquid Nitrogen (LN2).

Perhaps the most interesting recent development in the field is in what has become known as Cryo-Mechanical Freezing. This process combines the benefits of the rapid 'crust freezing' dehydration loss minimization ability of Liquid Nitrogen (LN2) or Liquid Carbon Dioxide (LCO2) with the low running cost of Mechanical Freezing to finish the freezing of the food product.

Apart from the frozen foods sector there is a vast and rapidly expanding market for Liquid Nitrogen (LN2) in the 'chilling' of foods. For fresh fruit and many convenience foods that do not withstand or even require freezing food chilling equipment is required. For fresh fruit in particular on site chilling solutions are required to prevent field heat deterioration. Several ground and diced food products are also cryogenically chilled in blenders using Liquid Nitrogen (LN2).

The two main methods of freezing food, cryogenically with Liquid Nitrogen (LN2) and Mechanical Freezing, broadly speaking, represent the options available to food manufactures. So in today's rapidly changing environment with fixed costs for energy production rising for all industrial users, are we about to see a fundamental shift in the market of food product freezing and chilling. *GAS WORLD* spoke to the industry experts to gauge opinion.

Mr. Karol Vanacke (KV:check name) of Cryogenic Equipment and Services (C.E.S), based in Belgium:

KV: 'I think for the moment the Gas companies are surely trying to get prices up because of the energy cost, but this is not a new phenomenon'.....'I think indeed there are two things to remember, one is that customers are very sensitive to the

gas price as the smallest change can increase cost considerably. Secondly that this does not necessarily happen at the same rate in the mechanical freezing market.....

But in the LN2 market is very sensitive to price instability, an increase of cost of up to 20% will scare off a lot of customers, that's a fact'.

Stateside Mr. Bryan Smith (BS) of Cryoquip Inc, based in California (check), was more circumspect when asked if higher energy costs was driving customers out of the LN2 market:

BS: 'Not to my knowledge. You either pay for the gas or the power. The few remaining cryogenic freezers are probably locked into the process unable to justify the capital expenditure to go mechanical or the process is unique enough to justify cryogenic freezing'

If then we are indeed seeing the demise of cryogenic freezing on a large scale basis is mechanical freezing making a comeback?

BS: 'The mechanical freezing industry made its "comeback" years ago. Once the USDA (?????) changed the rules allowing water extracted by the freezing process to be added back, it killed the cryogenic freezing industry [in the US], and gave the mechanical freezing boys a new market. With this new incentive they developed a whole new range of highly effective highly efficient machines that displaced practically all of the large cryogenic freezing installations. In turn that released enormous quantities of good quality nearly new machines into the market'

It would seem then that regulations have created somewhat differing market outlooks for Europe and the U.S. So what of future forecasts for the Liquid Nitrogen (LN2) food freezing market.

KV: 'I think that changes will not be dramatic and fast, they will be slight and they will be slow. One possibility is that the more centralized and concentrated the production of food becomes, with bigger and bigger plants servicing the large multi-national producers we may see the balance switch from cryogenic to mechanical freezing methods. The incentive being the increased speed which mechanical freezing offers.'

The U.S. viewpoint is somewhat different:

BS: 'The future for Liquid Nitrogen (LN2) in the food industry is that it will do well to hold its own. Growth will be hard to come by, and unless a surplus of LN2 is generated by the gas companies it is hard to see how it will compete with the new generation of mechanical freezers..... We are virtually out of the freezer manufacturing business....there are so many good freezers available second hand or through "refurbishers" that the new "standard freezer" market is dead. We have diversified into other products'.

Diversification is something that has become a fact of life in the European market as well:

KV: 'We are seeing diversification. We are now also selling to the bio -pharmaceutical industry, and now also the steel industry. That has been a big change for us. For the Steel industry particularly we are seeing a rise in demand for sub zero quenching applications'.

So will we see Liquid Nitrogen (LN2) use in cryogenic freezing go the same way as the US market? Without the same regulatory pressures Mr Vanacke sees a balance to be struck:

'In the future we may see greater use of both methods together, what is known as 'Cryomechanic' freezing, whereby immersion type freezers are placed in front of a larger the mechanical freezer. The immersion freezer acts as a booster, reducing temperature, before items

move through to the mechanical freezer. A small immersion freezer, only two to three metres long can increase output from the conjoined mechanical freezer by as much as 20 – 30 %'