CO₂—a product with many uses

CSR, through Carba Australia Limited, makes and markets the major proportion of the carbon dioxide (CO₂) used in Australia. CSR began production of liquid CO₂ in 1908 and began production of solid CO₂ (dry ice) in 1930.

CO₂ is produced by the fermentation process at the Pyrmont and Yarraville distilleries. When molasses, a by-product of sugar milling and refining processes, is fermented by the action of yeast, alcohol is produced and CO₂ is given off as a gas.

Marketing of CO₂

Until recently CSR marketed CO₂ in NSW supplementing the Pyrmont supplies with CO₂ produced at a plant at Botany where a raw CO₂ gas stream obtained from ICI's ammonia plant was purified and liquefied. CO₂ produced by fermentation at Yarraville was sold to Carba Australia Limited for distribution in Victoria.

In 1971 the CSR CO₂ and Carba activities were merged after Carba had become a wholly-owned subsidiary of CSR. CO₂ is now produced and marketed under the Carba banner in all States of Australia except Queensland, and New Zealand. In Queensland, CSR has interests in Dry Ice (Queensland) Pty. Ltd. and in Dry Ice (North Queensland) Pty. Ltd., who are the major suppliers.

Much of the CO₂ marketed commercially is recovered as a by-product of an industrial process, for instance the fermentation process, petrochemical or fertiliser production. Where there is no by-product source available, CO₂ is produced from the combustion of fuel oil in specially built flue gas plants. Some years ago another source became available to Carba when a well was sunk at Mt. Gambier, SA. to tap a natural underground CO₂ field.

Some uses of CO₂

The application of the physical and chemical properties of CO₂...
has made it a widely used material in manufacturing industries. Some of the main uses are:

- carbonating beverages, such as beer, wine and soft drinks
- food freezing
- refrigeration of vehicles and containers
- cooling agent in engineering where low temperatures are required
- hardening sand moulds in foundry casting
- as an inert gas in chemical processes
- deflashing moulded rubber products
- fire protection.

The variety of applications of CO₂ is emphasised further by some of the lesser known uses, for instance the freeze branding of cattle where CO₂ in dry ice form, together with alcohol, is used to cool metal brands to eliminate damage to cattle hides caused by hot branding. Freeze branding provides a more humane, simple, efficient and permanent identification of stock. Brands are cooled to minus 70°C by a mixture of dry ice and alcohol and applied against the hide. The cold first destroys an enzyme in cells of the hair follicle which produce colour pigment in the hair. An application for a standard time causes a white brand and very little damage to the leather.

CO₂ is also used as an insecticide for the storage of furs and for putting “bubbles” into foam plastics in some processes. In packaging it has been used in aerosol containers, and on the TV stage it has been used to produce fogs and clouds.

In food processing it has many uses. It is used in the chill grinding of meats and spices. CO₂ is also used to maintain flavour in food products under storage and to combat attack by atmospheric oxygen. CO₂, which does not react chemically with the complex organic compounds of the product, is employed to displace air from the pack to preserve such foods as coffee, milk powder, nuts, biscuits, cakes, cheese and bacon. CO₂ has also used it in solid form for seeding clouds in rain-making experiments.

Carba liquid carbon dioxide and dry ice are also used in the production of Australian wines to keep air from the wine at all stages of processing.

Oxygen in the air causes oxidation, “off” flavours and colour contamination.

CO₂, which is heavier than oxygen, is used as a barrier to prevent air reaching the wine.

One method involves the hanging of baskets of solid CO₂ or dry ice, over the surface of bulk wine in storage.

The dry ice gives off a steady stream of carbon dioxide gas which displaces any air above the surface of the wine.

CO₂ is also used to blow dust off the cork before its insertion into the bottle.

Further uses

Dry ice also plays an important part in maintaining production from Tasmania’s Savage River iron ore mines. The dry ice is used to assist in maintaining ball valves and sections of the 52-mile pipeline which carries crushed ore to Port Latta where it is pelletised and stockpiled.

The use of dry ice enables maintenance to be carried out without draining of the pipeline.

A fibreglass “jacket” enclosing both ends of the pipeline is filled with dry ice and topped with alcohol.

The slurry inside the pipe is frozen forming an ice plug which holds back the liquid until work is carried out.

Carbon dioxide is also used to preserve fresh poultry.

The markets for CO₂

Carba and associated companies, as well as marketing CO₂ throughout Australia and New Zealand, also ship small quantities to the Pacific Islands and Papua-New Guinea.

The main buyers of CO₂ have traditionally been the makers of beverages, food industries requiring solid CO₂ for distribution of ice cream and frozen foods, and certain industrial concerns. Currently sales of liquid CO₂ for food freezing and transport refrigeration are rising rapidly. Diversification into these and other new markets will ensure the future growth of CO₂ sales.

Although very little CO₂ is exported, Carba is now using expertise gained through years of operation in the Australian CO₂ industry to enter export markets. Australian-designed CO₂ production plants recently began operations in Kuala Lumpur and Hong Kong. Another large plant will be commissioned in Djakarta later this year.
An unusual application of CO₂. The dragon's impressiveness is heightened by the CO₂-produced vapour emanating from its nostrils during a procession in Melbourne.
How CO₂ is sold

CO₂ is sold in three forms:
- in cylinders ranging from 5 lb to 70 lb capacity
- as solid dry ice slabs, or as pellets
- as bulk liquid—either at 300 p.s.i. and 0°F. (storage units of 6 tons to 25 tons capacity)—or as Snow Flow at 100 p.s.i. and 50°F. (storage units of 580 lb to 6½ tons capacity). Snow Flow is a low-pressure CO₂ system which was developed by CSR a few years ago to provide maximum efficiency in refrigeration applications. It is finding increasing acceptance.

Bulk CO₂ delivered by tanker

Many factories require large quantities of CO₂ for their processes. For example, large soft drink manufacturers require up to 12 tons per week for carbonation of drinks. For these larger manufacturers Carba installs bulk liquid CO₂ storage vessels. These vessels are more convenient and economical than a battery of say 40 or 50 cylinders, which must be individually refilled at frequent intervals.

Road tankers which carry up to 12 tons of liquid CO₂ at a time are used to transport large quantities of liquid CO₂ to the storage vessels.

Carba provides services to industry

Carba has a number of skilled personnel who can provide technical information and maintenance services to users and prospective users of CO₂. Advice is given on the application of CO₂, the installation of plant, and on equipment used in conjunction with CO₂. For example, many poultry producers have encountered problems using water ice for packing fresh chickens. Carba engineers, with cooperation from major producers, have developed equipment to allow producers to replace water ice with CO₂. Snow Flow or conventional bulk CO₂ is injected into the carton of freshly packed chickens, forming a layer of “snow”. This maintains the low temperatures required and, as CO₂ converts directly from snow to vapour, there is no liquid to damage the product or cartons.

During trials, birds packed in this way were found to have a longer shelf life, and retained better appearance. Similar equipment has been designed and installed for producers in several States.

“Snow shooting” into road and rail transporters carrying food products from as far afield as Melbourne and Perth has eliminated some mechanical refrigeration. Liquid CO₂ is injected under pressure into the top of an insulated container. As the liquid is released it converts to “snow” and vapour, the snow forming a layer on top of the load.

Product bulletins are produced regularly for distribution to customers to maintain and increase awareness of developments in the CO₂ industry.

CO₂ used to solve an effluent problem

As well as developing new processes for industry Carba helps firms with individual problems. The NSW Division recently solved an effluent problem at one of Australia’s largest manufacturers of building products. The complex, close to a river, had the problem of disposing of between 7,000-10,000 gallons of process water an hour. Although effluent from the plant was treated, the company was instructed to further reduce the high alkali level of the water before discharge into the river. Carba assisted in some trials and it was found that after passing through CO₂ and an ash bed the water was crystal clear and pure enough for disposal in the river, or recirculation through the plant.

CO₂ in industry and nature

The industrial development of CO₂ began with some purely scientific experiments by Faraday on the liquefaction of gases in 1774. However, a couple of years earlier, Joseph Priestley discovered that under pressure CO₂ would dissolve in water. For this discovery he may be considered the inventor of artificially carbonated water.

Faraday’s work of making liquids from gases had an immediate appeal to other scientists, and finally Professor Pleischl in Vienna developed a mechanical compressor with which he was able to make liquid CO₂.

In 1882 Raydtt constructed an apparatus for carbonating water under pressure for use as a fire extinguisher, and in 1885 took out a patent on an ice and refrigerating machine.

The manufacture of CO₂ at this time was of little importance, because plentiful supplies of CO₂ were available from the earth. However, to avoid the transportation of the heavy cylinders, the need for an economical method of manufacturing the gas became evident, and in 1889 in Berlin, CO₂ was manufactured by burning coke.

CO₂ in nature

CO₂ is a “food” for flora and a waste product of fauna. It is present in the air in relatively small quantities and in the sea in large quantities. From the sea, CO₂ can be liberated to the atmosphere if its partial pressure in the air falls below that exerted by the gas in solution. On the other hand the sea can take in CO₂ from the air. Plants and animals in the sea relate to CO₂ in the same way as...
plants and animals on the earth. CO₂ has been liberated from the earth since the beginning of time. One well in Germany produced CO₂ at the rate of more than a ton per hour. Carba collects CO₂ from a well in South Australia. CO₂ is believed to be held as a liquid in pockets in the earth.

Natural waters almost always contain CO₂. Some contain CO₂ dissolved under pressure. The acidity of this water increases its dissolving action for rock material, thus producing "mineral water".

CO₂, which is 1½ times heavier than air, is also added to the atmosphere by the respiration of animals. A human being expires about 900 grams of CO₂ daily. On the basis of a population of 1,750 million people on earth this would add about 629 million tons of CO₂ to the atmosphere each year—about the same amount as burning 230 million tons of coal. The quantity produced during a large bush fire is enormous.

The main factors which reduce CO₂ in the atmosphere are the photosynthesis of plants and the weathering of rocks.

In the growing of one ton of sugarcane, for example, the plants use up about 44 tons of CO₂ from the air. (Most of the information for the latter section of this article was obtained from "Carbon Dioxide", by Quinn and Jones, 1936.)

CO₂ introduced into cartons of fresh chickens maintains freshness and appearance. A layer of "snow" is formed which converts to vapour.