

The history of freeze drying technology

Centuries ago, the ancient Peruvian Incas of the Andes found out the basic freeze drying knowledge to store their food on the high mountain. Before 1930s, Freeze - drying methods have been used for various technical purposes for over 100 years, mostly for drying virus, biology tissue and organs. Relevant freeze drying facilities were developed by scientists for experiment purpose. Until World War II, equipment and techniques were developed to supply blood plasma and penicillin to the armed forces, it promoted the freeze drying application in pharmaceutical industry. Started from 1938, but until the late 70's freeze - drying was commonly used for food industry. Until the late 80's the freeze drying industry discovered the allurements and longevity of freeze -dried flowers. The following contents will illustrate the history of freeze drying technology.

Stage 1: basic freeze drying knowledge originated from the ancient Peruvian Incas



The basic process of freeze drying food is known to the ancient Peruvian Incas of the Andes. They knew the basic process of freeze-drying food. Lyophilization, is the sublimation or removal of water content from frozen food. The Incas were drying their frozen meat in the sun under the reduced atmospheric pressure of high altitude. The dehydration occurs under a vacuum, with the plant/animal product solidly frozen during the process. Shrinkage is eliminated or minimized, and a near-perfect preservation results. Freeze -dried food lasts longer than other preserved food and is very light, which makes it perfect for space travel. The Incas stored their potatoes and other food

crops on the mountain heights above Machu Picchu. The cold mountain temperatures froze the food and the water inside slowly vaporized under the low air pressure of the high altitudes.

Stage 2: freeze drying technology development for experimental purpose

In 1792, Tissot suggested to make dry smallpox virus, when he vaccinated people. The first people who used freezing drying method was Altmann. In 1890, in order to keep the shape of tissue and organ samples, he used lyophilisation, and applied the freeze drying technology to biological samples. At that time, the facility used for freeze drying was small equipment made of glass.

In 1903, Wansteenberg successfully produced rabies virus by using sulphuric acid as drying agent. It appears to have evolved with time from a laboratory instrument that was referred to by Benedict and Manning (1905) as a "chemical pump".

Shackell took the basic design of Benedict and Manning and used an electrically driven vacuum pump instead of the displacement of the air with ethyl ether to produce the necessary vacuum. In 1909, Shackell published his freeze drying experiment report on *Am.J Physiol* magazine. The facility for his experiment was simple vacuum pump, salt and ice as cooling agent, sulphuric acid as drying agent. The dehydrated products were Mmplement, Antiscra and Rabies virus. Dr. Jennings' company has developed a number of instruments that are directly applicable to the lyophilization process, including their patented D2 and DTA thermal analysis instrument.

The purpose for lyophilisation was expanding those samples' storage ability and avoiding the instability caused by high temperature. In 1921, H.F. Swift suggested standard freeze drying method to keep bacterial strain. People started to realize the advantages of freeze drying, which combined the freeze and drying in a very low pressure. This new technology kept the structures and good shape of frozen product with minimum volume loss. Because the product is at low temperature, most of microbiological reaction and deterioration are stopped, obtaining a final product of excellent quality.

Stage 3: freeze drying technology application in pharmaceutical, food and flower industries.

In 1935, the first commercial freeze dryer which has a large chamber for freezing and a vacuum pump for removing moisture came out. Flösdorf and Greaves developed well-running freeze drying facility and equipment; this made the massive production possible. The first large-scale freeze-drying started in World War II. Getting enough plasma to Europe to treat soldiers who were injured in combat required extensive refrigeration, but a lack of resources prevented the plasma from staying frozen and some of it spoiled, which created a life-or-death situation in field hospitals. In order to make it possible to ship the plasma at room temperature, the United States Army started freeze-drying the plasma. The 2nd World War promoted the application of freeze drying in pharmaceutical industry. After the war, this new technology expanded into vaccine, drug industry. Until now, Lyophilisation tech was broadly applied in pharmaceutical industry.



The systematic research to freeze drying food started from fifties of 20 century, but freeze-dried coffee was first produced in 1938, and lead to the development of powdered food products. Nestle company invented freeze-dried coffee, after being asked by Brazil to help find a solution to their coffee surpluses. From 1948 to 1951, British Food Department made constant research in a lab located in Aberdeen. The followers were French and other countries. During sixties and seventies, the relevant experiments on freeze drying food were very active in America and European countries. Just in 1966, America announced 36 food freeze drying patents. They began with building plenty of experiment plants and improving existing technology and facilities, solved the problems occurred during freeze drying process. The research areas covered increasing the efficiency of freeze drying, keeping high quality of food, thermal analysis of freeze dryer.etc. About 1960, freeze drying technology expanded world widely. America, Japan, Germany, Holland and Denmark built their own freeze drying food plants. At that time, coffee seized most of shares in all freeze drying food in America and Euro countries. In Japan, freeze drying instant noodles took more than half of the whole constant noodle market. There followed a flood of freeze drying food, such as vegetable, shrimp meat, tricholoma matsutake, meat paste, fish, shell. Over 400 different types of freeze -dried foods have been commercially produced since the 1960s.

Floral freeze drying first developed in the late 1980's, as a spin off from herb & vegetable preservation. Today, in the U.S & Europe, there are hundreds of floral preservation companies, using specialized floral freeze drying machines.

Freeze-drying (lyophilisation) is a widely used method for dehydrating a vast range of materials, including foodstuffs, pharmaceuticals, biotechnology products, vaccines, diagnostics and biological materials. It may be carried out on a range of scales, from bench top through pilot-scale to a full-scale manufacturing process and offers a number of advantages over conventional drying and many other processing methods. Despite its wide use, however, it is still apparent that many regard freeze-drying as somewhat of an art. This is perhaps not surprising, given the lack of available texts devoted to the process itself, with many published articles tending to describe specific applications of the process. Specialised training courses are now arguably the most effective means of learning about the various aspects of freeze-drying technology.

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