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Thua Thien Hue Construction and  
Water Supply State One Member Co., Ltd.  
Quang Te 2 Water Treatment Plant

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In the Pursuit of Technological Development to  
Create Value at Customers' Sites, Azbil Promptly  
Implements Silicon Valley Technologies



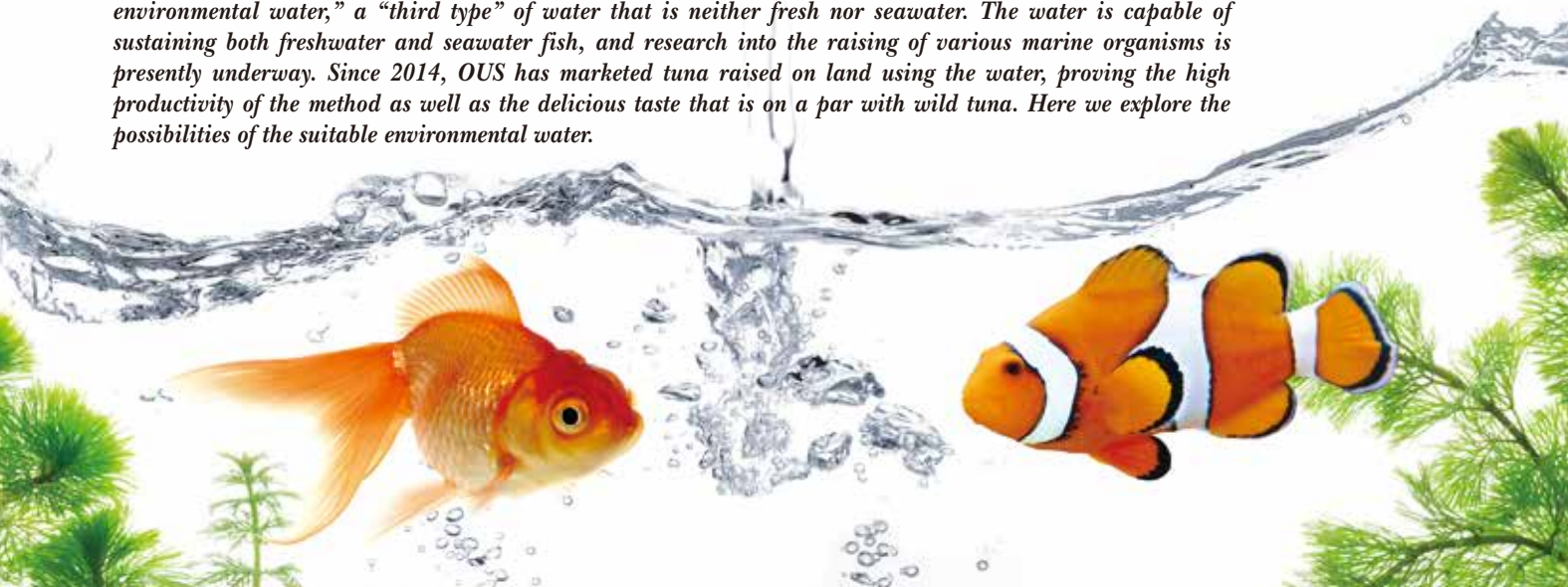
**Special Feature**  
**The Third Water**  
**Allowing Freshwater and**  
**Seawater Fish to Live Together**



# The Third Water

## Allowing Freshwater and Seawater Fish to Live Together

*In 2003, researchers at the Okayama University of Science (OUS) succeeded in developing “suitable environmental water,” a “third type” of water that is neither fresh nor seawater. The water is capable of sustaining both freshwater and seawater fish, and research into the raising of various marine organisms is presently underway. Since 2014, OUS has marketed tuna raised on land using the water, proving the high productivity of the method as well as the delicious taste that is on a par with wild tuna. Here we explore the possibilities of the suitable environmental water.*



### Water Stripped of Components That Fish Don't Need

In a hilly area about 20 kilometers away from the sea, the OUS Life and Animal Education Center is the research base for the suitable environmental water. In



The researcher who developed the suitable environmental water:  
**Toshimasa Yamamoto**  
Associate Professor  
Department of Applied Chemistry and Biotechnology, Faculty of Engineering, Okayama University of Science

the Center there is one 140-ton tank and four 35-ton tanks, plus the full range of water purification systems, for a landlocked, closed loop circulation aquaculture system that uses the suitable environmental water in place of seawater. The tanks hold and raise fish that migrate between ocean and river, such as salmon and eel, as well as ocean-dwelling species such as bluefin tuna, flounder, and grouper, and even black tiger prawns.

Landlocked methods of raising seawater fish include flow-through systems, in which seawater etc. is continuously fed into the system, circulated, and discharged, and closed loop circulation systems, in which a filtration system is used to purify and circulate the tank water. In mountainous regions far from the sea, the latter option is generally chosen. Associate Professor Toshimasa Yamamoto of the Department of Applied Chemistry and Biotechnology, Faculty of Engineering, Okayama University of Science, who developed the suitable environmental water, explains.

“Conventional closed loop circulation systems involve filling the tank with natural or artificial seawater and changing about 5% of that water per day. By con-

trast, with the suitable environmental water, all you have to do is add 10 grams of electrolyte powder per liter of freshwater, with basically no need for water replacement. The only water requirement is less than 1% a day to compensate for evaporation. In a sense, you can achieve a completely closed loop circulation system.”

Seawater fish can only live in seawater – this fixed idea was turned upside down with the suitable environmental water. How, then, did this water come to be developed? It all began with one student's experiment.

“One day,” says Yamamoto, “a student came to me and said he was thinking of raising ocean plankton to feed the Japanese bitterlings he was breeding. I didn't think that was possible, but I gave him some advice anyway, and a week later he came back to me all happy and excited, and showed me his plankton. I thought this would be a tremendous breakthrough if it was for real, and tried to reproduce his success, but to no avail. So I hypothesized that the student's success might have resulted from him not having washed the seawater tank prior to raising his plankton, hence the minute

quantities of seawater components adhering to the tank had allowed the plankton to proliferate. And I formed another, very fundamental hypothesis: that perhaps sea-dwelling organisms were actually capable of living in aquatic environments that were not 100% seawater.”

Yamamoto immersed himself in research on a freshwater-based aquatic system that would sustain seawater fish. Out of the roughly 60 kinds of seawater components, he would try subtracting one, then another. Or, he would add one seawater component at a time to a completely freshwater base. After countless trials with innumerable combinations, he ultimately focused on three components: sodium, potassium, and calcium. He then identified the optimum concentrations of each, and his suitable environmental water was completed.

### The Tremendous Benefits of Aquaculture with the Suitable Environmental Water

The development of the suitable environmental water has made major cost savings possible in terms of transportation costs for natural seawater and the water costs for producing artificial seawater, which got in the way of land-based aquaculture. Aquaculture utilizing the water also provides the following six benefits:

① Safety and security: Marine organisms are raised in an artificially man-

aged environment, which enables thorough traceability.

② Fast growth: Although it depends on the species, fish raised with the water generally grow 1.2 – 1.3 times faster than they do in seawater (under the same closed loop circulation conditions). This makes it possible to send them to market faster.

③ Less prone to disease: Because the water is neither freshwater nor seawater, the fish are less likely to develop diseases prevalent in either environment, eliminating the need for antibiotics.

④ High density cultivation is possible: The lower likelihood of disease makes it possible to raise useful fish with high market value at a higher density. In the Center, each cubic meter of water tank has managed to produce 109 kilograms of Japanese eel and 47 kilograms of Japanese pufferfish. The production density of conventional Japanese pufferfish farming is generally about 10 kilograms per cubic meter of water.

⑤ Can be used anywhere: Fish can be raised anywhere, as long as there is a water source. Physical distance from the sea is not a consideration, since there is no need to carry in seawater. Ocean-dwelling fish can be raised in mountainous regions.

⑥ Water recycling: With the water, almost no ammonia is generated, and filtering is easy. Therefore, the tank water can be used for a long time while recycling the water.

Up to now, these benefits have been proven through the raising of such fish species as bluefin tuna, Japanese pufferfish, flounder, grouper, yellow jack, and eel, and the grown fish have been delivered to market. Eel is already a popular brand-name product of the University. “All of the fish were delicious,” says Yamamoto. “The fact that they grow quickly means they are that much more comfortable in their living environment, and perhaps this favorable growth process is reflected in the good flavor. In the wild, fish select their ocean or river habitat depending on their respective set of conditions and situations, but I am certain that those living environments are not necessarily the most comfortable for them.”



Landlocked aquaculture facilities in Takeo Province, Cambodia.

### “Fish Factories” are Possible in the Desert or in Outer Space

Yamamoto sees “fish factories” as being key to meeting the burgeoning demand for food accompanying the explosive growth of the human population.

“Traditional aquaculture facilities utilizing rivers, ponds, or parts of the sea are increasingly vulnerable to outbreaks of disease due to global warming and so on,” he says. “Plus, there are also higher risks of typhoons, tidal waves, and other natural disasters. Marine products are nutritionally excellent food products, but aquaculture utilizing natural waters is a high risk, low return industry. From now on, we must focus on the idea of fish factories that are unaffected by natural environmental conditions, and we are at the stage where they can be achieved.”

Land-based aquaculture using the suitable environmental water is also attracting attention from countries outside Japan. Yamamoto and his research team work with Japan International Cooperation Agency (JICA) in industry-poor inland Cambodia, conducting research on giant river prawn, native to the brackish waters of the tropical and temperate zones, in an aquaculture project that includes raising them from spawn to larva. “The prawns we see swimming around so energetically were born and raised without ever having been in the ocean,” says Yamamoto. “When I see that, it gives me confidence that our landlocked aquaculture system can be applied to any remote mountain location or desert. In the future, my dream is to get ‘space aquaculture’ going in a space colony.”



Hydroponic vegetables are grown next to the suitable environmental water fish tanks. Nitrogen and phosphates are unnecessary for fish, but provide nutrients for plants. Water from the fish tank, containing fish by-products, is used for hydroponics. Vegetable growth is promoted and the water is filtered in a win-win setup.



# Thua Thien Hue Construction and Water Supply State One Member Co., Ltd. Quang Te 2 Water Treatment Plant



**Starting in 2001, Thua Thien Hue Construction and Water Supply State One Member Co., Ltd. (HueWACO) implemented a safe tap water project., the predecessor of the current Water Safety Plan. In 2007, HueWACO adopted and quickly implemented a Water Safety Plan which was suitable for the characteristics of the company. HueWACO declared the water supply throughout the province to be safe in August, 2009. In 2013, a new project was launched with the support of private Japanese companies. As a part of the project, a monitoring and control system was installed at Quang Te 2 Water Treatment Plant in order to automate the chemical dosing process, helping to improve the dosing of exact amounts of chemicals and the control of water quality.**

## Introduction to HueWACO

Thua Thien-Hue Province (hereafter "Hue Province") is located in central Vietnam. Its capital, Hue City, is famous as the capital of the Nguyen Dynasty, the country's last royal dynasty. The Complex of Hue Monuments, which is evocative of the Nguyen Dynasty era, is designated as a UNESCO World Heritage Site (cultural heritage site), and the number of tourists from overseas is increasing year after year.

In 2007, HueWACO implemented its Water Safety Plan with the support of the World Health Organization (WHO), and now provides safe water across Hue Province. HueWACO was highly evaluated and selected by WHO as a model company for presenting and sharing its experiences in the country and the region. Since then HueWACO has constantly upgraded and improved the water supply system in order to maintain a sustainable, safe water supply.

"HueWACO declared Hue City's tap water to be safe in June 2008, and did so for all of Hue Province in August 2009. During the period of 2009 till now, even though we have encoun-

tered some issues affecting safe water supply, we have come up with timely solutions to ensure its sustainability," says HueWACO President and Director Truong Cong Nam.

In 2013, the Vietnam-Yokohama Safety Water Supply Management Project was initiated under the Japan International Cooperation Agency (JICA) Partnership Program with the aim of sharing new technologies of private companies located in Yokohama, Japan, with HueWACO and other water supply companies in Vietnam.

## Constructing a System to Automatically Dose the Proper Amount of Chemicals at the Proper Time

The Vietnam-Yokohama Safety Water Supply Management Project has been providing support in four technical areas: chemical dosing control using a supervisory control and data acquisition (SCADA) system, flexible pipe method, water leakage monitoring detection utilizing L-sign devices, and rehabilitation of filtering sand. With regard to these four areas, Azbil Corporation's role was to provide technical assistance for the use of the monitoring and con-

trol system for water purification plants. Specifically, Azbil provided support for the installation of the above system to automate the chemical dosing process at HueWACO's Quang Te 2 water treatment plant (WTP) in order to dose the needed amount of chemicals to control the quality of water supplied. In addition, Azbil provides HueWACO with technical support for the operation of this system.

At the water treatment plant, chemicals such as PAC, polymers,  $\text{KMnO}_4$ , and chlorine are dosed at various stages of the water treatment process.

Luu Ngoc Tuan, Vice Manager of Planning in the Technical Department of HueWACO explains, "The SCADA system at Quang Te 2 WTP, which was installed in 2009, just performed semiautomatic chemical dosing and the determination of chemical dosing amount was still done manually. As a result, sometimes the amount of chemicals injected did not meet the requirements, which in turn increased our production costs or affected the water quality."

In the project, Azbil's Harmonas-DEO™ monitoring and control system was used as the cen-



[1] In the central monitoring room, Harmonas-DEO monitors the flow rate of water entering the water receiving well and the degree of water turbidity, and controls the rotation speed of chemical dosing pumps and the opening and closing of control valves.

[2] Harmonas-DEO calculates the amounts of chemicals to add and sends instructions to the chemical dosing pumps and control valves.

[3] Analyzers determine the concentration levels of chemicals, degree of water turbidity, and water quality by analyzing the water obtained through conduits, and then transmit the data to Harmonas-DEO, which implements the results of control calculations.

[4] Training was held at Azbil's Fujisawa Technology Center for the three engineers dispatched from HueWACO.

tral equipment of the new automatic chemical dosing control system. The system receives data from the existing monitoring system through a gateway, calculates the amounts of chemicals to add, and controls the chemical dosing process so that the appropriate amounts of chemicals are automatically added at the appropriate times.

To prepare for the construction of the system, three HueWACO engineers were dispatched to Japan and received system-related training at Azbil's Fujisawa Technology Center. After learning the basic technology of the automation and control system, the three engineers and Azbil Corporation began developing the control program to be installed in Vietnam.

## Advanced Methods Attract Considerable Attention from Water Utility Personnel Throughout Vietnam

The system began operation in June 2015. Detailed evaluation of data accumulated by Harmonas-DEO and full-fledged implementation of measures for correcting any glitches discovered through evaluation have not yet started, but the system has already achieved results.

"During two years of implementing the project, including all four areas, the automatic chemical dosing control at Quang Te 2 WTP has achieved definite results which the technical team of HueWACO has assessed using the advanced technologies of Azbil as well as the experience of the experts of Yokohama Waterworks Bureau (YWWB) in Japan. The automatic chemical dosing control system has helped to determine the appropriate amounts of chemicals and also

has dramatically reduced the time and effort required to add in the chemicals, which contributed to better control of water quality at the plant," says Mr. Tuan.

Chau Ngoc Long, Manager of Planning in the Technical Department of HueWACO comments, "In this project, regarding the SCADA system at Quang Te 2 WTP, owing to the support from the JICA project, Azbil Corporation, and YWWB, HueWACO was able to successfully connected the automatic chemical dosing control system to the SCADA system. HueWACO has also invested much additional machinery and equipment to ensure optimal system operation. I think this is the first success area of this project."

A seminar on the Vietnam-Yokohama Safety Water Supply Management Project was held in June 2015 at the head office of HueWACO. In the seminar, details of efforts in the four technical areas, including the construction of the Quang Te 2 system, were presented.

"The seminar was attended by about 200 water utility personnel from 40 municipalities across Vietnam. The case study of the system built at the Quang Te 2 WTP attracted a great deal of attention from the participants and was highly evaluated," says Mr. Long.

HueWACO plans to install a similar system at other water treatment plants operated by the company.

Mr. Nam states, "In the future, HueWACO will establish a central control center for monitoring and operation of the water supply system. In these efforts, we look forward to Azbil's technical assistance and support for human resources development as well as machinery."

## Thua Thien Hue Construction and Water Supply State One Member Co., Ltd.



Location
103 Bui Thi Xuan Str., Hue City, Vietnam
Establishment
1909
Business lines
Maintenance and operation of facilities such as water purification plants and pump stations; supply of drinking water; etc.



Truong Cong Nam  
President and Director



Chau Ngoc Long  
Manager of Planning,  
Technical Department



Luu Ngoc Tuan  
Vice Manager of Planning,  
Technical Department



# In the Pursuit of Technological Development to Create Value at Customers' Sites, Azbil Promptly Implements Silicon Valley Technologies

Azbil Corporation has established Azbil North America Research and Development, Inc. in Silicon Valley in the U.S. as a technological development base and set up a system to swiftly respond to technological innovation from a global point of view in order to create products by leveraging advanced technologies. Employing state-of-the-art technologies, Azbil strives to provide customers with greater value.

## Developing Advanced Technologies in Silicon Valley is Essential to Support Globally-Operating Customers.

Living up to its corporate philosophy of "human-centered automation," the azbil Group meets a variety of needs of customers operating inside and outside of Japan as their partner by expanding operations in its three business areas of Building Automation, Advanced Automation, and Life Automation. Azbil



**Takeshi Kawai**  
President  
Azbil North America Research and Development, Inc.

Corporation believes it is essential to develop technologies by adopting new approaches from a global point of view in order to quickly provide customers with advanced technologies and products.

As a matter of course, Azbil Corporation established Azbil North America Research and Development, Inc. in February 2014 as a base to take on technological development for Azbil's future by catching up with the trend of technological innovation and changing markets from a global point of view. Its office is located in the City of Santa Clara, California, part of the area called Silicon Valley, and the select few are working there.

The main reason why Azbil has set up the R&D base in the U.S. is that increased basic technical capabilities and rejuvenated product development by means of advanced technologies can be expected through collaborations with U.S. research institutes, academia, and enterprises that are leading the world in terms of both technology and business. Furthermore, cultivated know-how can be leveraged a great deal into the improvement of individual engineers' skills. Particularly for young engineers bearing the azbil Group's future, Azbil believes that the R&D experience in the U.S. will contribute greatly to their own future development, which will eventually lead to the increased appeal of azbil

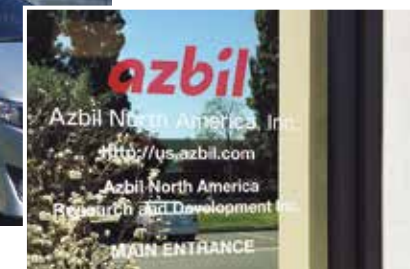
Group products. Silicon Valley is home to start-up companies and known as a hub of leading technologies, where world-renowned high-tech companies gather. In fact, Google Inc., Apple Inc., the National Aeronautics and Space Administration (NASA), the Ames Research Center, Stanford University, and Carnegie Mellon University are located nearby, so Azbil North America R&D office has swift access to the most advanced technologies in the world. It is also advantageous for Azbil North America R&D to be based in the U.S. because it can take root in communities made up of these kinds of leading organizations and therefore can promptly participate in their activities.

## Promoting Collaboration with Academia and Research Institution in Examining Next-Generation Sensor Network

Taking advantage of its work environment surrounded by U.S. R&D resources and abundant information sources, Azbil North America R&D plays three major roles: technological development, technological research, and operations related to international standardization. In the technological development field, Azbil North America R&D focuses on "highly-reliable wireless technology" that enables stable signal transmissions through the air. In associa-



Having an office inside Azbil North America, Inc. another affiliate of Azbil in the U.S., Azbil North America R&D shares knowledge and experience with Azbil North America to bring about collaborative effects.



tion with a think tank called SRI International, formerly SRI founded by Stanford University as its research institute, Azbil North America R&D was working on feasibility tests for the reliability of wireless communications from September 2014 to January 2015. And then from the following February to April, Azbil North America R&D worked with the University of California, Berkeley (UC Berkeley), examining the realization of a low power wireless sensor network with high reliability in constant signal transmissions using new frequency bands other than those already being used. If this technology is realized, many achievements can be expected, such as faster transmission of a large amount of data, lower power consumption by communication modules, and the improvement of robustness\* and security of communications. Azbil North America R&D and UC Berkeley have been discussing over the theme in further detail in preparation for the future application of the technology. In actual applications, for example, the technology might be used for checking behaviors of valves operating at

industrial plants, or it can be adopted in wireless communications to collect different kinds of data.

Azbil North America R&D has actively been working on developing other technologies, such as wireless transmission of electricity and energy harvesting technology deriving energy from external sources, including solar power, illumination sources, machines' vibrations, and thermal power.

With regard to technological research, Azbil North America R&D's important themes include studying technologies defined as Azbil's strategic field, such as autonomous measurement and control technology and human-machine system technology. In addition to these themes, the IoT (Internet of Things) is gaining attention as a technology that will have a great impact on our future activities in society and industry. Promoting research is one way that Azbil North America R&D is keeping relations with academia, research institutes, and start-up companies that are looking for new IoT-based business opportunities. Another approach is that Azbil North America R&D also takes part in conferences and events mainly held in Silicon Valley as a member of the local community.

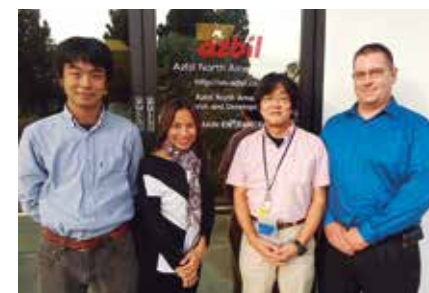
## Through Active Involvement in Developing International Standards, Azbil North America R&D Operates Keeping in Line with the Latest Tech Trends

Azbil North America R&D's third major role is actively getting involved in developing international

standards for automation. Since October 2014, Azbil North America R&D has been a member of the International Society of Automation's ISA108 Committee, which is responsible for discussing and defining standards. The committee defines standard templates of work processes for operations, diagnosis, and maintenance of facilities equipped with networked intelligent devices within industrial plants. For the azbil Group providing products that can be used for more than 20 years at customers' sites, the processes and practices defined by ISA108 are extremely important in supporting customers' production. From that point of view also, Azbil North America R&D engages itself in developing standards on its own initiative.

Meanwhile, Azbil North America R&D also takes an active part in promoting ISA100 standard for wireless networks for factory field devices as a board member of ISA100 Wireless Compliance Institute whose role is supporting ISA100 users and vendors developing products.

In light of leading technological trends around the world, the azbil Group will accelerate the implementation of measures to provide products with up-to-date value and strives even more to help customers by addressing their challenges.



The handpicked few are working at the Santa Clara office.

\*Robustness refers to the quality of being hardly changed internally by the impact given from outside. In the field of communication technology, it means the resistance to interference or the ability to cope with errors and faults.

A method for preserving substances without destroying their characteristics by freezing and then drying or removing the water content (ice) by sublimation.

### Why does freeze-dried food have a long shelf-life with no loss of quality?

Freeze-dried food is a type of familiar instant food. Typical freeze-dried food includes soup, which can be enjoyed by just pouring in hot water, and tin-packed instant coffee, etc. Freeze-dried food is made through a process called "lyophilization," in which the food is frozen and its water content is sublimated directly into gas at low temperature (sublimation\*), allowing long-term preservation of the food without a loss of flavor or quality. This process is also known as "freeze-drying."

During a lyophilization process, food is generally treated under a vacuum, which dramatically speeds up sublimation. It can lower the food's sublimation point, so the water content can be sublimated into vapor quickly even at a low temperature. Thanks to the technology enabling low-temperature processing, the flavor and quality of the processed ingredients remain intact.

When dried through lyophilization, the substance will have an infinite number of microscopic pores, which rapidly absorb water and allow the product to quickly rehydrate and regain its original form.

Freeze-dried products have little residual water content, so the form of their building blocks is hardly altered. This is why they have a long shelf-life at room temperature. They are also

convenient for transportation since they are light-weight. Processing food under a vacuum is advantageous also because it is easy to create an aseptic environment for production.

### Possibility expanding in other fields including pharmaceuticals and the restoration of old books

As mentioned above, the lyophilization method has numerous merits, thus is adopted by various industries besides the food industry. In fact, the technology is contributing a great deal to the development of the pharmaceutical industry.

Lyophilization technology demonstrates its capability when it comes to the preservation of pharmaceutical products made up of micromolecular protein whose complex structure makes it difficult to remain stable unless it receives special treatments. Vaccines, antibody drugs, and interferon used for treating liver cancer and hepatitis C are examples of such products.

The technology, for instance, contributes to the stabilization of vaccines for diseases, such as measles, mumps, German measles, Japanese encephalitis, and chicken pox. Since lyophilized vaccines are solid, doctors, nurses, and other medical staff reconstitute them by adding the diluent provided by the manufacturer for that vaccine immediately before administering them.

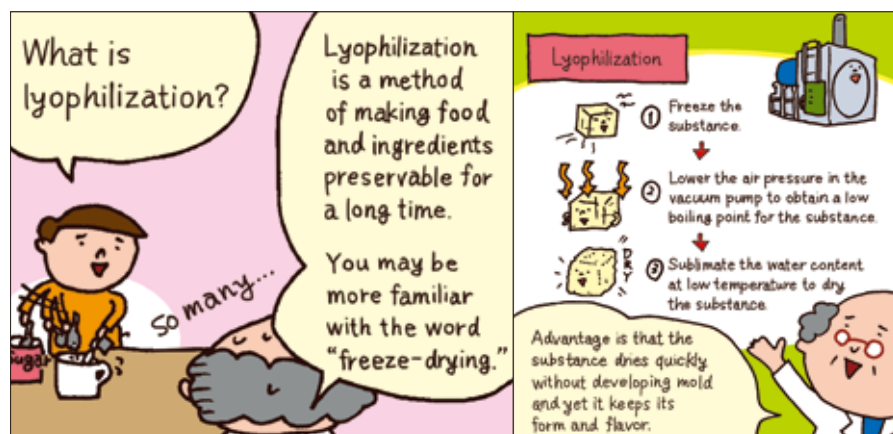
Lyophilization is increasingly used in different fields. Its involvement in the expanding biophar-

maceutical market is very likely, and the use of this technique is expected in manufacturing oral tablets that disintegrate more easily for infants, and for the elderly with dysphagia or problems with swallowing.

The possibility of lyophilization is expanding even into other fields. One such field is the restoration of old documents for the purpose of preserving cultural assets, such as historically-important documents damaged by water and mud due to natural disaster. With the lyophilization process, even documents with pages stuck together by water damage can be restored, and at the same time the freeze-drying process removes mold and mildew, which can improve the preservation level of such documents.

Lyophilization technology has also begun to be used for the preservation of living cells and microorganisms in the scientific research field and for the manufacture of photoreceptors such as organic pigments, micromolecules, and plastic materials that are required in the electrophotographic process. The technology is also used, for example, to recycle remaining liquid concrete for later use and to manufacture the new ceramic that is necessary to make dust filters. The possibility of lyophilization seems never to stop expanding.

\* Sublimation is the direct transition of a substance from the solid to the gas phase or in the reverse order without going through the liquid phase. It is a phenomenon that can be observed with dry ice transforming into vapor without being liquefied.



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Lyophilizers are mainly used by the food and pharmaceutical industries. Azbil Telstar, S.L.U. is specialized in manufacturing lyophilizers for pharmaceuticals. Its products freeze-dry pharmaceuticals, such as vaccine, blood products, and antibody drugs, whose active ingredients can be redissolved easily, and then process the ingredients into powder without deteriorating their quality so they can be preserved for a long time.



Cover photo by Koji Mizutani, MERRY PROJECT Representative

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Yamatake Corporation changed its name to Azbil Corporation on April 1, 2012.

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