

Earth-Friendly Innovations

Japan was once afflicted by heavy pollution, and Japanese companies—having seen the environmental degradation that accompanied high economic growth—recognize that they will not succeed if they do not harmonize their activities with environmental concerns. Here Japan Echo introduces two SMEs that are developing products with a view to reducing the burden on the environment.

Twinbird Corporation CFC-Free Cooling Device

We, the producers, and the customers who use our products are like a pair of birds. We want to foster relationships of trust to bring prosperity to all.” So runs the company’s mission statement that gave Twinbird Corporation its name. Twinbird is the current incarnation of Nomizu Electric Plating Works, founded in 1951 in the city of Sanjo, Niigata Prefecture, as a family-run subcontractor. In 1977 the company changed its name to Twinbird Corporation and since the 1980s—to fulfill a desire to build products under its own brand name—began full-scale production of the household appliances and other products that continue to make up the bulk of its business today.

In the years since then, the company has come to excel in niche markets, where, Twinbird President Shigekatsu Nomizu says, “the larger appliance manufacturers find it difficult to do business,” developing products like waterproof DVD players, electric scalp-washing brushes, and shoe dryers. Consolidating the appliance development expertise the company

had accumulated over several decades, it decided to establish a new pillar of operations and, in 2002, became the first company to successfully develop mass-production technology for the “free-piston Stirling cooler.”

Over 1,000 Prototypes

In 1991 Twinbird became the first Japanese company to commercialize a portable, in-vehicle electronic refrigerator using a thermoelectric transducer called a Peltier device. The cooling method employed was significant in that it not only eliminated the need for harmful cooling agents, such as chlorofluorocarbon gases, but also made possible compact, lightweight cooling devices with minimal operating noise. The drawback was that it took a long time for units to reach below-freezing temperatures, and the coefficient of performance, which measures the volume that can be cooled or heated per unit of electricity, was quite low at 0.2.

Twinbird continued to look for ways to build an environmentally friendly cooling device with enhanced energy efficiency. Professor Tadashi Sasaki, a consultant with Twinbird since 1995, intro-



President Shigekatsu Nomizu

duced the company to the Stirling cooling technology developed in the United States. The Stirling cooler uses a piston to compress and expand a gas within a cylinder. At the time it was reserved for highly specialized uses, such as artificial satellites and miniature military sensors, and was quite expensive to build. Mass producing the cooler for the consumer market required a low-cost, durable material that could withstand repeated heating and cooling and a method for assessing such durability.

Having built many innovative household appliances, audiovisual equipment, and health products by introducing a broad range of technologies, though, President Nomizu was confident of success. The company had built a thousand pro-

prototype devices since 1998, when development of mass-production technology began, but the durability issue had proved a bottleneck to progress. Developers continued to search for piston materials that could withstand changes in temperature and offer a low friction coefficient. It took several years for Twinbird to hit upon a specially engineered plastic created by mixing resin with carbon fibers.

To achieve the unique configurations of the stainless-steel shell, it invested in custom-manufactured processing equipment. And to concentrate management resources on the development effort, Twinbird established a new Stirling cooler department, not only cutting the budgets of other departments to secure funds but also shutting down a metal molds division and outsourcing production to China.

“We cut costs by 600 million yen and allocated 300 million yen of the savings to developing the Stirling cooler,” Nomizu explains. “Until we finally succeeded in 2002, the Stirling project was having a negative impact on business results, and people within the company started questioning why we

were pursuing the business. Still, day after day, I kept trying to convince the naysayers.”

Cooling to Minus 120°C

The Stirling cooler uses helium as its cooling agent. Whereas carbon dioxide has a global warming potential of 1.0, the figure for helium is 0.0, making it an environmentally friendly choice, and as an inert gas it is quite safe.

The coefficient of performance for the 40-watt Stirling cooler capable of cooling to minus 20°C to 30°C that was marketed in 2004 reached 1.1. Because it operates at a mere 12 volts, the device can be connected to typical household power sources, car batteries, and even solar cells. To date, Twinbird has shipped 5,000 units of the 25-liter portable freezer/cooler, whose compact size and light weight make it ideal for installation in campers and yachts.

While Twinbird originally developed the Stirling cooler for the consumer market, it has also begun developing industrial-use coolers. There are many potential applications in the fields of physics and chemistry, for instance, since temperatures can be controlled in 0.1° increments by adjusting the pistons' amplitude. The company developed its own technology for high-precision press-working and spinning to surpass the 140,000-hour mark in durability tests that measure the mean time between failures. By introducing its own performance and other assessments tests, it lowered the defect rate to less than 1%. These achievements may be said to be the culmination of its broad expertise in processing technologies.

“People often say that our manufacturing facilities are rather modest, but our production line is

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Capital: ¥1.7 billion
Employees: 274
Website: <http://www.twinbird.jp/english/index.html>

backed by years of expertise,” says Tsuneo Yamagiri, general manager of R&D and Production Operations, smiling as he looks across to the factory.

After clearing stringent durability and performance tests, the company began shipping to overseas customers several hundred coolers with a fixed 4°C temperature for use in transporting blood and vaccines.

“Coolers to preserve organs and manufacture precision machinery require lower temperatures,” adds Yamagiri. “Conventional freezing devices are quite large and consume a great deal of electricity. A Stirling cooler can cut down on both size and power consumption. In 2009 we launched a product that can cool to minus 120°C and maintain internal temperature levels. If lower temperatures can be achieved, Stirling devices may come to be used with such equipment as electron microscopes, semiconductor manufacturing equipment, and magnetic resonance imaging devices.”

Low temperatures are particularly important in the production of semiconductors, since all unneeded suspended particles must be frozen to create a clean environment. Twinbird therefore plans to develop the technology needed to build a Stirling cooler capable of reaching temperatures of minus 180°C by March 2010.



Twinbird's free-piston Stirling cooler.

Izumi Paper

Paper Recycling Innovator

Shikoku is the smallest of the four main islands making up the Japanese archipelago. The island's four prefectures enjoy a temperate climate, including Ehime, where the city of Shikoku Chuo is located. Facing the calm Seto Inland Sea, the city has developed into a leading center for paper manufacturing and processing in Japan.

Shortly after its establishment in the city in 1947, Izumi Paper Co., Ltd., began producing toilet paper from recycled wastepaper. Izumi Paper manufactures roughly 100 types of facial tissues, toilet paper, paper towels, and other paper products from recycled paper. Although a small company at the time with just 30 employees, Izumi Paper became one of the first in the region to introduce a wastewater treatment system and develop a range of innovative paper-manufacturing technologies, which have revamped the image of the paper manufacturing industry.

Izumi Paper President Shozo Udaka explains: "Around 1970 the paper manufacturing industry was causing damage to the environment not only by using enormous amounts of water but also by sending contaminated wastewater into the rivers. I wanted to contribute to a solution through research into wastepaper recycling technologies that use as little water and chemicals as possible."

After studying organic chemistry at university, Udaka went on to work at a major chemical firm, where he was involved in materials

research. "One day, though, I was asked to take over the papermaking business from my father, and honestly speaking, I wasn't sure what to do. In the end, I decided to accept the offer out of a desire to help clean up the local rivers, which I could swim in when I was a boy, by developing new paper-making technologies."

After joining Izumi Paper in 1971, Udaka first took on the challenge of developing a low-cost wastewater treatment plant, which at the time was very expensive and difficult for a small company like Izumi to install.

Thanks to support from a local machinery maker, "We completed installing the wastewater treatment plant on the factory grounds in just six months," Udaka recalls. "I was really moved when clear water first flowed out of the plant."

Chemical-Free Recycling

Udaka next embarked on the development of a new wastepaper treatment method to produce white paper without the use of chemicals. Wastepaper treatment, which involves creating pulp from wastepaper, had been handled by the Ehime Pulp Cooperative Association, which local papermakers jointly set up in 1969. Udaka believed, though, that this, too, had to change if local rivers were to be really cleaned up.

Ordinarily, when making recycled paper, water mixed with an alkaline agent and a surfactant is added to the wastepaper, and a kneader is used to separate the fibers and to disperse ink particles.



President Shozo Udaka

Recycled paper pulp is made by removing the dispersed ink from the mud-like slurry, bleaching it, and then washing and removing the water. This requires the use of large amounts of chemicals, which have been adversely affecting the environment. To address this concern, Udaka took the initiative to work with a local machinery manufacturer to develop a new method.

"Wastepaper for recycling includes papers of various textures, such as magazines, newspapers, photocopy paper, and milk cartons," Udaka notes. "To produce high-quality paper from mixed wastepaper, it is important that the fibers are thoroughly and uniformly separated."

"One time we stirred the wastepaper solution too long, and it came out like sludge. We went ahead and deinked the solution anyway and, much to our surprise, it came out white. Until then, we had been giving all our attention to the type of surfactant, but we learned that a more important factor in removing the ink was making sure the ink particles were uniformly atomized. This was a major

discovery made from what had been a mistake. We built an improved kneader to crush and unravel the wastepaper using frictional force and succeeded in miniaturizing—and then removing—the ink particles.”

The company also set to work on improving deinking technology. Until then, the ink that had been dispersed could not be prevented from reattaching itself to the fibers. After five or six years of trial and error, the company developed a proprietary flotator device that generates foam to absorb the ink and removes it.

As a result of numerous subsequent trials carried out at a test plant incorporating the improved kneader and flotator, Izumi Paper completed its first plant capable of producing white, recycled paper pulp without the use of chemical bleaching agents in 1987.

“We’ve been able to make recycled paper with a higher white contrast without the use of chemical agents, such as chlorine bleach,”

Udaka says. “Because the bleaching process has been eliminated, water usage has been reduced to just one sixth of previous levels. Now the rivers are incomparably cleaner.”

Expanding the Use of Recycled Paper

Believing that promoting the use of recycled paper was indispensable to protecting the local natural environment, President Udaka is working with a local manufacturer of papermaking equipment to improve production facilities, raising productivity and making them more suited to the production of household paper, to enable Izumi Paper to lower the prices of its products.


Making paper ordinarily involves rotating a cylindrical wire mesh onto which the paper pulp is run, draining the water, and turning it into sheets. One difficulty was the fact that when the wire mesh is rotated at high speeds, the

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Capital: ¥ 45 million
Employees: 85
Website: <http://izumi.kami.ne.jp/index.html> (Japanese only)

pulp on the mesh cannot be dehydrated due to the rise in the centrifugal force. To facilitate the dehydration process, Udaka developed the Best Former, a papermaking machine with a decompressed wire mesh that sucks in the water from inside.

The Best Former can produce sheets of paper at five times the speed of earlier machines. It is now used not only locally but among papermakers around the country. Three of five manufacturers of household paper in Japan produce their products with this machine.

Izumi Paper has introduced innovations not just in production technology but also in its lineup of recycled household paper products. “I want to change the image of recycled paper,” Udaka claims, “by offering attractive, refined paper products.” Izumi Paper now manufactures soft, finely textured toilet paper and paper towels. They cost a little more than other recycled products, but with their soft texture and attractive floral-print designs, they are quite popular among consumers.”

Izumi Paper has opened up new possibilities for recycled paper not just with its environmentally friendly production technology but also by developing high-quality products catering to consumer needs. It is continuing its work to develop new products to expand the use of recycled paper. 



A giant roll of toilet paper. The paper is turned into product-size rolls and then cut.