NEWS maker

Cathay Industrial Biotech

This Chinese biotech exemplifies how companies in emerging markets can thrive in low-margin industrial applications.

Xiucai Liu, majority owner of Cathay Biotech.

Last year's largest producer of biobutanol was not chemical giant DuPont or oil and gas multinational BP. It was privately held Cathay Industrial Biotech in Shanghai. After completing construction of its fermentation facility in 2008, Cathay quickly scaled up its production capacity to 21 million gallons per year of biobutanol. That's nothing compared with the massive ethanol plants in Brazil and the US, but it's a bright spot in the biobutanol field. And Cathay is also blazing a trail in the other half of its business: bioprocess-based long-chain diacids. To stay in the biobutanol game, however, the company will have to accelerate its plans to switch to next-generation technologies.

The company got its start in 1997 on the small fortune amassed by co-founder Xiucai Liu from his work in pharmaceuticals. Liu was born in 1957 in an impoverished village in eastern China's Anhui Province, found his way to a PhD in biochemistry from the University of Wisconsin in Milwaukee in 1989 and in 1994 headed back to China to found Unistone Pharmaceutical, where he partnered with Beijing University and the Stone Group, a Chinese investor, and brokered a series of successful pharma-related deals.

Liu liked the idea of searching for weak spots in the chemical industry's products and using the tools of biology to make them better. He saw an opportunity in long-chain dicarboxylic acids, or diacids, which are the building blocks of nylon, adhesives and other products, and are traditionally made through multistep chemical processes. Fermentation routes to diacids require fewer steps, but many companies that had discovered these routes in the 1980s and 1990s found them too costly and complex. Liu, however, improved those fermentation techniques in ways that allowed him to scale up the operation. The company's processes start with paraffin, which are hydrocarbons, or fatty acids from palm or coconut oil. The starting materials are fermented with yeast, resulting in long-chain diacids such as polymer-grade dodecanedioic acid, or DC12, which is used to make a kind of nylon known to hold up against chemicals and maintain strength in wet environments. About two-thirds of the raw material for toothbrush bristles is DC12.

Cathay's first break came when Liu and co-founder Qixian Zhang licensed some of their fermentation technologies to companies, such as Archer Daniels Midland Company in Decatur, Illinois. Then came the first investor, Chinese liquor maker Anhui Gujing, which in 2001 gave Cathay $23 million—enough to build a diacid plant in the Shandong Province and begin operating in 2003. Three rounds of funding between 2006 and 2008 brought more than $175 million from large backers such as Goldman Sachs, Gramineae Holdings, GM Investment and New Horizon Evergreen Investment. Today, Cathay exports 99% of China's long-chain diacids and produces about half the world's output, according to the company. Its largest customer is DuPont, headquartered in Wilmington, Delaware.

Cathay got into biobutanol in an effort to expand its portfolio and seize a little market share from petroleum-based butanol, which is used largely as an industrial solvent or chemical intermediate in products such as paints, resins, plasticizers, herbicides, pharmaceuticals and food-grade extractants. Biobutanol can also be used as an alternative fuel to gasoline—a potentially limitless market, the way Cathay sees it, but one that is further away from commercialization.

Cathay chose to build its biobutanol production facility in Jilin, which is located about 220 miles from the border of North Korea but looks more like the US corn belt. Regional corn growers supply the raw material for Cathay's conversion process, which involves anaerobic acetone-butanol-ethanol fermentation using *Clostridia* bacteria. The process yields *n*-butanol and its co-products acetone and ethanol, along with by-products methane, hydrogen, fiber, germ and protein. All of the products are sold to Chinese customers, particularly those in the regional area. Cathay is also testing biobutanol as a fuel in a Chinese government–funded project.

Like many biofuel and bioproduct developers, the fate of Cathay's biobutanol business hinges on the company's ability to advance from corn to cellulosic biomass as its raw material. When the Jilin plant began operations in 2008, corn prices in China were low enough to make the operation economical, according to the company. But since then corn prices have soared to more than $9 per bushel, making it nearly impossible for Cathay to compete with petroleum-based butanol. The company has been operating at a net loss for the past two years, forcing it to limit production to about 7 million gallons per year, or about a third of its capacity. The Jilin plant shut down at the end of 2011 and there are no immediate plans to resume operation.

The situation has accelerated Cathay's efforts to scale up a pilot plant that produces biobutanol from corn stover, the energy-packed leaves and stalks of corn that, like other cellulosic feedstocks, could make Cathay's process more economical. The company has licensed the largest collections of *Clostridia* it can find and has developed a technology to rapidly test each strain on its biomass processes and feedstocks. Combining this search with mutagenesis, the company has developed *Clostridia* that show resistance to biomass inhibitors that are produced when sugar is broken down—a trait that reduces processing costs.

Other players in the biobutanol space are already at Cathay's heels. Songyuan Laihe Chemical, also in China's Jilin Province, is collaborating with Green Biologics in Abingdon, Oxfordshire, UK, to build an *n*-butanol pilot plant that will run on cellulosic feedstocks. And Englewood, Colorado–based Gevo, which applies synthetic biology to the production of isobutanol, says its 18-million-gallon-per-year operation will be producing and shipping isobutanol by next month.

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