Turning corn into clothing

Cathay and Siemens work together to build a world-class digital bio-manufacturing site in Wusu, Xinjiang

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Many exquisite clothes adorn the bright shop windows in malls. This is a common sight, but few shoppers realize that the raw materials used to make this air-permeable, hygroscopic and wearable clothing may come from golden corn growing on the vast lands in Xinjiang!

Besides garments, the manufacturing of many things we use every day, including toothbrushes, automobiles, computers and mobile phones, requires a chemical material called polyamide.

In the past, polyamide could only be synthesized using raw fossil materials. However, now there is a company capable of producing pentanediamine and binary acid by decomposing, converting and recombining abundant saccharides found in corn and other renewable biomass. The monomers can be changed into bio-based polyamide through further polymerization. The company is Cathay Industrial Biotech Ltd. (Cathay) founded in 1997.

Cathay Wusu site is expected to set the benchmark for digital manufacturing.

“Conventional petrochemical industries are not only faced with the risks of resource exhaustion, but also the problem of carbon dioxide emissions during production, which results in serious environmental pollutions. Compared with chemical processes, bio-manufacturing has many advantages, including regeneration raw materials,

mild reaction conditions and environmental friendliness," said Liu Xiucai, Chairman and CEO of Cathay.

Not content to rest on its laurels, Cathay sought further improvements, taking bio-manufacturing to a new level. Cathay and Siemens are working together to build a world-class digital bio-manufacturing site in Wusu, Xinjiang of China.

A giant leap forward

Why could the petrochemical industry thrive for so long, since bio-manufacturing offers so many benefits? That's because the organisms used in bio-manufacturing are too complex and mutable. It's like a double-edged sword – the process can produce special chemical materials with excellent characteristics that could not be synthesized through chemical methods, but at the same time may generate different kinds of metabolites. This could significantly lower the yield of the target products.

Siemens software and hardware help Cathay improve bio-manufacturing efficiency.

Bio-processes are extremely mysterious. It is difficult for people to fully master all of the complex and subtle details of the conversion from maize to polyamide. But with sufficient data accumulated from experiments, screening, and trial, people can identify the relationship between different strains, reaction conditions and the final yield of the target products, thereby significantly increasing biological reaction efficiency.

"With big data, we can find out relevance and the laws of guiding production. This is why we built the digital manufacturing site in Wusu, Xinjiang," said Liu. "We are highly experienced in bio-manufacturing. But only through the partnership with leading companies such as Siemens could we achieve digitization. The efficiency of bio-manufacturing is improved by integrating the whole production chain with hardware and software control, collecting, processing, and analyzing data automatically, and then feeding the analysis results back to production. What I want is reinvented productivity."

Building a digital bio-manufacturing site was also a big challenge for Siemens. "Bio-manufacturing process is characterized by complex reactions, high continuity and rigorously imposed requirements for process standardization and confidentiality. Physical and chemical changes also happen during the process. Any faults in the system could have impact on end products," said Xu Yibin, Industrial Director of Process Industry, Siemens Process Industries and Drives Division.

Siemens eventually became the partner to provide Cathay Wusu manufacturing site with complete digital solutions covering the whole lifecycle of the process. After coming into operation, Wusu site is expected to turn out 100,000 tons of bio-based polyamide, 50,000 tons of bio-based 1.5-pentanediamine and 30,000 tons of long-chain dicarboxylic acid every year.

Boosting R&D

For Howard Chou, Head of R&D of Cathay, his job, like a "plastic surgeon for microorganisms", is to change the microorganisms found in the nature into

reactors meeting production requirements.

Having created “microorganism reactors”, could Chou’s team rest easy? Not at all. Even twins with identical genes can look quite different if they grow up in separate environments. To bring the microorganisms’ full potential into play, from lab to factory, R&D staff needed to screen out strains and fermentation conditions through three steps: first, carrying out small experiments in petri dishes, then putting suitable strains into shake flasks for further reproduction and up-scale, and finally carrying out experiments in small fermentation-tanks.

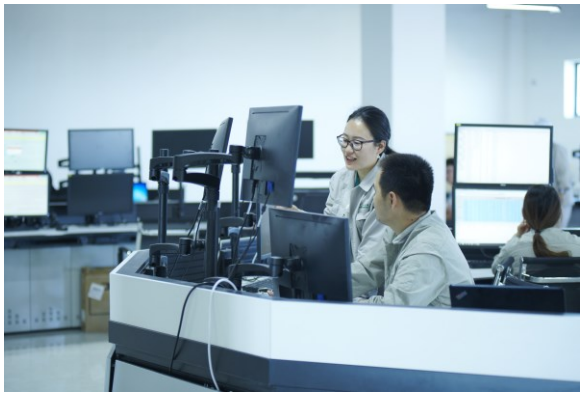
In most cases, promising results of lab-scale tests may turn out to be disqualified in real production. Researchers test more than 500,000 samples a year, but maybe only one of them will meet the requirements of industrial production. To identify the key factors affecting the changes, they must repeat the screening processes over and over.

As a result, Cathay chose Siemens’ SIPAT system. Application of SIPAT could help the researchers to directly identify the relations between some important parameters and the final yield through digital analytics, reducing the number of processes required. “For our R&D efficiency, this is going to be a remarkable boost,” said Chou.

Ensuring uninterrupted reaction

If every microorganism is a micro-reactor, a factory is a large generator pooling numerous micro-reactors for mass production. Unlike discrete industries such as automobile and electronics, bio-manufacturing may not be interrupted once started, requiring the factory’s underlying automation system to be seamlessly integrated. Siemens’ DCS control system Simatic PCS 7 ensures continuous production of the process industry.

PCS 7 has such characteristics as decentralized control, centralized management, simple installation, low running cost and intelligent maintenance and management. From the perspective of control, the equipment in the system is like a group of soldiers without a leader. Now every group is led by a leader, which in turn takes orders from a chief commander. Engineers only need to send an order to the chief commander, then everyone will act in perfect unison.



Central control room at Cathay Wusu site.

In addition, PCS 7 could be highly integrated with Siemens’ plant asset digital management system COMOS. COMOS builds unified digital models for plant assets including processes, electrical systems, instruments, automatic control, pipelines to form the factory’s “digital twin” throughout its whole lifecycle. This means that the information relating to all underlying equipment in the engineering phase can be stored in a unified repository, which could be properly preserved and easily accessed in the future.

“Siemens’ COMOS could help us package plant design outcomes into a database. We expect to use the information for the design of the next factory,” said Zang Huiqing, Cathay’s Vice President in charge of legal and intellectual property management.

Stable and efficient production
In addition, Siemens' manufacturing execution system Simatic IT will help ensure stable and efficient productions at Cathay Wusu manufacturing site.

The system, like a pedantic schoolmaster, will send electronic work orders to operators every day, evaluate work quality and record it accurately. Production could not proceed to the next step if any ingredient is not in place, or if any seed fermentation has not been completed. In addition, many steps in productions will be replaced by automation programs, thus reducing the operation cost and error rate.


Simatic IT helps reduce operation cost and error rate.

Real-time feedback of the digital system also makes a direct contribution to improving efficiency. Li Naiqiang, Cathay's Vice President in charge of Technology, described the changes: "We perform many sampling and testing steps during the production process. The test results need to be fed back into the production to adjust the process parameters. It sounds simple. But for example, the workshop is probably several kilometers away from the test site, and so several hours are wasted going back and forth, which had impacts on production efficiency. With the digital system, the test results can be uploaded to Simatic IT Unilab, which are then fed back to the system to realize real-time control. This could help improve the production efficiency."

Given its particularity, bio-manufacturing industry is strict when it comes to the confidentiality of the raw materials, formula and process conditions. This important knowledge was kept by some experienced operators in the past. Now digital technologies help Cathay to store its process parameters in Simatic IT. The system could direct production by automatically matching formula with the raw materials.

Integrated operation and maintenance
Mostly managing and maintaining the equipment is not an easy job, requiring the input of information from thousands of machines.

The combination of Siemens' COMOS and PCS 7 will help Wusu manufacturing site to manage the integration of engineering, operation and maintenance. COMOS can not only automatically develop maintenance plans based on the equipment status, but also allow information about any piece of equipment in the factory to be easily retrieved.


COMOS and PCS 7 will help Wusu manufacturing site to manage the integration of engineering, operation and maintenance.

In case of a fault, PCS 7 sends an alarm immediately, which triggers COMOS to generate and send a repair order to the responsible people. Then the operator services the equipment following pre-set

procedures. When the fault is fixed, an electronic record is generated automatically, making it traceable and searchable, providing reference for future maintenance work and improving efficiency.

In the past, such functions could only be achieved through manual discovery and scheduling. Automatic triggering, maintenance and recording require data interconnectivity between the two systems. Once data interconnectivity is realized, the value contained in the data is able to be fully utilized, significantly improving the efficiency of operation management and maintenance, and ensuring reliable and uninterrupted operation.

COMOS also provides data interfaces with Siemens' operations intelligence platform XHQ, which integrates information display, traceability analysis and trend prediction. Through the platform, the management team can learn the specific status of the plant assets and compare it with historical data. This in-depth knowledge of the plant's operation status could greatly facilitate future decision making.

Liu expressed his deep convictions: "I wanted to demonstrate three points through the success of Cathay: first, biotechnology could manufacture better materials; second, bio-manufacturing is capable of having lower production costs than the petrochemical industry; third, bio-manufacturing could realize mass productions."