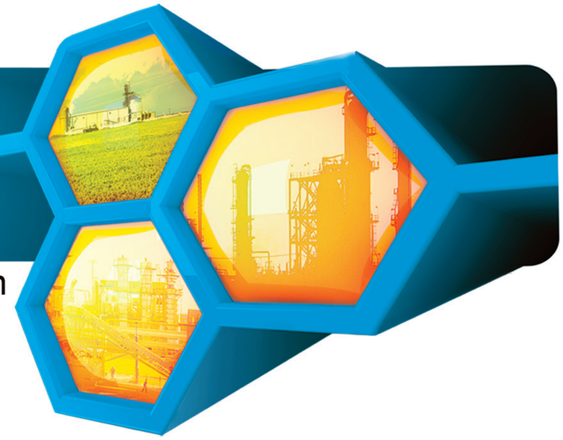

www.system302.com

"SMAR's SYSTEM302 has proved its superior reliability and availability in over 10 years of operation at various units of our plants. In addition, it's easy to install, commission and operate. But most importantly, it helps us reduce cost and improve efficiency in today's tough economic environment", said ***Wu Bopei, Instrumentation Director of Wuhan Youji.***

SYSTEM302 Improves Safety and Availability of Chemical Additives Plant

Wu Bopei, Wuhan Youji Industries Co., Ltd.
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The following article describes how SMAR's FOUNDATION fieldbus control system-SYSTEM302 was used to automate a chemical additives plant operated by Wuhan Youji Industries Co., Ltd. in the People's Republic of China. The process involves the production of sodium benzoate, a food and beverage preservative, from toluene or methylbenzene. In particular, the article discusses how a new, FOUNDATION fieldbus-based control system met the need for improved safety and fault tolerance at the plant, and provided a solution for increased availability and reduced losses of raw materials and finished products.

Background

Wuhan Organic Synthesis Factory was founded in 1956. It was reorganized and renamed in 1994 as Wuhan Youji Industries Co. Ltd. with assets totaling RMB350 million, 1,100 employees and an area of 93,000 square meters. As a main production and export base for organic chemicals in Wuhan, it produces food additives as well as intermediates for pharmaceuticals, Pesticides and organic synthesis totaling 100,000 metric tons. Wuhan Youji Industries Co., Ltd. remains the largest producer of Sodium Benzoate and Benzyl Chloride in China.

The processes involved in the production of sodium benzoate are highly flammable and explosive. First, toluene is oxidized with air in the presence of a catalyst to produce benzoic acid. The benzoic acid is then neutralized with sodium bicarbonate to produce sodium benzoate (Fig. 1). In these processes, strong interactions among such parameters as temperature, flow and pressure can occur. Improper control of one parameter can affect the other parameters in such a way that a resonance-like phenomenon is created. This phenomenon can result in a complete loss of control throughout the plant, with the accompanying disastrous consequences.

The plant's original automation technology included analog controllers and 4-20 mA transmitters. The rigidity of this system made expansion or changes very difficult, and led to long project cycles.

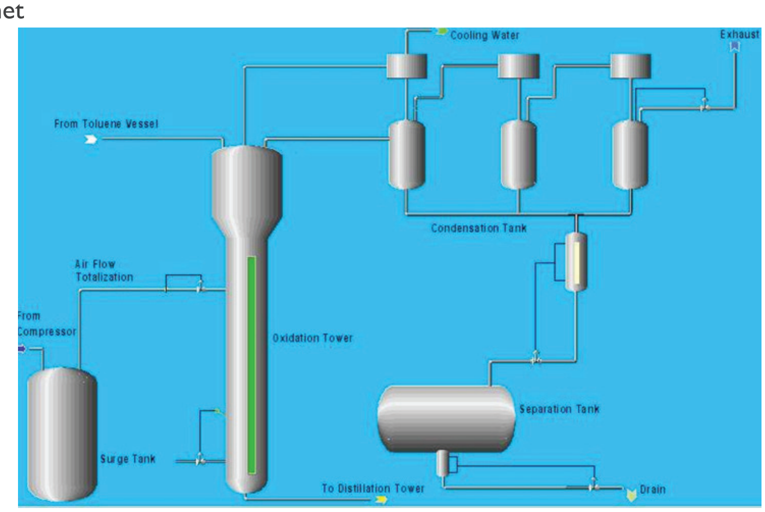

Fig. 1 - Oxidation Unit

In addition, the analog controllers and devices provided very little process information from the field. Because of these drawbacks, Wuhan decided to undertake a major control system modernization with the goal of improving the plant's safety and fault tolerance capabilities while still improving productivity.

SMAR control systems at Wuhan Youji

The First SMAR SYSTEM302 in the Plant

In 1997, Wuhan Youji's Sodium Benzoate Plant became one of the earliest in the world to adopt SMAR's state-of-the-art fieldbus control system-SYSTEM302. Without much knowledge and experience in fiedbus systems, but with unsurpassed support from SMAR's engineering team, Wuhan Youji's first SYSTEM302 was successfully started up in April 1998 in a record 6 months from the initial stage of plant engineering. The following is a list of the hardware and software involved in this system.

Hardware:
- SMAR LD302 Pressure Transmitters
- SMAR TT302 Temperature Transmitters
- SMAR FI302 Fieldbus to Current Converters
- SMAR FY302 Fieldbus Valve Positioners
- Workstations with SMAR PCI302 Fieldbus Interface Cards

Software:
- Stations with SMAR SYSCON Engineering and Maintenance Software
- Stations with SMAR OPC server
- Stations with OPC process visualisation software client

The Latest SMAR SYSTEM302 Control Systems in the Plant

In 2007, the latest SMAR control system-SYSTEM302 Version 7 in the plant was installed for an expansion project. SYSTEM302 Version 7 integrates all class-leading and open control and information technologies such as FOUNDATION Fieldbus H1 and HSE, OPC, DCOM, ActiveX, TCP/IP and UDP/IP, making its integration with other hardware and software simple and seamless.

Wuhan Youji's systems implemented true redundancy by using redundant controllers with HSE/H1 bridges capability as well as redundant system topologies, achieving better system reliability and plant availability (fig.2).

Since 1997, Wuhan Youji has installed and commissioned nine SYSTEM302 control systems with a total of over four hundreds field devices and one hundred I/O modules.

Phase	Interface Type	System Version	Year
1	PCI-ISP	Ver.1.1	1997
2	PCI302	Ver.2.0	1998
3	DFI302	SYSTEM302V3	2001
4	DFI302	SYSTEM302V3	2002
5	DFI302	SYSTEM302V4	2003
6	DFI302	SYSTEM302V5	2005
7	DFI302	SYSTEM302V6	2005
8	DFI302	SYSTEM302V6	2006
9	DFI302	SYSTEM302V7	2007

SYSTEM302 Improves Safety and Availability of the Plant

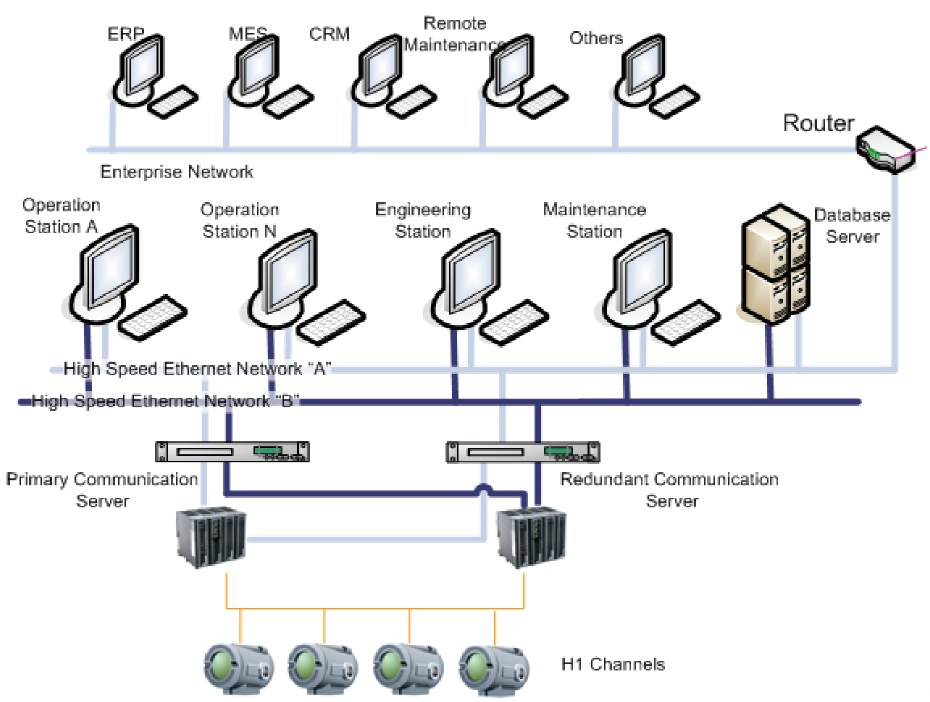

Fig.2 Redundant System Architecture in the system expansion

Control Requirements

Wuhan Youji identified a number of key criteria for evaluating alternative control technologies for its chemical additives plant. In particular, plant management was seeking a control system that ensured the safety of its employees, the environment and plant equipment. At the same time, however, the new technology had to maximize plant availability so as to improve productivity, increase the availability of finished goods, and reduce raw material usage. This was a challenging requirement, inasmuch as the plant's operating procedures previously mandated that control loops automatically shut down in the event of a critical process deviation or system failure. The new objectives included the ability to safely remain in operation, even in the presence of a fault.

Wuhan determined that the conflicting requirements for shut down and uninterrupted operation could not be met by a conventional process control system, and thus decided to look to available new technologies for an optimum solution.

Solution

After considering several approaches to automating and re-instrumenting the sodium benzoate process, Wuhan decided to implement a new control system employing FOUNDATION fieldbus technology.

Engineering and design work for the new controls began in April 1999, and installation was completed in June. Plant engineers commissioned the system in July 1999.

The fieldbus-based control system chosen (SYSTEM302) consists of a host with redundant operator workstations, as well as intrinsically-safe fieldbus pressure transmitters, temperature transmitters and converters for 4-20 mA. A programmable controller handles discrete control, and is connected to the fieldbus network by an interface module. To ensure availability, the system employs redundancy at several levels, including the fieldbus interfaces, workstations and power supplies. Two communication paths between the fieldbus and the workstations ensure plant floor data reaches operators continuously.

Wuhan's engineers and operators received in-depth training in fieldbus technology prior to each phase of the system implementation. This process went smoothly, and plant personnel encountered only minor challenges during installation of the new host computer and field instrumentation. For example, bad connections resulted in low voltage for some devices, but this problem was easily identified because the devices showed up as "dead" or "ghosts" in the device live list.

Wuhan's system designers employed FOUNDATION fieldbus' multidropping capability in the configuration of the fieldbus network. This included the use of repeating barriers, with four barriers having one intrinsically-safe segment each, and one common interconnecting segment on the safety side. The network configuration provides the economy of 12-16 devices per fieldbus interface port, and results in a substantial reduction in the amount of wiring, I/O modules and controller hardware throughout the plant .

The distributed nature of the fieldbus architecture ensures fault tolerance by distributing control loops across multiple network segments. By situating only one critical loop per barrier, the extent of any failure is limited. This differs from a conventional control system architecture, where the failure of a centralized controller may cause the failure of many loops. Achieving equivalent reliability with a conventional system requires all I/O modules be redundant, which is a cost-prohibitive approach in many applications.

A key feature of the fieldbus system is the ease with which operators can monitor the status and performance of instruments and control loops. The system not only transports more diagnostic data than ever before available from field instruments to the operator workstations, but also can takes action based on this information. These extensive diagnostics are a unique capability of FOUNDATION technology. And because of fieldbus' standardized communications protocol, self-diagnostic results from field devices are passed to the operator in real-time, thus permitting a real-time response.

Wuhan viewed fieldbus' system diagnostic capability as essential to ensuring both safety and fault tolerance at the plant. Fieldbus diagnostics are performed at a speed and granularity not possible with a conventional system, even those using so-called "SMARt" instruments (e.g., 4-20 mA hybrids with proprietary, digital communication). They cover not only a single state for the entire device, but also its physical parts and individual function blocks and their parameters. Early, constant and valid diagnostic data can lead to a significant extension of asset life, further reducing plant operating cost.

From their workstations, operators determine if a problem is due to a sensor malfunction, memory failure, configuration error or communication failure. They can also follow closely process values, the quality of each value, and any limits imposed on it. Using the system's engineering and maintenance tool, checks can be done on special diagnostic parameters in device transducer blocks to determine the exact nature of a problem, thus reducing mean-time to repair (Fig. 3).

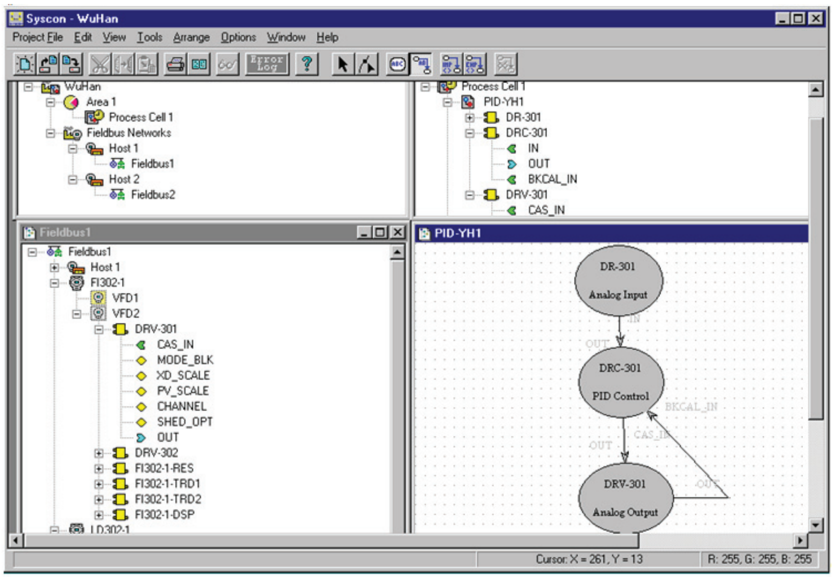

Fig. 3 Engineering and Maintenance Tool

The system verifies constantly the status of every field instrument, enabling faults at every level — all the way down to sensors and actuators in the most remote areas of the plant — to be quickly detected. This is an important capability, as undetected faults pose a significant risk if the process is not shut down quickly enough. It also minimizes spurious shutdowns due to "false" faults, and provides operators with a high level of confidence in validating field instrument values.

In the event a transmitter detects a fault, its status is set accordingly and propagated to the controller (typically resident in the valve positioner). Based on this status, the control loop sheds to manual, and a pre-configured fault state is initiated on the valve output — all without additional configuration by the user. Should there be a communication failure on the bus, the affected loops automatically take the same action to ensure a safe and orderly shutdown.

The FOUNDATION fieldbus function block language has proven to be a valuable asset to Wuhan. It provides a single tool for configuring, maintaining and calibrating all field instruments, as well as building control strategies without the need for a second tool for proprietary languages. Plant engineers have used the function block language to distribute control to field instruments. Because the configuration tool provides all common loop types as templates, system designers are not required to configure the individual blocks by themselves. The ease of configuration and loop calibration further reduced implementation and start-up time.

In addition, the FOUNDATION fieldbus function block language is the only programming language to make full use of device diagnostic information. Standard function blocks have a built-in mechanism providing automatic shutdown in the event of control loop failure. As such, system designers only need to use function blocks when configuring loops, because the necessary safety interlocks are already in place.

In the event of a communication failure on the bus, the affected loops automatically take the same safety action, ensuring a safe and orderly shutdown. However, because each fieldbus segment has two redundant interfaces acting as a primary and secondary Link Active Scheduler (LAS), as well as additional backup LAS capability in the field, a communication breakdown is of negligible likelihood.

Results

Since the start-up of the FOUNDATION fieldbus control system in April 1998, Wuhan has achieved significant improvements in the safety, availability and productivity of its sodium benzoate production operation. According to company management, the number of unplanned shutdowns has been reduced by two-thirds, while plant availability has increased by a factor of three. The flexibility of the fieldbus architecture, coupled with ease of configuration and more rapid start-ups, shortened project cycle times by more than 50 percent.

Additionally, Wuhan realized significant installation cost savings through FOUNDATION fieldbus' multidropping and field-level control capabilities. This includes an 85 percent reduction in the number of terminal blocks, and an 80 percent savings in wiring.

Conclusion

By implementing a new, FOUNDATION fieldbus-based control system, Wuhan Youji Industries simultaneously improved the safety, availability and productivity of its chemical additives plant. The company is utilizing fieldbus' distributed architecture to minimize the effects of loop failures, and its multidropping capability to decrease the amount of wiring and I/O plantwide.

Furthermore, plant engineers are employing the fieldbus function block language to distribute numerous regulatory control functions to the field level. This, in turn, frees the plant's supervisory control system to handle a variety of real-time production control tasks.

With its robust system diagnostics, the new control system provides enhanced tools for maintaining such tangible assets as field instrumentation, controllers and rotating equipment. Operators now have an expanded view of the process, and are able to identify such problems as device malfunctions, configuration errors or communication failures from their control room workstations.

Fieldbus also improves management of the plant's regulatory control loops, which is a key benefit considering Wuhan views these loops as "intellectual property" which is equally as important as the plant's physical assets.

Finally, the simplicity of the fieldbus architecture shortened the cycle time for implementing new technology, and enabled these benefits to be achieved without the need for costly, outside consultants.

About the Authors

Mr. Wu serves as Instrumentation Director of Wuhan Youji Industries Co., Ltd. He holds an engineering degree in instrumentation and automation from Wuhan Chemical Engineering College, and has over thirty years of experience in the control and instrumentation field.

Mr. Tan is the application engineer of SMAR China. He holds a bachelors degree from University of Science and Technology of Beijing, and has over six years of experience in field instrumentation and control system engineering.