SMART-FIRE CONTROL & MANAGEMNET SYSTEM FOR HOT DIPGALVANIZING PRODUCTION LINE

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ABSTRACT

As the continuing effort has been made to the control system more efficient and flexible, personal computer and internet networks technology are migrated to Industrial automation and control systems to achieve business objectives. This kind of intelligent control system enables a more flexible, responsive system that encompasses both real-time data from the production floor. The networking architecture of this kind of control system provides connectivity, collaboration, and integration from the device level to enterprise business systems.

This paper provides a general overview of SMART CONTROL & MANAGEMENT SYTEM for hot dip galvanizing furnace in China market and its benefits in the data networking environment. It discusses the requirements and benefits of using a highly integrated Computerized Programmable Automation Controller System in industrial networking environments for galvanizing industry. Benefits include:

● Real-time network performance to provide remote online supervision and diagnosis service
● Security
● Reliability
● Proactive manageability and ease-of-use features
● Open ability to add innovative technologies such as voice, video and collaboration from vendor side

INTRODUCTION

Today, in China, galvanizers are increasingly seeking to improve processes, increase productivity, expand operations in different places to address new opportunity and reduce operating costs. They are also seeking to continuously improve efficiency, reduce zinc consumption, extend the kettle life, lower energy usage, and drive down idle time for existing galvanizing furnaces and processes. Achieving the goals of production expansion and operation excellence requires improving connectivity

between plant and business systems for real-time visibility to information and effective collaboration at different process phases or from vendor sides. This helps galvanizers to be able to balance production with demand to optimize galvanizing furnace operation, while continuing to meet increasingly exacting customer requirements and metrics for on-time delivery. Both galvanizers and galvanizing furnace supplier also need to improve response to events that occur on the plant floor, regardless of location, while implementing more flexible and agile operations in order to react to changing production conditions.

As galvanizers seek to improve processes, increase productivity, reduce operating costs, and integrate galvanizing production and business networks, a smart control and management system is required to provide support besides the process controller function as the traditional PLC control system does on the plant floor. This kind of retrofit is rapidly gaining momentum at this time.

This paper will present a general overview of the most traditional PLC control system for hot-dip galvanizing furnace in use today. It will also discuss how a computerized programmable automation controller upgrades traditional PLC system to a low-cost, high-performance, scalable architecture. Finally, this paper will review some of the intelligent features that make the smart control and management system an attractive choice for galvanizers in China.

1. **TRADITIONAL PLC CONTROL SYSTEM FOR GALVANZING FURNACE**

The popular hot-dip galvanizing furnace is the high-velocity type, which consists of a kettle containing molten zinc heated by high-velocity flame surrounding the kettle as shown **in Figure 1.**

Most of the high-velocity galvanizing furnace, currently, is still controlled by a traditional PLC system. The temperature in the zinc bath of a high velocity furnace is traditionally controlled by a feedback controller employs PID technology as shown **in Figure 2.**

The controller generates a time-based square wave to switch the burners automatically between high fire and low fire as per the deviation between the real-time temperature signal received from the process and zinc bath temperature setpoint as shown **in Figure 3**.

Typically, the PLC system equips a HMI (Human Machine Interface) panelview for operators to review the furnace status and modify process parameters. Most

galvanizers, in China, stay with this device level network currently as shown as **Figure 4.**

In this control architecture, the device-level network links the controllers with the furnace and other plant floor's I/O devices, including sensors such as transducers, photoeyes, and flowmeters, and other automation equipment, such as variable frequency drives, and actuators. It is a separate network from the corporate IT network. All the operation and management have to implement on the plant floor. The production information is limited to the job site. As the control program is preloaded in the controller by the furnace supplier, any innovative control improvement the galvanizer makes to the galvanizing furnace operation requires vendor service dispatch

2. HYBRID PC/PLC CONTROL SYSTEM

For better understanding of the galvanizing furnace control and management excellence, PC-based controller, like a personal computer, is introduced to the control system. It requires a control level network to connect control and monitoring devices, including programmable automation controller, I/O racks, drives and HMI, to the PC-based controller **(Figure 5).**

This network, which typically has not been based upon standard Ethernet and IP in the past, requires a special hardware, like a specific PC card, a router or, in most cases, a network gateway to translate application-specific protocols to the PC. This translation lets information pass between the control network on the factory floor and management office, but has limited functionality and bandwidth. This has been much improved along with the booming of industry Ethernet technology. Today, most PLC controllers provide Ethernet port selection, which delivers substantially higher performance. And because the industry Ethernet is based on industry standards, it can run and be connected over any Ethernet-compliant device from different vendors.

Besides network communication connection, much additional engineering work, like setting up OPC (OLE for Process Control) server, building HMI and developing special program, have to be implemented on the PC for data acquisition and control application. This limit the information and visualization only available to the PCs with specific software environment installed and has lead to the need to have multiple sets of spares, skills, and support programs within the same plant, which requires professional human resource support and significant effort to keep up to date.

3. COMPUTERIZED PROGRAMMABLE AUTOMATION CONTROL SYSTEM

Different from standard PC or traditional PLC, the computerized programmable automation controller adopts low power consumption CPU, which is fan-less, noise and vibration free. It has been designed to meet the standards of industrial PC (JB/T 8384-1996) and PLC (GB/T 15969.2-1995), EMC and States safety criteria and CE certificates, etc., for harsh industrial environment operation. It equips with high speed real-time control function, open software and hardware architecture, plentiful combination of HMI.

Incorporating Windows CE operating system, the computerized programmable automation controller system is a highly integrated development platform with control that consists of computers, PLC, on-site networks, and HMI technology all in on structure. It not only retains traditional PLC systems reliability, simple programming development and easy maintenance, but also has the openness, flexibility, scalability, high-speed computing and large storage capacity, which makes the industry control architecture much simpler, lighter, modular, more transparent and intelligent **(Figure 6).**

This kind of Computerized Programmable Automation Controller system has been successfully applied to many industrial areas worldwide, such as automation machine, package printing, industrial robots, metal processing and other industries. In comparison with the traditional control system, Computerized Programmable Automation Controller shows the advantages as below:

• Powerful Functionality: PLC, on-site field bus networks and HMI all in one structure, flexible to configure the hardware and software development platform.

• Reliability: Multi-task & real-time control; high stability and reliability hardware.

• Safety: Fast DAQ & Encryption, including online data acquisition, tracking the data curve and variables changes anytime and anywhere; and encryption for source code, licensing and Hardware Binding.

• Efficiency: Built-in web OPC server, including data acquisition and visualization via internet without requiring specific HMI software, which offers flexible and fast remote online supervision and diagnosis, comparing to a hybrid PC/PLC decentralized control system.

• Low cost: Features a highly integrated control system, with lower cost, better performance and less maintenance, comparing to a hybrid PC/PLC decentralized

control system.

4. SAMRT FIRE TECHNOLOGY TAILORED FOR INTELLIGIGENT FOR GALVANIZING FURANCE

Based on the openness, flexibility, scalability, high-speed computing and large storage capacity feature of the computerized programmable automation controller, WEDONE Thermprocess , the leading designer and manufacturer of high quality hot-dip galvanizing furnace in China market, develops and integrates an intelligent Smart Fire system for their products.

The Smart fire system configuration **(See Figure7):**

- Special tailored HDG computerized programmable automation controller
- HMI, 12” true color touch screen
- Siemens S7-300 local I/Os
- FM approved flame safeguards
- Pressure and temperature transmitters for process sampling

The first Smart Fire system for high velocity galvanizing furnace is successfully applied in Yongfeng Galvanizing Group, Shanghai, China, in March, 2013. The control system architecture is as shown **in Figure 8.**

The primary difference between the Smart Fire system and the traditional PLC system is the type of combustion technology function and internet connectivity fashion.

5. COMBUSTION TECHNOLOGY

The zinc bath temperature is critical for hot-dip galvanizing process. Different steel work piece might require different galvanizing temperature. Maintaining requested zinc bath temperature steadily is helpful drive down the furnace idle time and save the energy consumption, while the burner combustion is the key factor to determine if the heat is transferred to the zinc bath efficiently in a high-velocity galvanizing furnace. Un-efficient combustion might lead cold flame and lower flame velocity, which leads to a way to slow down the heat transfer and increase the fuel usage. In the Smart Fire system, the system maintains the factory-preset air/fuel ratio for the desired heat output set by the process controller. Meanwhile, the changes that might affect combustion performance, such as air and fuel temperature and pressure and chamber pressure, is considered by the system as well, to trim the air/fuel ratio and proper burner turn-down, which guarantee a perfect combustion and uniform heat flux throughout the galvanizing process.

6. QUALITY SERVCIE

A critical factor when resolving a problem on the plant floor is having the right information in real time. The transparent network architecture of the Smart Fire system offers secured remote supervision and diagnosis via flexible and fast web access in both enterprise intranet and internet. The data and HMI visualization does not require specific professional HMI software tools. This helps the galvanizer to improve the response to events occur at the galvanizing furnace. Also, as the Smart Fire system supplier, WEDONE Thermprocess could provide immediate authorized remote technical support, such as online diagnosis, tuning parameter, and even program update per the galvanizer's request. The quality remote service helps to improve the enterprise efficiency, reduce furnace down time and cut down the operation cost.

7. CONCLUSION

The Smart-fire system, based on computerized programmable automation controller, for galvanizing furnace has been growing steadily in the market as China galvanizers recognize the many benefits that can deliver. From 2013 to 2014, over 30 galvanizing furnaces have been set up or retrofitted to Smart-fire system in China. The reasons behind the success of Smart-fire system are clear. The computerized programmable automation controller architecture makes the Smart-fire system a plug-in play, turn key system for easy installation and set-up. It not only gives the galvanizing furnace a much faster way to communicate, but also gives the better connectivity and transparency, enabling galvanizers and furnace supplier to connect to the furnace system they want without requiring special software tools. Because of the Smart-fire system's intelligent features, galvanizers can enjoy substantially remote control over their SMART galvanizing furnace with vendor's immediate technical back-up.

Along with the developing of wireless mobile internet and data cloud server, a well-implemented SMART system can do much more than traditional PLC system. In near future, the internet connectivity fashion of the SMART system will make much more possibility come into true, galvanizers might be able to log in cloud server to have control or get production data whatever they want, such as voice, video, process status, event logs and production report, with their PDA or cell phone.

Reference

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4. Ogawa, M.: Henmi, Y., "Recent development on PC+PLC based Control Systems for Beer Brewery Process Automation Applications" SICE-ICASE, 2006.
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Figures

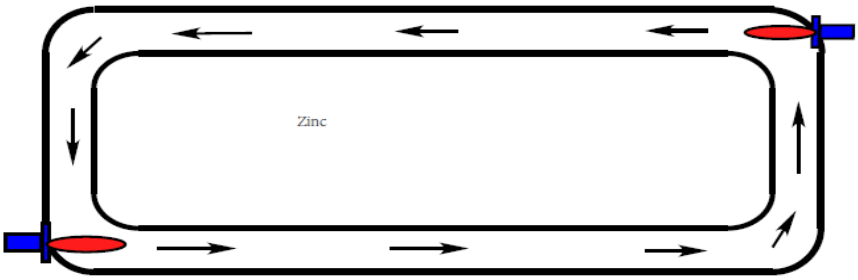

Figure 1 The pulse fire high-velocity type hot-dip galvanizing furnace layout

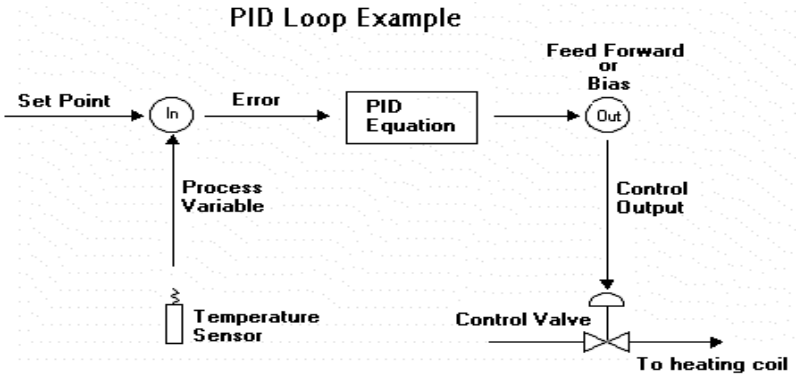

Figure 2 PID Loop Example

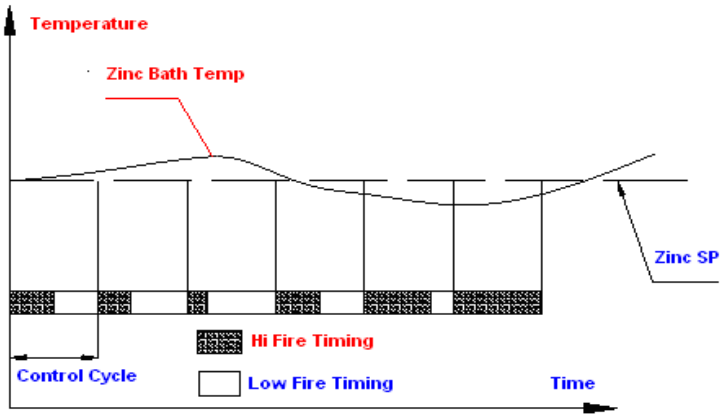

Figure 3 Typical High Fire, Low Fire and resultant furnace temperature

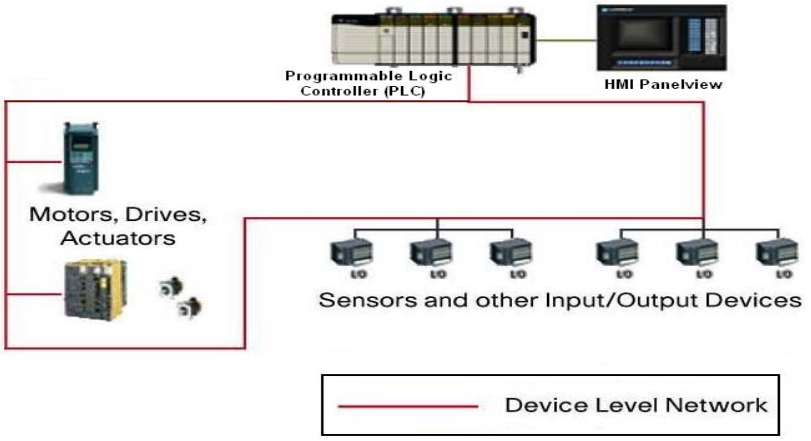

Figure 4, Typical PLC control architecture

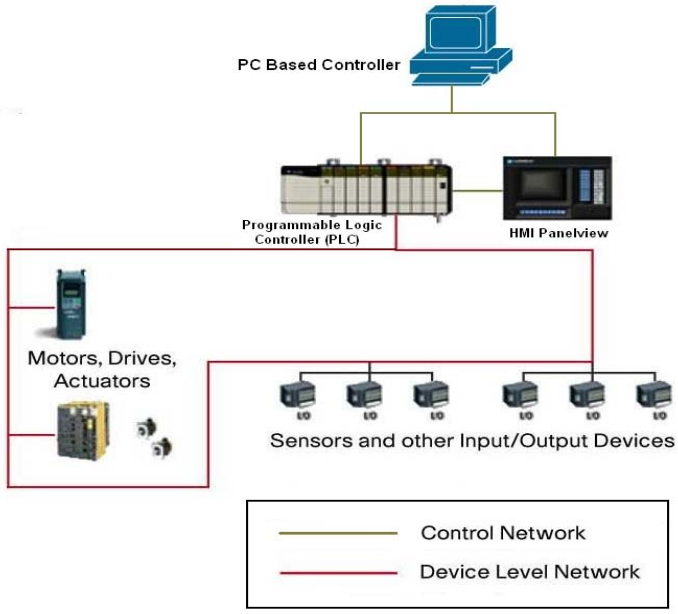

Figure 5 Hybrid PC/PLC control architecture

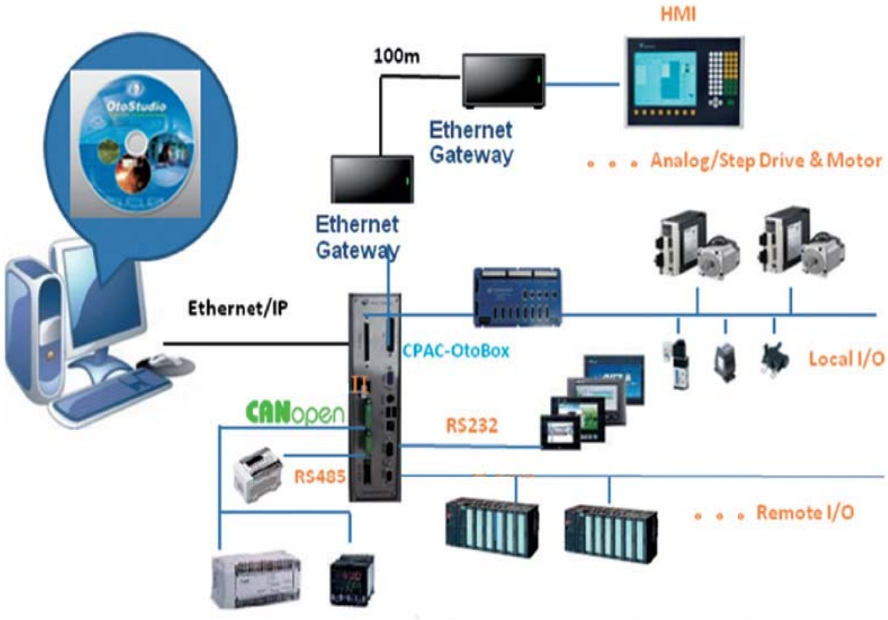

Figure 6 Computerized Programmable Automation Controller System

Figure 7 The Smart fire system configuration

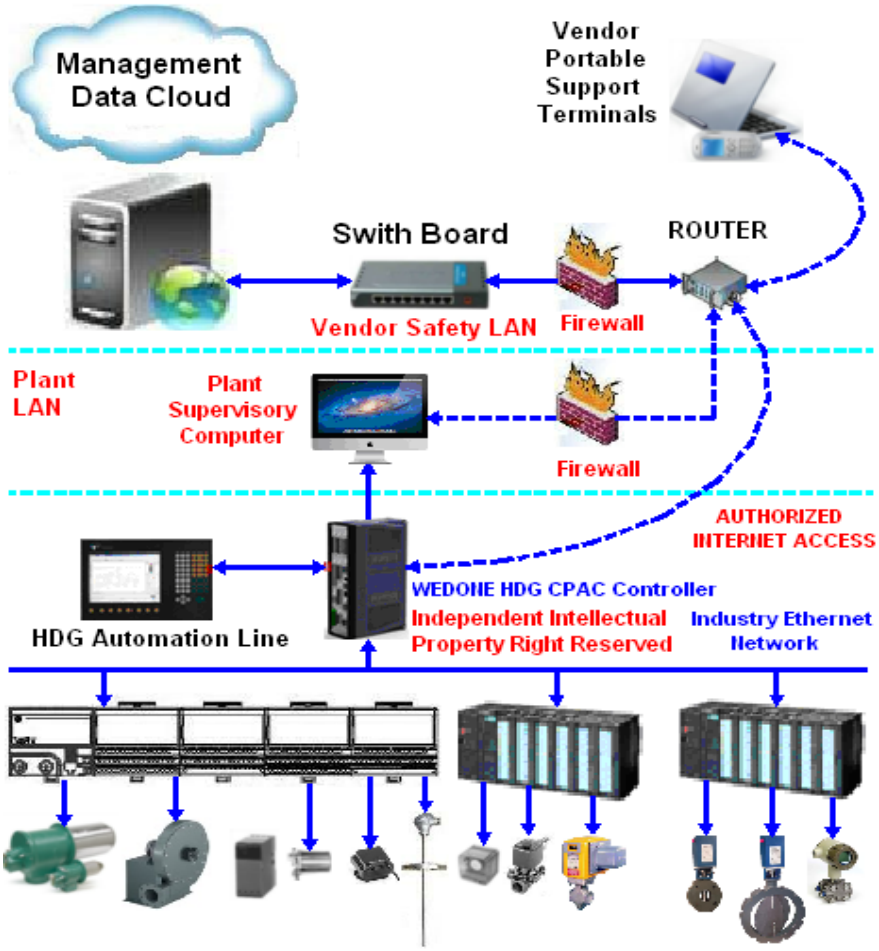

Figure 8 The smart-fire control system architecture