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Integration and Use of Present Day Flowmeters into Distributed Control Systems

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INTEGRATION AND USE OF PRESENT DAY FLOWMETERS INTO DISTRIBUTED CONTROL SYSTEMS

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ABSTRACT

Within a control room, operators are presented with data regarding flow and other process conditions, as well as control system status. The technology of these field devices is undergoing a significant change. The transistor is giving way to the microprocessor so that two classes of electronic field devices now exist. Conventional flow and other process parameter devices use transistors, while intelligent field devices use microprocessors. The intelligent, i.e. "smart" field device provides improved accuracy and functionality over its conventional counterpart. Consequently using a modern distributed control system which can interact with these intelligent field devices enhances overall plant operations.

INTRODUCTION

In general, field measurement technology and in particular that used in flowmeters has lagged the development of digital distributed control systems. The flexibility, computational power and accuracy of distributed control systems has been limited by the installed line of analog field measurement devices. However, the application of the microprocessor to process transmitters has resulted in a new class of "smart" field measuring devices.

The advancements of digital electronics has increased the performance, reduced power consumption and lowered cost of key components such as microprocessors, memory and semi-custom integrated circuits. The application of this technology to process flowmeters has expanded their role in process control. With this new smart capability, flowmeters can accomplish remote communications, complex calculation, logical operations, self diagnostics and improved performance. A properly chosen smart flowmeter allows a totally free interface in the digital domain to both the meter and the control system.

This new smart capability will dictate that the field devices and control systems become natural expansions of each other. The information provided from these field instruments will be used in powerful control algorithms resident in the control system. More efficient and effective movement of information between the field devices, control systems and process operators is required. However, the migration of intelligence from the central control system to the field devices will allow for control logic partitioning and more responsive, reliable and field safe system operation.

FLOWMETERS

In all fields of flow measurement, ranging from process plant measurement to custody transfer of liquid and gaseous hydrocarbons, there continues to be a desire and economic need to measure critical parameters more accurately. The dominant flow meter used throughout the world for almost all process and custody transfer metering applications is the orifice flowmeter. Conventional differential pressure devices provide reliable measurements but their accuracy may be larger than it has traditionally thought to have been. Other flowmetering devices are available which may provide for more accurate and repeatable measurements. These include magnetic, turbine, vortex, ultrasonic, coriolis and thermal meters. The choice of which one to use depends upon the application and sophistication of the total metering system.

In determining the appropriate metering device to use, the meter's value to the overall process system should be the primary criterion. This value may be different for each application. Accuracy is usually a major portion of the value when measuring flow to a reactor or custody transfer applications. Reliability and maintainability are important considerations in many different applications. In addition, the rangeability of the flowmetering device can become extremely important if flow rates vary widely, such as steam and natural gas flow between summer and winter. Therefore, it is essential to determine exactly what the critical criterion required in the particular flow device and choose the best possible meter for the intended applications.

The technology of flowmetering is undergoing a major evolution. The transistor is giving way to the microprocessor. Two classes of electronic flow measurement devices exist. One is the conventional utilizing transistors and the second is the intelligent "smart" utilizing microprocessors. Three measurement devices which have made this transition are the differential pressure, vortex and mass flowmeters. Digital electronic technology advancements have increased performance, reduced power consumption and lowered cost of key components in these smart flowmeters. With their new found intelligence, these flowmeters can accomplish remote communications, complex calculations, logical operations, self diagnostics and improved performance. A properly designed microprocessor based flowmeter (Figure 1) allows an interface in the digital domain to both the sensor and the control system.

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The impact of this increased performance in the flowmetering measurement due to digital design directly impacts process profitability. The key areas where these benefits arise are: improved measurement accuracy, which provides for more economical control; remote communications for up-to-date reporting of process information and providing for changing flowmeter parameters on the run; the ability to perform complex calculations at the measurement site; self diagnostics for improved reliability and maintenance; and the ability to perform new functions such as reporting instantaneous flow, average flow and totalized flow at the same time. The differential pressure, vortex and mass flowmetering devices are the first to make this evolution but it will not be long before all the flow measurement devices will follow. The advantages of intelligent flowmeter have just begun to be realized by the process control industry. However, the processing power resident in the smart measurement device will dictate that the flowmeter and the control systems become natural extensions of each other.

The two most recent flow measurement devices to be part of this evolution are the vortex shedding meter and the coriolis based mass flowmeter. The smart vortex shedding flowmeter is designed for measuring volumetric flow of fluids. The flowmeter uses advanced fiber optic technology to measure flow ratio down to 3.75% of maximum rated flow. This is a 27 to 1 turndown rate. The smart electronics provide digital communications capabilities using the 4 to 20 mA signal base. The digital electronics package employs the latest microprocessor technology, allowing the user to troubleshoot and calibrate the meter from remote locations. The two wire, 4 to 20 mA output and frequency (pulse) output are compatible with all types of totalizing and control loops. The output can be directly proportional to the volumetric flow rate or can follow a user defined relationship. Key features include wide temperature applications, integral flow computer, remote communications, simultaneous analog current output and communications, pulse output, and secure operation.

The second field device, the coriolis based mass flowmeter, addresses the fastest growing segment of the flowmeter market. The direct mass flowmeter measures mass flow rates (depending upon meter size) from 10 lb./min. (4.54 kg/min.) to 5000 lb./min. (2271 kg/min.) and densities up to 32 g/cc (200 lb./ft.^{3}) of liquids and slurries. The digital electronics package of the meter allows the user to troubleshoot and configure the unit from a remote location. The meter continuously runs through a series of self diagnostics with components and results such as the transducer temperature, input circuits, and memory are monitored and irregularities indicated for maintenance personnel. The meter is suited for measurements of liquids, slurries, emulsions and suspensions in areas of custody transfer, blending, energy management and petrochemical applications. Key features of this device include non-intrusive design, direct mass flow and density measurements, microprocessor electronics, in line installation, no maintenance transducer assembly, remote communications, single line continuous dialog and simple, rugged design.

These two flowmetering devices are becoming the standards for their respective flow measurement capabilities. With the incorporation of smart functionality into their design, they will become the leader in providing the most cost effective process control scheme for their users. Both devices, and in particular the mass flowmeters, are being used in new applications where high accuracy, reliability and functionality are required.

INTEGRATION

Currently, the information provided by flowmeters can be used in powerful control algorithms resident in distributed control systems. However, the migration of intelligence to the new flowmeter will allow for reconsideration of control logic positioning and more responsive, reliable and fail safe control structures. The integration of the digital communications feature will allow the efficient movement of information between the field metering devices, distributed control systems and process operators (Figure 2). Total system performance can be optimized by storing trend data in flowmeters, exception reporting process information and allowing configuration, diagnostic, and tuning information available to process operators. Complete flowmeter diagnostics and configuration ability at the system console allows rapid problem identification and control strategy modifications without even sending a technician to the field.

Control system manufacturers currently providing centralized flowmeter communications all have proprietary hardware to interpret the communications signal. If the communication protocol does not allow for simultaneous transmission of process variables (PVs) and communications, a regenerated process variable signal may be required at that communication link. The approach would make the control system dependent on this signal generator.

Several vendors provide for simultaneous PV signal (4 to 20 mA) and communications. With this input hardware approach, the user is provided with several levels of PV security. Two styles of communication modules are typically used to facilitate flowmeter communications while bringing the PV signal in for control and data collection. For high volume performance monitoring or those applications where security is not of prime importance, an inexpensive analog slave module will allow 15 smart flowmeters to communicate with the operator console. Where control security is prime, a control input /output slave handling four PV inputs and two control outputs may be emphasized. Since a real-time PV signal is always present, some additional level of redundancy is always available.

This communication link between the flowmeter and the distributed control systems has been established on the same wires previously used to transmit the 4 to 20 mA process variable. This point to point architecture, while allowing the benefits of digital interchange, can be and is being improved. A field bus structure allowing multiple field metering devices to exist on one redundant communications highway further improves the digital coupling to the control system (Figure 3). Peer to peer information exchange, standard communications protocol, and reduced installations costs are the prime field bus benefits. Currently, an industry wide solution to the field bus architecture is being pursued by ISA and IEC committees. While a standard is not likely in the near future, several proprietary field bus systems have been introduced to address this need.

Once the communication signal is available to the system, the need to handle information along the particular system's data highway is obvious. The method of handling the data within the system is different with every system supplier but the benefits to the process system are very nearly the same.

The overall control efficiency is drastically improved by the use of smart flowmeter devices which are effectively integrated into the distributed control system. For example, a mixing process may call for operation under high and low flow conditions. Present solutions require two flowmeters, one for high flow and another for low flow or to have a technician rerange the devices when switching flow rates. The coupling of the flow to the distributed control systems allows a control scheme to exist which automatically reranges the flowmeter to the required range. In addition, process startups generally require flowmeters to perform over the full operating span of the devices. After establishing steady state process conditions only a fraction of this original span is used. Smart flowmeter reranging ability throughout automatic control improves the measurement resolution about the quiescent point, resulting in more precise measurement and tighter controls.

The ability to adjust smart flowmeters from the control room is now practical. The improved control, reduced engineering effort and lower inventory continue to be prime benefits of these devices and this new integration technology. Flowmeter security, batch processing, and process flexibility are benefits now possible but not yet widely implemented throughout the industry.

CONCLUSION

During the last five years, technology advances have had a profound effect upon the process control industry. This can be seen in the evolution of the control room as well as the field devices so critical to the measurement needs. The future promises to be even more dramatic with respect to technology related changes in the process control industry and in particular to the integration of the control room and the intelligent field devices.

The integration of the smart flowmeter to distributed control systems has begun. The integration provides new tools and approaches for solving measurement and control problems in process applications. The truly integrated systems provide the designer and operator the opportunity to pursue new control system strategies, which will produce economic benefits to the end user.

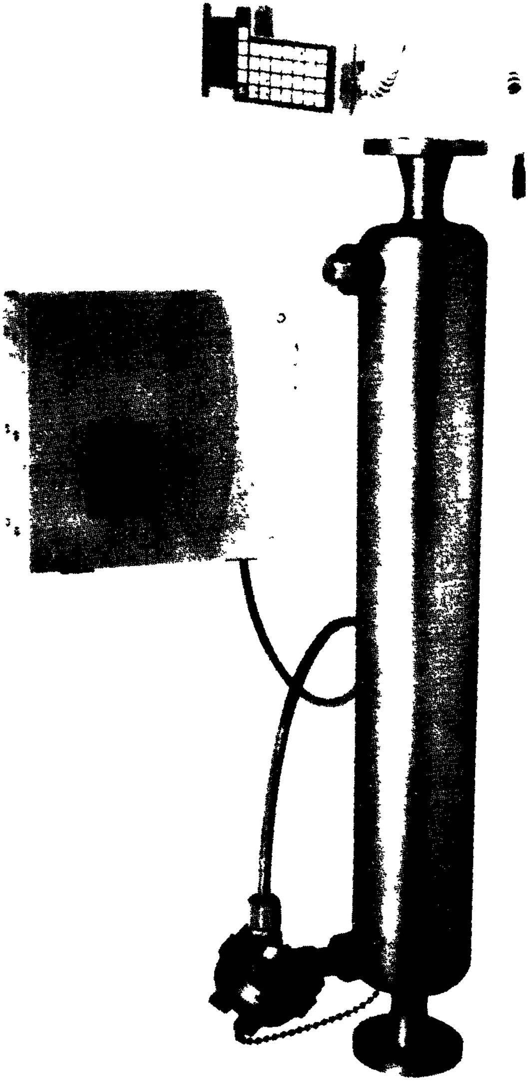

FIGURE 1 Smart Coriolis Mass Flowmeter

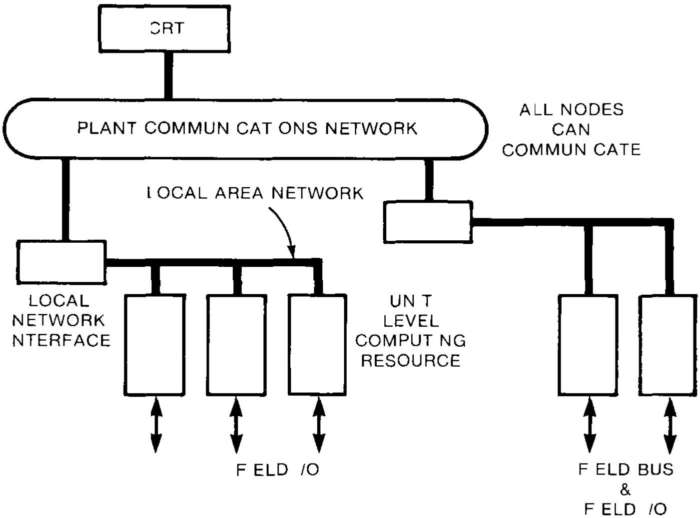

FIGURE 2 Typical System Architecture

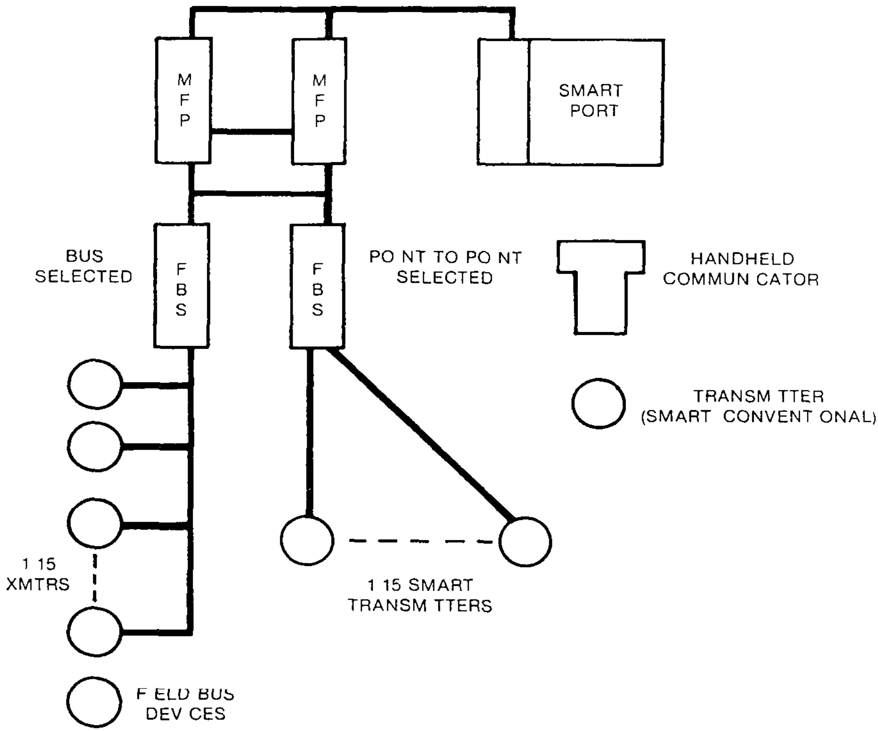

FIGURE 3 Field Bus Architecture

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