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PLC and SCADA based Automation in Milk Processing Industry – A Study

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ABSTRACT: The nature of dairy operations has changed over the past few decades. Small, local dairies with manual operations have been replaced by larger units with factory-style production.
Automation is a fast-moving field. Only a few decades ago, process control systems were based on electro-mechanical relays, wired together in a logical pattern. They were replaced by hardwired electronic control systems, which were faster and more reliable, as they contained no moving parts.

The next improvement was programmable control systems with the logic expressed in data bits stored in an electronic memory, not in the physical arrangement of the wiring. This not only made it easier to modify the programme whenever necessary, but also reduced the cost of the hardware.

In modern control systems, the growing capability and reduced cost of computers and microprocessors has been utilized to distribute control functions to local units. This gives the system as a whole more flexibility and a very high potential. The new processors can be used to control a single machine, or build up a total control and management system to make an entire plant more productive.

KEYWORDS: Manufacturing Execution System (MES), Programmable Logic Controllers (PLC) Supervisory Control and Data Acquisition (SCADA)

I.INTRODUCTION

Extensive mechanization of dairy operations gradually became a reality. Mechanization, together with the rapid expansion of production capacity, also led to a substantial increase in the number of operations that had to be executed. More valves had to be operated, more motors had to be started and stopped. The timing of individual operations also became critical. Operating a valve too soon or too late, for example, could lead to product losses. Every malfunction in the process, and every operator error, could have serious economic and qualitative consequences. Automation was the solution to handle these problems.

II. METHODOLOGY OF AUTOMATION

Any Milk Industry will have the totally integrated plant control system.
It consists of more than one process area, e.g. liquid milk production (with pasteurization, homogenization and cream separation), curd, ghee, cheese etc. Each area has a its own configuration of one or more Process Controllers and they will often have a User Interface for operators, handling product transfer from one process area to the other. It is essential to keep track of production and economy in a plant. The Process Controllers generate a substantial

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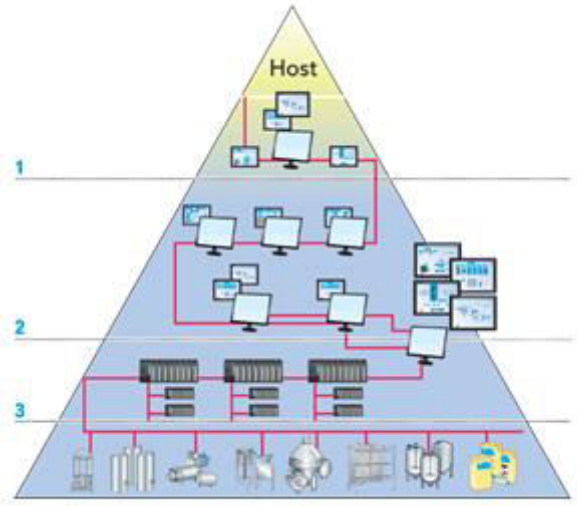
amount of data from the process at all times, day and night, week and month. Knowing what is happening is a key to be able to run the plant more efficiently and economically.

The Process Controllers themselves provide all the raw data for the Manufacturing Execution System (MES), where the data can be further processed and stored in a database. This is handled by a separate computer.
A modern MES system is dedicated to handle large volumes of data. It computes and processes the data to transform it to useful information. Visualizing this information in various types of reports helps the users to analyse production economy, etc. and to assist in planning and making preventive maintenance forecasts.

Fig shows the Schematic control system layout for a complete process line.

1. Business planning and logistics
2. Manufacturing operations and control
3. Production control



III. TASKS OF AN AUTOMATION SYSTEMS

The four tasks of an automation systems are:
1. Digital control
2. Analog control
3. Monitoring
4. Management Information

Digital control
Digital control is based on the fact that the controlled objects can be in one of two states, ON or OFF.
On this basis, completely different levels of automation can be envisaged:
A. Remote control, meaning that single objects are controlled from a control panel, is simply an extended arm of manual control. This level should not be considered as automation.
B. Group control, meaning that a group of objects is controlled at the same time, e.g. the valve cluster under a tank.
C. Control of functions, e.g. opening or closing of product lines in the process or control of agitation.
D. Sequence control, meaning that functions are carried out one by one, in a certain order.

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Analog control
Analog control means that an object is controlled by analog signals from the control unit. Normally this type of control is based on another (continuously varying) feedback signal to the control unit.

Monitoring
Monitoring means that various process objects and process states are supervised and that the system triggers an alarm if a fault occurs.
Monitoring is based on feedback signals from the objects. These signals can be designed in several ways:
• Simple monitoring of certain critical objects.
• Simple registration of fault conditions.
• Interlocks that prevent functions from starting or continuing if fault signals are received. Start of cleaning procedures, for example, may be blocked if the low-level signal from the tank to be cleaned has not been received.
• Automatic restart of functions when the fault has been corrected.

Management Information
Computers make it possible to improve productivity, not only on the shop floor but also at management level. They can collect and analyse data, and present them in a form on which rational management decisions can be based. Modern systems have this capability. A few examples of management routines are:
• Data logging – retrieval of data from the process.
• Product tracking, where the automation system keeps a log-book for all the process units and products in the plant. This enables data for all finished products to be traced:
• raw material identity
• how the product has been processed.
• Production logging, where all production data are logged and processed. These data provide input for reports on production of both end products and intermediates. The reports can be generated at desired intervals, e.g. per shift, day or month.
• Quality assurance. A bad run can easily be traced to its source with the help of information from the computer

IV. PRINCIPLE OF AN AUTOMATION PROCESS CONTROL SYSTEM

Automation systems usually comprise both PLCs (Programmable Logic Controllers) and SCADA System. The PLC was originally a small copy of the larger computer, but the boundary between PLCs and computers has become blurred as PLCs have grown larger

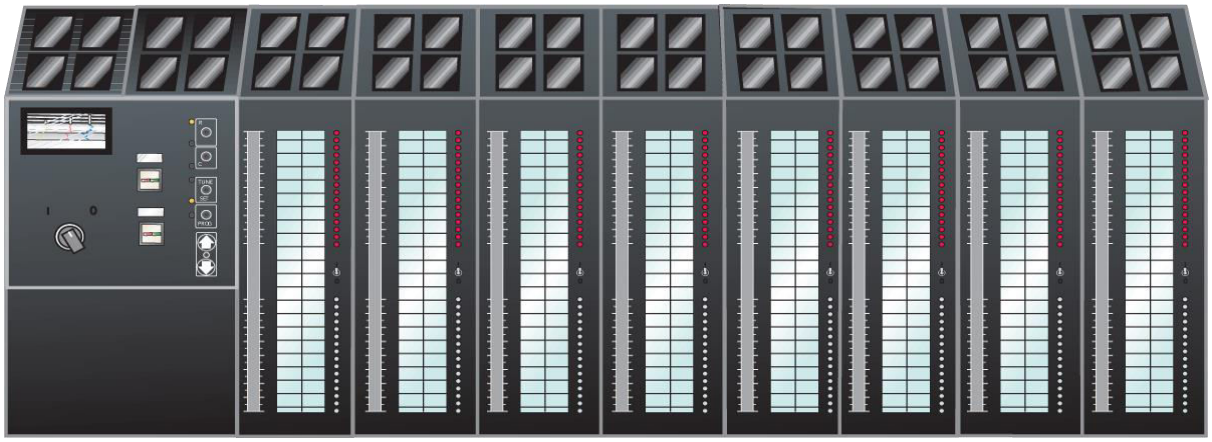

Fig : Process Control is normally executed by a PLC (Programmable Logic Controller).

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A various blocks of process control system include:

1. Operator interface
2. Printer terminal
3. Input/Output units
4. Process equipment

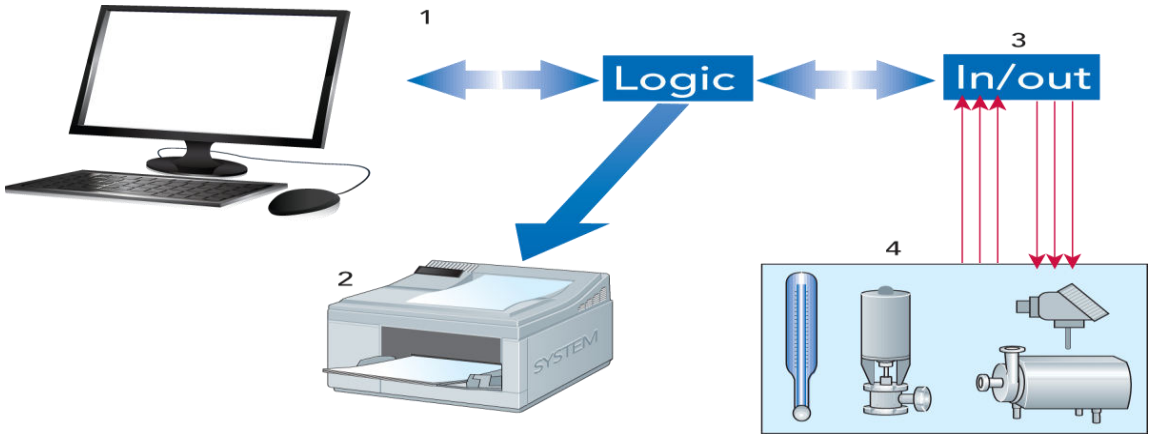

Fig : Process control system

All the transmitters and control modules in the process (4) are connected to the logic by the Input/Output (I/O) system (3). In this way, all the necessary information regarding temperatures, flows, pressures, etc. is transmitted to the logic of the control system. After processing of I/O signals and operator commands, the logic sets the correct output signals to actuate the control modules involved in the process. This is done in a certain order to comply with the logical conditions that apply to the process. The control modules send back feedback signals confirming that the commands have been carried out. These feedback signals are used by the logic as conditions, permitting the next step in the sequence to be actuated. The principal layout of a control system is shown in Figure.

If the output signal and the feedback signal do not match, an alarm signal is generated, trying to bring the related process to a safe state. This assumes, of course, that the fault in question can be predicted. As a process becomes more complicated, and demands on operational security and economy become stricter, the required control programme (logic) has to be extended accordingly. All user interfaces (1) are connected to the logic as well as local operator panels.

V. CONCLUSION

The milk industry has undergone a significant transformation with the integration of automation. From dairy farming to processing and packaging, automation has improved efficiency, quality, and sustainability. Automation using PLC and SCADA in the milk industry is a game-changer, making dairy production more sustainable, efficient, and profitable. As technology advances, the future of dairy will be even smarter and more consumer-friendly.

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