AUTOMATION & CONTROLS IN WATER & WASTE WATER TREATMENT PLANTS

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Present economic and environment concerns require business to take a pragmatic approach to managing productivity, improving quality of product/service, reducing downtime and operating costs. The objective is to **optimize** the process efficiency and the use of resources (raw material, power, labour/manpower, etc). Automation is one of the most effective tools to achieve this.

Automation can be defined as the use of scientific techniques to automate the operation and/or control of equipment, process, or system; with the aim to minimize human intervention and achieve the above objectives. Automation can be as simple as a time- based operation of a traffic signal or as complex as a single room control of a large petroleum refinery. In this article, we will restrict ourselves to automation using PLC (Programmable Logic Controller).

Automation has economic impacts in the form of costs involved and more importantly in the form of savings. The cost involved depends upon the degree of automation desired (whether simple timer based or a complex SCADA based) and the criticality of the process / equipment. It's important that the organisation is clear about the cost and anticipated return on its investment (in the form of savings).

Some of the benefits of automation can be summarized as:

- Improved and/or consistent product quality
- Repeatable performance
- Greater environmental compliance and values
- Increased productivity
- Reduction in downtime and maintenance costs
- Reduction in operation costs
- Use of manpower in other value creating activities
- Availability of accurate data/information, enabling timely decision making and better process control
- Greater customer satisfaction and brand leverage

Role of Automation in Water & Waste Water Treatment Industry

The benefits mentioned above extend to the water treatment industry too. Water being a critical utility in many industries (pharma, electronics, power, etc), it is important to evaluate the benefits of automation on water and wastewater treatment plants.

Let us consider certain examples to understand the importance of automation in water & waste water treatment.

- **Bottled water Industry & beverage Industry:** If the conductivity and pH of the treated water are not monitored and controlled, they will not meet the norms specified for packaged / bottled water specified by BIS.

- **Pharma industry:** This industry requires high purity water for formulations (purified water) and Injectables. The quality parameters to be maintained are Conductivity (<1μS/cm) and TOC (<500 ppb). Apart from this, most high purity water systems today prefer non-chemical treatment processes favoring RO-EDI-UF system. One of the feed limitations to RO is that there should be no free chlorine content. This necessitates the need of an ORP (Oxidation-Reduction Potential) meter.

- **Waste water treatment:** The key design parameters for efficient waste water treatment includes monitoring dissolved oxygen (DO) levels during various cycles of operation. In the absence of instrumentation to monitor it, the treated effluent will not be able to consistently meet the discharge norms with respect to BOD/COD/ammonical nitrogen/phosphorous levels.

The above examples reflect the necessity for automation of water and wastewater treatment processes, to consistently meet the standards of treatment.

As with any project/process/equipment, the criticality of the process (softening for washing pipes or for boiler feed water) will determine the degree of automation (timer/ PLC/SCADA). A range of automated solutions have been developed, from simple timer based dosing systems to PLC based systems for monitoring high purity water.

In this context we shall discuss a few ultra-modern technologies available.

A) New Generation Automatic Demineralisation System

The system comprises of automated twin bed deionisers incorporating superior counter flow ion exchange technology (previously available only in large custom-built plants). Such systems are required for high purity water generation with resistivity greater than 0.2 µS-cm. The operational cycle of the packaged unit is controlled by sophisticated PLC. The PLC is designed to operate a bank of solenoid valves in the regeneration sequence, which in turn operates the piping valves. The PLC performs the following operations:

1) Once the desired volume throughput is achieved, the control system stimulates the **rapid-regeneration** cycle of 30 mins. The regeneration of the cation and anion bed is simultaneous, producing a near neutral waste thereby reducing the disposal cost.

2) A message display continuously reads out the system status and provides information of flow rates, throughput, and number of regenerations. The system is fitted with an audible alarm to indicate any defaults and also indicates the 'no-flow' condition.

3) The control system can be scaled up and connected to level sensors in chemical tanks to prevent regeneration when insufficient chemicals are available.

B) New Generation Reverse Osmosis-Electrodeionisation (RO/EDI) System

The RO/EDI system generates high purity water at the touch of a single button. It is a compact skid mounted unit which comprises pretreatment (softener/activated Carbon), reverse Osmosis, electrodeionisation, and post treatment (ultra filtration / ultra-violet).

The system is controlled by a fully integrated PLC & a touchscreen HMI (Human Machine Interface) housed in a SS cabinet. The PLC controls the system operation and provides 9 levels of security.

The softener operation and regeneration (including dilution of saturated brine solution) is set in stages and each stage is preset on the HMI.

The system sounds an alarm or shuts down if the set conditions are exceeded. This provides **foolproof** security to ensure consistent treated water quality. Conductivity and temperature of the treated water are monitored to meet the design specifications.

The hot water cleaning and sanitisation of the RO membranes and EDI is initiated automatically. The temperature and pressure during the cycle are continuously monitored and controlled through the PLC.

C) New Generation Waste Water Recycling Technology

The system is designed to ensure complete and consistent treatment for carbon oxidation, nitrification (N), denitrification (DN), and bio-phosporous.

The treatment cycle consists of **fill-aeration,** settling and decantation which is completed in the same tank in 4 hours.

Plant control is essentially automatic which is a major factor in reducing operating costs. The cycle and its sequence are controlled by a scalable PLC. The automatic basin air distribution system is also regulated by the same PLC. This means that optimum operation and performance are synonymous. Steady state is easily maintained even during high and low load conditions.

The basic feature of the system is its ability to measure the dissolved oxygen content in the aeration basin and its ability to vary the blower speed through a variable speed drive. This results in almost 30-50% power saving (as blowers are the largest consumers of power in the treatment plant).

D) Water Treatment Process Analysers

The instruments for conductivity, resistivity, redox and pH measurement are available as online process analysers as well as in portable models.

The online process analysers are ultra-modern microprocessor based instruments that measure the quality of water and wastewater. These analysers have been specially developed to meet the need of the discerning user for high-end, value-packaged features at an economical price. The systems are based on Application Specific Integrated Circuit (ASIC), with quick access and great flexibility through the menu driven SETUP program. The 0/4-20 mA transmitter output current is galvanically isolated providing accurate and reliable measurements. Moreover, these modern process controllers comply with the Electro Magnetic Compatibility (EMC) standard and are protected against electro magnetic interference.

Conclusion

Automation in general leads to quality improvement, fewer errors, higher productivity per person, as well as reduction in time required to complete a particular process.

This overview is a brief attempt to provide the reader with the present state of instrumentation and automation in the water & waste water treatment industry.

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