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NEED OF AUTOMATION IN COMMON EFFLUENT TREATMENT PLANT

Sravanthi Animireddy and T. Chandra Shekhar Rao

Electrical Department, Chh. Shahu College of Engineering, Aurangabad, India
Department of Humanities &Science, Chh. Shahu College of Engineering, Aurangabad, India

ABSTRACT

Common effluent treatment plant (CETP) is used to treat effluents from a cluster of Small & medium scale industrial units. CETP not only helps the industries to control the pollution, but also provides cleaner environment and services to the society. Automation of CETP has many benefits in terms of savings of chemical, energy, O&M cost in addition to generate better quality of treated water. Most of the CETPs in India are operated manually due to cost involved in automation without realizing savings of these long term hidden costs. Advance innovations in technology offers compact and economic tools to automate CETPs. Automation can be implemented at least in the areas where there is a major contribution of the total annual costs. Usage of online measurement devices can also reduce the labour cost since there is no necessity of sampling and testing in laboratory for several quality parameters and to adjust the controls according to that. Treated water quality will also be improved due to the accuracy in measurements of quality parameters and timely control of operation of different equipment's. Extent of automation which gives the economic benefits can be chosen by doing life cycle cost analysis before selecting any automation scheme. This paper illustrates the need of automation and its advantages in automation of CETPs.

Keywords-*Common Effluent Treatment Plant (CETP), Automation, Programmable Logical Controller (PLC), Supervisory Control and Data Acquisition (SCADA), Human*

I. INTRODUCTION

Water is one of the important natural resource used for various domestic and industrial purposes. About 70-75% of Earth's surface is covered by water resources out of which only 2.5% is fresh water suitable for human consumption. Of this only 0.5% is available as ground water and 0.01% as surface water in the form of lakes, streams, rivers etc. which can be readily accessible. The remaining is in the form of ice caps. This small amount of water is used for different purposes like drinking, transportation, heating and cooling, industry etc. by human population.

India is the second most populous country in the world and is likely to surpass china by 2050 but is 7th largest country in terms of area. India has 4% water resources and 2.45% land area of the world but it has16% of the world population. As per an estimate India has only 1,000m^3 of water per person i.e., less than 1,700 m^3 of water per person per year and is considered as water-stressed country.

Machine Interface (HMI) Water Scarcity problems in India are due to rapid population growth, inadequate water treatment facilities and lack of finances for investment. Wherever facilities are available that is not maintained properly. Presently, only about 10% of the waste water generated is treated and the balance is discharged into water bodies without proper treatment there by polluting water bodies. So, there is a need to recycle the waste water effectively to fulfil the increasing water demand and to protect the health of water bodies.

The existing economic and environment concerns require an approach for increasing productivity, imp-roving quality of product, reducing downtime and operating costs with the sole objective to optimize the use of resources (raw material, power, labour, etc) and process efficiency. This can be achieved by automation which is the introduction of scientific techniques to automate the operation and/or control of system to minimize human intervention and to imp-rove productivity and efficiency of the system.

Automation has various economic impacts in the form of costs involved and mainly in terms of savings and the costs involved depends on the degree of desired automation (Ex: simple timer or complex SCADA based) and the criticality of the process.

I. LITERATURE SURVEY.

Satyanarayana, [2004] discussed the need of automation in waste water treatment processes and its advantages.

Sunil et al., [2014] discussed the importance of SCADA in waste water treatment plants for monitoring and controlling processes that are distributed among various remote sites and its effective working.

Demey, et al., [2001] demonstrated the practical implementation and validation of advanced control strategies, designed using model based techniques at an industrial wastewater treatment plant of a large pharmaceutical industry.

An advanced process control algorithmic approach was proposed by Alexander [2012] to computerize the plant processes using micro controllers which are designed and simulated in real time proteus to control the flow rate of water and temperature of the plant including boiler and cooling water.

Jamil, et al., [2003] discussed the technical solutions for the operation of fully automatic water treatment plant to achieve high efficiency in quality of productivity.

The above literature survey reveals that most of the work has done on automation of STP and ETP but not on the CETP. In India, most of the CETPs are still running manually because of the cost involved in the automation without no focus on the long-term benefits in terms of savings of labour, chemical, energy costs.

II. CASE STUDY OF CETP, AURANGABAD CETP, Aurangabad is in Waluj Maharashtra Industrial Development Corporation (MIDC) which is located about 20 km from Aurangabad City. There are about 1400 industries covering small, medium and large industries. Most of these industries are the major effluent generating units. MIDC consists of chemical, engineering (electroplating and surface treatment), breweries, bulk drugs, pharmaceutical industries etc. and the total effluent generation is about 10 MLD out of which 7 MLD is f r o m industrial a n d 3 M L D from domestic units.

TABLE I: DESIGN PRINCIPALPARAMETERS

Sr. No.	Parameter	Unit	Inlet	Outlet
1	pH	---	6 -7	**6.5 – 9.5**
2	**COD**	**mg/l**	**1200**	**< 250**
3	**BOD3**	**mg/l**	**500**	**< 30**
4	**Oil & Grease**	**mg/l**	**75**	**< 10**
5	**TSS**	**mg/l**	**500**	**< 100**
6	**TDS**	**mg/l**	**< 2100**	**< 2100**

The plants consist of physic-chemical treatment, primary clarifier, biological treatment, secondary clarification and tertiary treatment. All these processes are operated manually without automation.

III. PROPOSED AUTOMATED SYSTEM

The proposed system aims to automate raw water pumping, coagulation, flocculation and control of Sedimentation, pH, DO, backwash, chlorination and treated water pumping to save O & M, energy and labour

TABLE II: PROPOSED AUTOMATION SCHEME FOR TREATMENT PROCESSES OF CETP

Process	Existing scheme	Proposed scheme	Advantages of proposed scheme
Raw water pumping control	Raw water pumping is done manually by adjusting the number of pumps in operation to match the flow rate with the amount of raw water being delivered to the plant.	Raw water flow should be adjusted automatically with the help of variable frequency drive(VFD) to match the desired plant flow rate and starting and stopping of raw water pumps combined with overall plant start up, shutdown and in response to the emergencies.	Reduced energy costs with the help of Ds since the pump speed and capacity can be matched to a more uniform flow rate. Automatic start-up and shut down will be there in response to emergencies or water demands. Reduced labour costs. Improved water quality because of more uniform flow rates.
Neutralization Control **Coagulation, flocculation & sedimentation** **Black wash Control** **Clorination control**	pH is measured manually with the help of probes and accordingly, the dosage levels of lime solution to be added is decided. Jar testing is performed on a scheduled basis and it will be increased in frequency when quality of source fluctuates.	Coagulant feed rates and dosages should be adjusted automatically in response to variations in plant flow and source water quality. Automatic shutdown of the plant should also shutdown the coagulant feed and feed back control of the coagulant dose to be accomplished using streaming current detectors and controllers.	Chemical savings by closer control of chemical feed. Labour savings due to reduced operator attention because of automation of the coagulant addition. Improved water quality due to better particle reduction.
Dissolved oxygen (DO) and blower control	DO measurement is done with the help of probes. Based on DO levels blower speed will be changed in VFD by operator	DO levels should be measured using online DO meter and if the level is outside a specific range, air flow is modulated by changing number of blowers in operation and blower speed speed automatically using.	Labour savings due to automatic DO measurement and changing of air flow. Energy savings due to no of blowers in operation and blower speed is changed automatically according to DO level. Improved water quality because of consistent DO level

IV. AUTOMATION FEATURES

The proposed automation solution for treatment plant involves the use of online field devices which continuously monitor the PH, DO, operation of pumps, closures and other devices, collect and execute commands coming from the higher levels, while programmable controllers (PLC) are used to control various processes based on the data and the built-in algorithm and it will communicate with a centralized SCADA system. The SCADA system is programmed so that all the control logic is in the PLC and the SCADA HMI operates in a supervisory mode. The plant is operated in an unattended manner which is monitored via SCADA from the operations control centre. The SCADA system will alarm the operator in the event of a problem at the plant and also can send message through wireless global system for mobile communications (GSM). SCADA system also generates reports and other data automatically.

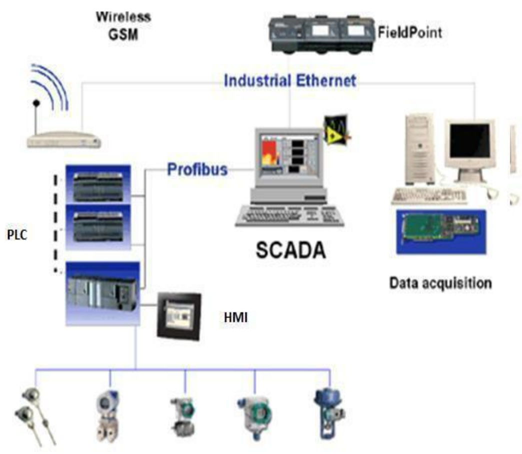

Fig. 2: Generalized architecture of proposed SCADA system

Through the HMI operator can also change the status of the field devices manually which communicates to the PLC.

Most of the CETPs in India are not implementing the automation scheme because of the costs involved in the automation but several cost-effective solutions are available in the market which reduces engineering effort and costs associated with automation projects. Latest innovation of PLC and SCADA integrated complete automation tools with pre-configured and tested engineering libraries, built-in full suite of diagnostics and maintenance tools and integrated document management capabilities are adding value to all phases of automation system project from design process to engineering, control system development, installation, commissioning, start-up and acceptance testing, all the way through to operation, maintenance, repairs and ongoing upgrades.

V. ESTIMATION OF BENEFITS FROM AUTOMATION

According to literature after implementing automation annual costs savings will be as follows.

- Energy cost savings will be 13 % - 27 % (For economical analysis it is taken as 20%).
- Chemical cost savings will be 15% - 40 % (For economical analysis it is taken as 30%.
- Labour cost savings will be 40%.
- Maintenance cost savings will be 15 - 20 % (For economical analysis it is taken as 15%).

Annual costs of CETP will be reduced after implementation of automation.

1) Estimated energy cost after automation = 8991605- (8991605 * 0.2) = Rs.7193284.
2) Estimated chemical cost after automation =2794048- (2794048 * 0.3) = Rs.1955834.
3) Estimated operating labour cost after automation =2029147- (2029147 * 0.4) = Rs.1217488.
4) Estimated maintenance cost after automation =1477487-(1477487*0.15) = Rs.1255864.

So, annual costs of CETP after implementing the proposed scheme of automation is shown in below table

TABLE-III: ESTIMATED SAVINGS INANNUAL COSTS OF CETP AFTER AUTOMATION

S. No	Item	Annual Cost before automation (in Rs.)	Annual cost after automation (in Rs.)	Estimated annual aavings (in Rs.)
1	Energy cost	8991605	7193284	1798321
2	Chemical cost	2794048	1955834	838214
3	Operating labour cost	2029147	1217488	811659
4	Maintenance cost	1477487	1255864	221623
Total estimated annual savings after automation				**3669817**

Total estimated annual savings after implementing Proposed automation is Rs. 36,6 lakh

COST BENEFIT ANALYSIS FOR AUTOMATION OF CETP

Objective of this analysis includes quantification of a tangible costs and benefits. Construction cost is the main component of the life cycle cost analysis. This analysis makes use of NPV method in which all costs and benefits of a project throughout its life cycle are expressed in terms of NPV i.e., equivalent cost in today's rupees. These costs include capital costs, operational and maintenance cost, training cost throughout the life cycle of the project and benefits include reduction in labour costs, operational and maintenance costs, energy costs and chemical costs.

For carrying out the analysis of cost-benefit of any project, costs required for the implementation and estimated benefits throughout the life cycle of the project are identified.

TABLE- IV: COST BENEFIT ANALYSIS OF PROPOSED AUTOMATION SCHEME

Year	Cost	Benefit	Discount factor	Present value of cost (in Rs.)	Present value of benefit (in Rs.)
1	1163820	-	0.90	10474218	-
2	-	3669817	0.81	-	2972552
3	-	3669817	0.73	-	2678966
4	-	3669817	0.66	-	2422079
5	-	3669817	0.59	-	2165192
6	-	3669817	0.53	-	1945003
7	-	3669817	0.48	-	1761512
8	-	3669817	0.43	-	1578021
9	-	3669817	0.39	-	1431229
10	-	3669817	0.35	-	1284436
Total				10474218	18238990

B / C ratio = PV of benefit / PV of cost

= Rs.18238990 / Rs.10474218 = Rs. 1.74

NPV = PV of benefit - PV of cost

= Rs.18238990 - Rs.10474218 = Rs.7764772

Payback period = 5yrs (After 5 Yrs. project starts giving benefit).

RESULTS AND DISCUSSIONS

An annual cost of existing facility which is operating manually is Rs. 1.5 crore. Chemical costs and energy costs are major contributors towards this annual cost. Raw water pumping, DO control, filtration process, back wash water recovery, treated water pumping are the major areas which consumes lot of energy and coagulation, flocculation, sedimentation and chlorinetion process control are the major areas contributes towards the chemical costs. So proposed automation scheme is designed for these areas with the main focus to reduce annual costs.

Cost required for the implementation of proposed scheme at CETP, Aurangabad is Rs. 1.1 crore and expected benefit from automation annually is Rs. 36.6 lakh up to 10 years. Considering present value of costs and benefit by taking discount rate as 11% the total cost required for the implementation of proposed scheme is Rs.1.0 crore and expected total expected benefit from automation is Rs. 1.8 crore. Benefit to cost ratio is 1.74 which is >1 and Net present value is 77.6 lakh which is positive that indicates proposed automation scheme for CETP is economically feasible and it is more profitable. Payback period of this project is 5 years. It indicates that after implementing the proposed automation scheme total capital cost invested for automation can be re generated within 5 years and project starts giving after 5 years.

Annual costs of proposed automated facility are Rs. 1.1 crore. Nearly 25% reductions in total annual costs can be realized by the implementation of proposed scheme. Apart from this tangible benefits there will be some intangible benefits from the implementation of proposed scheme like improvement in the quality of treated water, personnel availability, automated report generation, better documentation, improved staff morale, easy collection and handling of historical data, odour control etc. So, CETPs should implement the automation to reduce their annual costs and improve the quality of treated water. Government also should support financially for the automation of CETPs.

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