AUTOMATION OF COMMON EFFLUENT TREATMENT PLANT

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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 invovled in automation without realizing savings of these long term hidden costs. Advance innovations in technology offers compact and economic tools to automate CETPs. 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 Machine Interface (HMI)

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 remaning 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 huamn population.

India is the second most populus 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 1,000 m^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.

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 are 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 thereby polluting water bodies. So there is a need to recycle the waste water effectively to fulfill the increasing water demand and to protect the health of water bodies.

1.1 Need of Waste Water Treatment

The waste water treatment is necessary to protect and maintain the health of the rivers/lakes failing which the health of the water bodies is under deterioration,thereby threatening the public health,wildlife habitat, fisheries, recreation and ultimately the quality of human lives.The treated wastewater can also be used for the purposes where drinking water quality is not required.

1.2 Waste water treatment plants

Three types of waste water treatment plants i.e,Sewage treatment plant(STP),Effluent treatment plant(ETP) and Common effluent treatment plant(CETP) are used to treat the waste water to make it more compatible or acceptable for consumption of various uses by human or for suitable discharge into a water body.

This paper focuses only on CETP which is used to treat the effluents from Small & medium industrial units.The waste water from individual industrial units may have significant concentration of pollutants and reducing them to desired concentration by individual treatment is techno-economically unfeasible. Moreover the CETP provides economical and better option as the equalization and neutralization occur in the plant. The Mertis of CETP are easy availability of sufficient land and trained staff for the operation of treatment plant which can be difficult at the individual industry level,easy handling and disposal of solid waste and compliance of the stipulated norms becomes easier for regulatory authorities.

1.3 Automation

The existing economic and environment concerns require an approach for increasing productivity, improving quality of product, reducing downtime and operating costs with the sole objective to optimize the use of resources (raw material, power, labour/manpower, 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 in order to minimize human intervention and to improve 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.

1.3.1 Need of Automation in a Waste Water Treatment Plants

Manual operation control includes collection of physical samples and its testing in standard laboratory and accordingly the control elements are adjusted manually to maintain the water quality parameters within a desired ranges.As the techonology becomes affordable direct measurement instrumentation like online sensors, portable spectrophotometers,handheld meters replaced the standard laboratory testing methods but still optimisation is not acheived due to the time lag between measurement and adjust of control elements.

So STP,ETP &CETP needs a specific time based logic to achieve consistent quality of treated water that can never be achieved with accuracy by manual operation.

1.4 Literature survey

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

Sunil L.A 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.D et al [2001] demonstrated the practical implementation and validation of advanced control strategies, designed using model based techniques at an industrial waste water treatment plant of a large pharmaceutical industry.

An advanced process control algorithmic approach was proposed by Alexander M.L[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.

Zhao L.J et al[2005] proposed an integrated automation system consisting of Process Manage System (PMS) and Process Control System (PCS) to overcome the problem of high production costs in wastewater treatment plants in China due to low automation level. The proposed sysem was successfully applied to the wastewater treatment plant in the southern suburb of Shenyang and acheived great benefits for both economy and society.

Jamil. I et al[2003] disussed 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 of Waluj Maharashtra Industrial Development Corporation (MIDC),Aurangabad established in 1982-83, located about 20 km from Aurangabad City. The total MIDC area is about 1520 ha. 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 from industrial and 3 MLD from domestic units.

Some of these large and medium scale industries have their own treatment facilities consisting of primary,secondary and tertiary treatment and have sufficient land for the disposal of the treated effluent, but in many cases the disposal of treated effluent is not properly done. The treatment facilities of small scale industries have only primary treatment facilities which are inadequate for treating the effluent to prescribed standards and this partially treated effluent is disposed off in the environment.

To overcome this problem the above CETP of 10MLD capacity was set up to treat effluents from various industries of Waluj MIDC. The inlet and outlet characteristics of CETP are regulated by Maharastra pollution control board(MPCB). Nearly 120 industries are connected with this CETP for their effluent treatment and safe disposal. Major effluent generating industries send their effluent through underground pipeline of MIDC, while the remaining industries are sending by special tankers.The CETP makes use of activated sludge process with diffused aeration system for the treatment and the treated water is discharged for gardening, tree plantation and excess treated effluent is disposed at a designated point approved by MPCB & National Environmental Engineering Research Institute(NEERI).

Main features of CETP are:

- Source of Effluent – Industries of MIDC,Waluj.
- Module of Project – Build Own Operate & Transfer(BOOT).
- Hydraulic Loading – 10 MLD

Table 1: Design Principal Parameters

Sr. No.	Parameter	Unit	Inlet Characteristics	Outlet Characteristics
1	pH	----	6 - 7	6.5 – 9.0
2	COD	mg/l	1200	<250
3	BOD_3	mg/l	500	<30
4	Oil & Grease	mg/l	75	<10
5	TSS	mg/l	500	<100
6	TDS	mg/l	<2100	<2100

2.1 Unit operation of CETP

The plant consists of the following sub units

- Physico- chemical treatment

The waste water received in collection sump is pumped to physico – chemical treatment section using raw effluent transfer pump.The effluent is treated with lime solution as well as ferric alum in flash mixer to increase pH of the effluent to 8. From this the effluent is transferred to flocculator ,where again ferric alum is added to carry out flocculation and coagulation of suspended and precipitated particles which is passed through reaction channel ,where suitable polyelectrolyte is added to increase the settling rate of coagulated and flocculated mass.

- Primary clarifier

From the reaction channel the effluent is fed to tube deck type hopper bottom lamella clarifier to seperate precipitated solids from the waste water by settling under gravity. Tube deck packing provides high surface to volume ratio for settling under gravity.The water from primary clarifier is conveyed to aeration tank for biological treatment. Settling sludge from the bottom of the primary clarifier is transferred to primary sludge tank and it will be further transferred to filter press for getting cake of sludge.

- Biological treatment

Activated sludge process is used for biological treatment, in which the soluble BOD is stabilized by the oxidation of organic matter by microorganisms.Desired oxygen is provided by air blower through membrane diffusers of non-clog type to achieve the higher rate of oxygen transfer efficiency and nutrients in the form of DAP & Urea is fed to aeration tank from respective tanks.From aeration tank, mixed liquor overflow is taken to secondary clarification to seperate microorganisms from treated effluent under gravity. The bottom sludge from clarifier is returned back to aeration tank and the recycle ratio is decided based on the design level of MLVSS in the aeration tank and excess biomass is discharged through the sludge handling system.

- Secondary clarification

From aeration tank ,mixed liquor is taken to secondary clarification process to seperate bio-mass from the treated effluent under gravity.Tube-deck type hopper bottom lamella clarifier is installed for the secondary clarrification ,which provides high surface to volume ratio for settling under gravity. From the secondary clarifier, a part of the settled biomass is recycled back to aeration tank and excess bio-mass is transferred to secondary sludge tank.

- Tertiary treatment

Biologically treated effluent from the clear water tank is further treated with pressure sand filter (PSF) and activated carbon filter (ACF) to remove fine suspended solids, odour and colour from the effluent. Finally, this effluent is collected in treated water tank and discharged for the green belt development.

All the above processes are operated manually without automation.

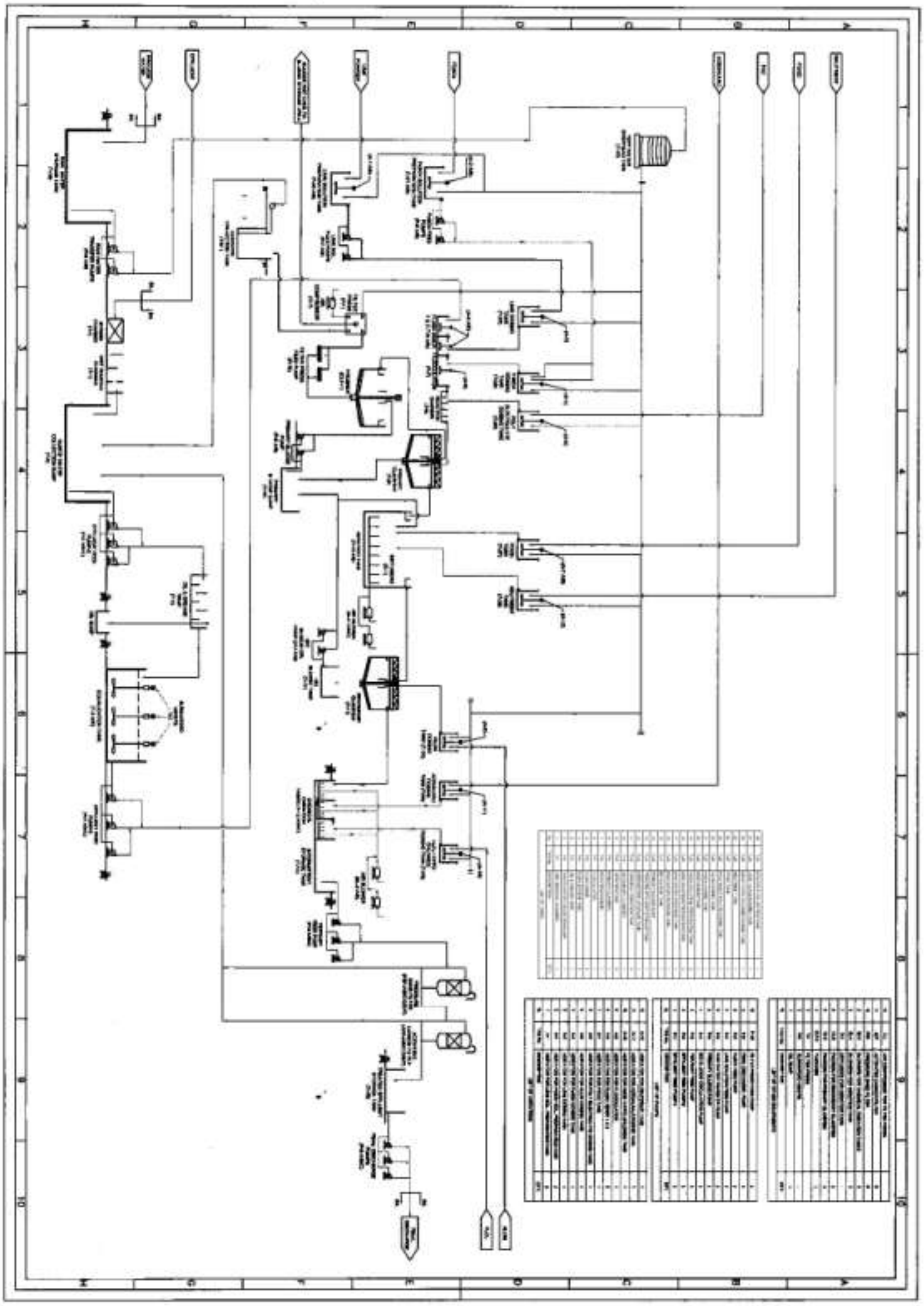

Fig 1: Operational Flow Chart Of CETP,Aurangabad

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 costs.

Table 2: 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 ferquency drive(VFD) to match the desired plant flow rate and starting and stopping of raw water pumps combined with overall plant startup,shutdown and in response to the emergencies.	• Reduced energy costs with the help of VFDs since the pump speed and capacity can be matched to a more uniform flow rate. • Automatic startup and shut down will be there in response to emergencies or water demands. • Reduced labour costs. • Improved water quality as a result of more uniform flow rates
Neutralization control	PH is measured manually with the help of probes and accordingly the dosage levels of lime solution to be added is decided	PH should be measured continuously with the help of online PH meter and accordingly lime solution dosage is adjusted automatically	• Reduced labour costs • Consistent PH level • Reduced chemical costs • Improved water quality
Coagulation,flocculation & sedimentation	Conttrolling of coagulant dosages is done manually by adjusting the coagulant,coagulant aid,and acid or caustic feed rates based upon observation,jar tests and instrument readings.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 feedback 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 level 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 automatically using VFD.	• 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
Back wash control	Back wash is initiated manually with operator intervention	Backwash should be done automatically based on filter headloss, run time of filter or turbidity levels of the filtered water exceeding a certain setpoint to reduce filter bumping and to terminate the backwashing run based on the turbidity measurements	• Savings in labour cost due to autoamatic backwash process. • Savings in chemical costs. • Longer filter run times will be reduced which result in reductions in power and sludge handling costs. • Better water quality.
Chlorination control	A fixed dosage is set manually based on plant flow rate,the chlorine demand and the desired chlorine residual so that the chlorinator delivers a constant rate of chlorine during plant operation .But if the plant flow rates are not constant ,significant swings in the finished water residual can occur and this situation may require plant operator intervention to make manual adjustment of dosage rate.	Chlorine dosage should be adjusted automaically based on a combination of plant flow rate and continuous feedback of the chlorine residual to accommodate changes in plant flow rate and chlorine demand.	• Reduced chemical costs since the dosage control is used to avoid over feeding of chemicals. • The reduction in the labour for process adjustments and travel time to/from the plant. • The energy costs associated with operating chlorine disinfection systems are relatively low. • More consistent treated water chlorine residual.
Treated water pumping control	Finished water pumping is done maually by selecting the proper number of fixed-speed pumps to match plant production	Finished water flow rate should be adjused automatically to match system demand based on treated water tank level, distribution system pressure	• More consistent treated water flow. • Lower energy costs with the help of VFDs since the pump speed and capacity can be matched to a more uniform flow rate. • The reduction in the labour for process adjustments and travel time to/from

		or a preset flow rate.	the plant. • Minimized demand charges and to adjust raw water flow rates to match the plant production rate with system demands.

IV. AUTOMATION FEATURES DESCRIPTION

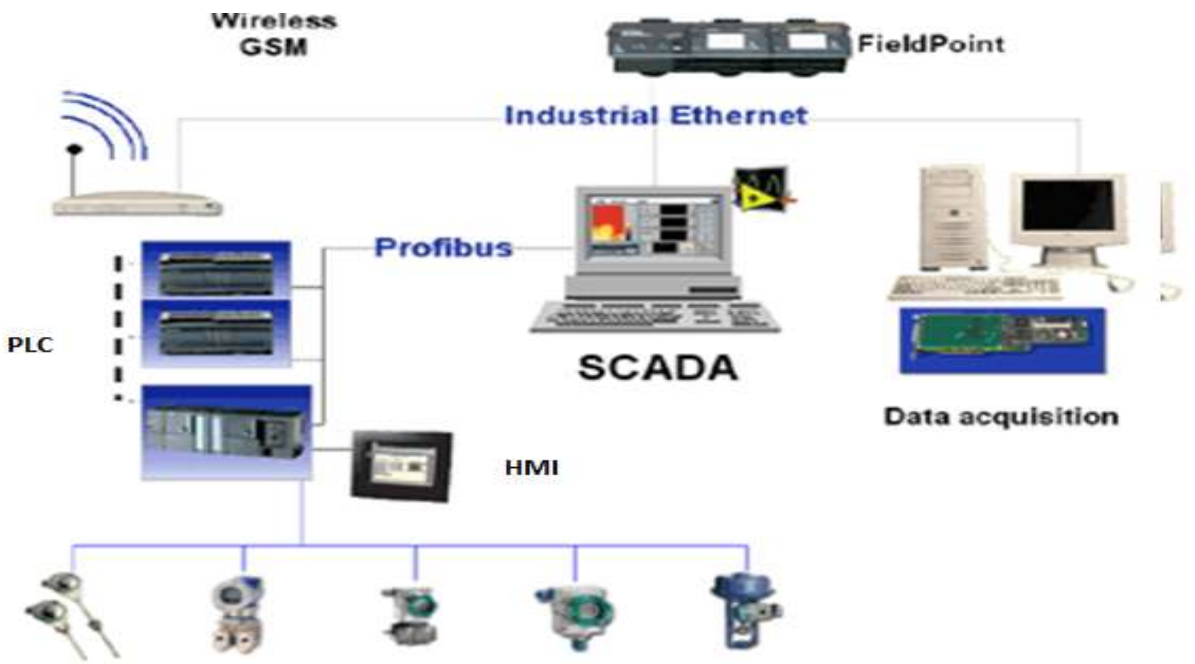

Fig 2: Generalized Architecture of Proposed SCADA System for CETP

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 center. 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. 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. CONCLUSION

Water is a basic human need.Treating of waste water from industries is very important to address the water scarcity problem and in order to keep our environment clean.So to increase the quality of treated water and to improve the treatment plant efficiency, automation of common effluent treatment plants is necessary.By using the cost effective and on going life cycle management tools like PLC &SCADA integrated tools we can easily automate even small common effluent treatment plant and reduce O&M costs.

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