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Performance Evaluation of Sewage Treatment Plant at Juet Campus, Guna (MP), India– A Case Study

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Abstract— *Sewage Treatment Plants (STPs) are recognized as the solution to domestic and industrial wastewater treatment in developing countries. These are cheap, easy to construct and do not require high skilled labor. This paper describes the performance evaluation of the STP located at Jaypee University of Engineering & Technology (JUET) campus, Guna (MP), India. It includes testing of biochemical oxygen demand (BOD), chemical oxygendemand (COD), total dissolved solids (TDS),total suspended solids (TSS) and pH. Samples are collected and analyzed over eight months at five different sampling points i.e., inlet, and effluents of aeration, equalization, pressure filter and outlet. The BOD, COD, TDS, and TSS average removal efficiency were observed to be 57%, 68%, 12% and 40.43% respectively. The treated effluent values were below the tolerance limitsspecified by Bureau of Indian Standards for sewage effluent discharged into surface water sources and public sewers. The results demonstrated that STP is working very efficiently and contributing to clean and healthy environment of the university campus.*

***Keywords*— Biochemical oxygen demand, Chemical Oxygen Demand, Total dissolved solids, Total suspended solids.**

I. INTRODUCTION

Sewage is used water from residential, institutional, and commercial and industrial establishments. In homes, sewage includes liquid from toilets, baths, showers, kitchens, sinks, washing machines and dishwashers. In many areas, sewage also includes liquid waste from industry and commercial establishments. The domestic sewage contains 99.9% water, 0.02-0.03% suspendedsolids and other organic (70%) and inorganic (30%) substances. Inorganic components include ammonia, chloride salts and metals. Metal industries and mines also contribute to the inorganic. Organic components include either nitrogenous compounds like proteins and amino acids or non-nitrogenous compounds like carbohydrates and lipids. Animal sewage is high in protein and lipids and plant sewage is rich in cellulose and lignin. Lipids in the form of fatty acids which escape digestion in the digestive system account for the lipids in the faeces. Sewage water normally comprises of fungi, protozoa, algae, bacteria and viruses. In addition storm runoff burdened with harmful substances via run off from roads, parking lots and rooftops can harm our fresh water systems. Sewage contains substances such as human waste, food scraps, oils, soaps and chemicals. Human waste naturally contains bacteria that can cause disease. Once water becomes infected with these bacteria, it becomes a health hazard. The disposal of untreated or poorly treated sewage into surface water bodies in urban areas is common in most developing countries, including Zimbabwe [1].If raw sewage directly discharges into streams causes increased algae, reduced oxygen and murkiness destroy the ability of a stream or lake to support wildlife, and all of the fish, frogs and other life forms quickly die. That's why it is essential to build sewage treatment plants (STPs) and enforce laws against the release of raw sewage into the environment.

STP plays a vital role in the process of removing the contaminants from sewage to produce liquid and solid (sludge) suitable for discharge to the environment or for reuse. Many countries in the world contain limited fresh water resources. Hence, after proper treatment of sewage, can be reused for agricultural purposes. The complete treatment of sewage accomplish by a sequential combination of various physical unit operations, and chemical and biological unit processes. The general yardstick of evaluating the performance of STP is the degree of reduction of BOD, and suspended solids, which constitute organic pollution [2]. The performance efficiency of STP depends not only on proper design and construction but also on good operation and maintenance[3]. The performance evaluation of STP is extremely useful as it provides information on how the system is working and possible to identify drawbacks for betterment.

About STP

Fig. 1 provides flow diagram of STP located at Jaypee University of Engineering & Technology (JUET) campus, Guna (MP), India. The STP has a capacity to treat 700 m^3/d of wastewater from the campus. It's a modern small-scale treatment plant where treatment of sewage takes place and produced wastewater suitable for reuse in irrigation or garden supply. The wastewater generated from the academic block, hostels and faculty accommodation were collected by means of sewer pipe line. This wastewater screened through a bar screen chamber to remove large debris such as sticks, leaves, trash and other large particles which may interfere with subsequent purification steps then it passes to the equalization tank where it is retained. This tank equalizes the flow rate into subsequent parts of the treatment system. While entering the effluent into aeration tank, urea and DAP (Di-Ammonium phosphate) were added as nutrient for the growth of microorganisms. In the aeration tank air was continuously introduced, which bring about satisfactory aeration of sewage. Sewage also gets thoroughly mixed up with the activated sludge during its downward journey. Then it passes to the settler tank, where sludge settled and water goes to raw water tank. The settled sludge was treated in sludge drying beds. Then it treated in the pressure filters which basically aerated filters. The dual purpose of this media is to support highly active biomass that is attached to it and to filter suspended solids.

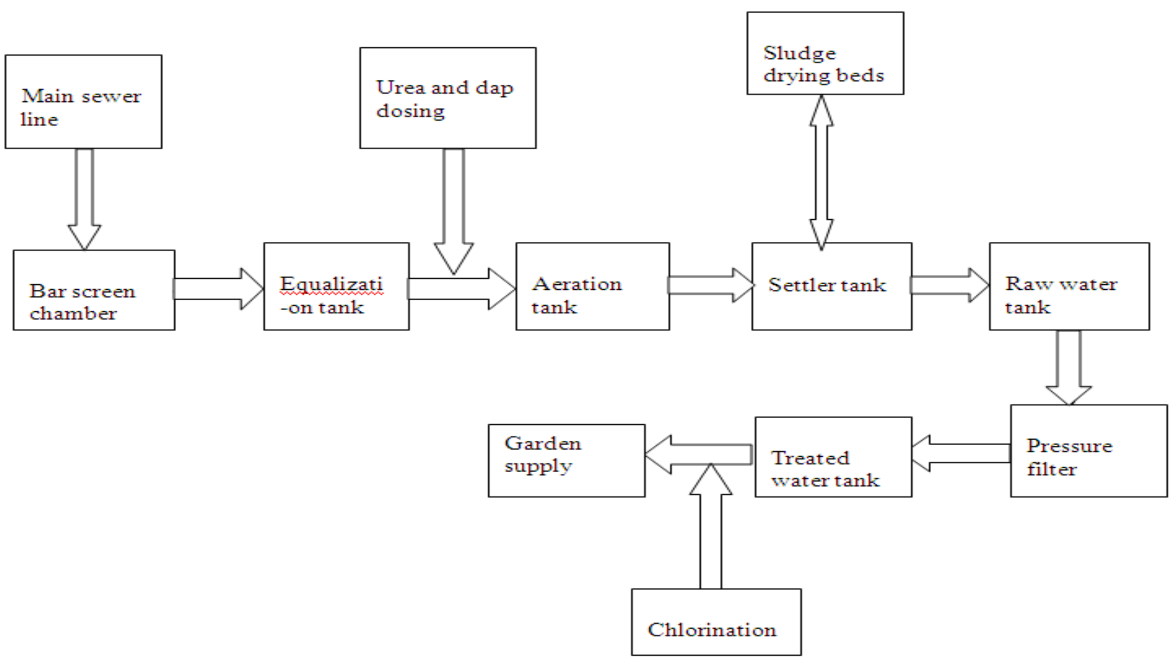

Fig. 1. Flow Chart of JUET's Sewage Treatment Plant

Carbon reduction and ammonia conversion occurs in aerobic mode and sometimes achieved in a single reactor while nitrate occurs in anoxic mode. After that treated water gets collected in the treated water tank. The chlorination of treated water was done so that treated water should be free of pathogenic (disease causing) microorganisms that cause illnesses as typhoid fever, dysentery and cholera. Then the

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treated wastewater is used for gardening, irrigation and recreational purposes.

Dimensions and specifications of the treatment units:

Screen chamber: It is provided with 20 mm equal spacing made from 6 mm thick MS flats.

Equalisation tank: One rectangular tank of 8 m length, 6 m width and 2.5 m liquid depth.

Aeration tanks: Three numbers of aeration tank of 8 m length, 5 m width and 2.5 m depth each are provided. There are three numbers (2 on duty and 1 stand by) of blowers with capacity of $175 m^3/h$ and $0.4 kg/cm^2$.

Settler tank: It was one number constructed with RCC and size of rectangular tank was 8 m x 5 m x 2.5 m

Sludge drying beds: There are five identical RCC rectangular tans, having 2.5 m x 2 m x 1 m.

Raw water tank: It was constructed with RCC and size of rectangular tank was 8 m x 4 m x 2 m

Pressure filter and carbon filter: These filters have capacity of 35 cumecs each.

Treated water tank: It consists of one rectangular tank of 8 m length, 5.5 m width and 4.5 m depth.

In view of the above scenario, the present study has been undertaken to find actual treatment ability of STP by collecting and testing samples in various treatment units. In addition to give suggestions for further to improve the efficiency of STP.

II. MATERIALS AND METHODS

Performance appraisal has been carried out for a period of eight months (September 2009 to April 2010) by comparing the concentrations of pollutants at the inlet and outlet of the treatment unit. The grab samples were collected once in a month of September, November, January, March and April and composite samples in the month of April.The samples were collected at five different units of the treatment plant, namely, a) Influent to the treatment plant, b) Effluent of i) aeration tank ii) settler tank iii) pressure filter unit and iv) outlet unit, and analyzed as outlined in the standard methods for the examination of water and wastewater [4]. The samples were analyzed for various parameters like pH, 5-day BOD, COD, TSS and TDS.

III. RESULTS AND DISCUSSION

3.1 Biological oxygen demand

Fig. 2 shows the variation of BOD pattern from influent to effluent of STP. The BOD values decreased in the effluent

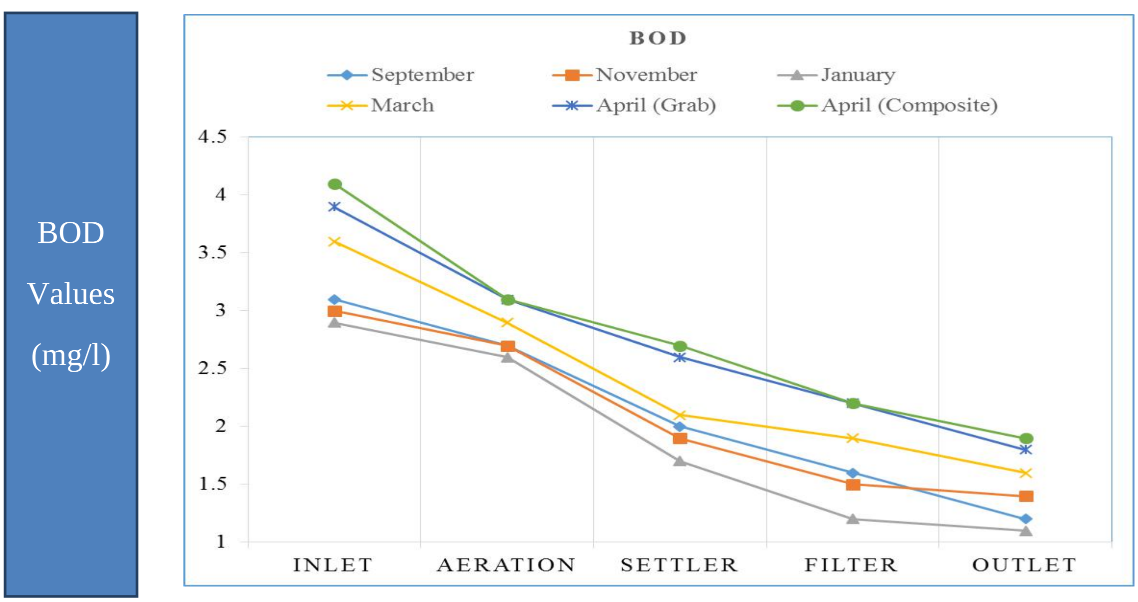

Fig. 2 Variation of BOD during the period of data collection

coming from various treatment units. It has been observed that BOD values in the month of April are higher than the remaining months. The treatment efficiency for the composite sample collected in the month of April reduces ~ 25% by aeration unit and overall reduction takes place by 54%. The aeration tank is considered as a most important step in activated sludge process as it provides DO to the sewage, facilitates rapid decomposition of organic matter.

Table 1. Average efficiency of STP during observation period.

Parameter	Treatment efficiency (%)			
	Aeration	Settler	Filter	Outlet
BOD	15.15	37.57	49.09	56.96
COD	8.22	28.51	54.84	67.77
TDS	2.93	5.8	9.69	11.54
TSS	14.7	33.33	38.57	40.43

Table 1 shows that 57% of average BOD reduction takes place in the STP during the observation period against the expected value of 70-85%. This slight decrease is attributed to the recycling of old sludge that contains fewer microorganisms, besides insufficiency of Mixed Liquor Suspended Solids for the aerobic digestion of the organic matter [5].The microorganisms such as bacteria are responsible for decomposing of organic waste in the sewage. The tolerance limit for sewageeffluent discharged into surface water sources and public sewers as 20 mg/l [6]. However, sewage from JUET campus has been observed maximum value of BOD as 4.1 mg/l indicates does not require any treatment.

3.2 Chemical oxygen Demand

Fig.3 represents variation of COD pattern during the period of testing the performance. This figure illustrates the decreasing of COD values of influent at end of different treatment units. The influent COD values varies between 40.1 to 47.6 mg/l. Table 1 shows organic matter in the form of COD decreased by 8.22%, 28.51%, 54.84%, and 68% at the end of aeration unit, settler unit, pressure filter unit and outlet unit respectively.Table 1 shows that 68% of average

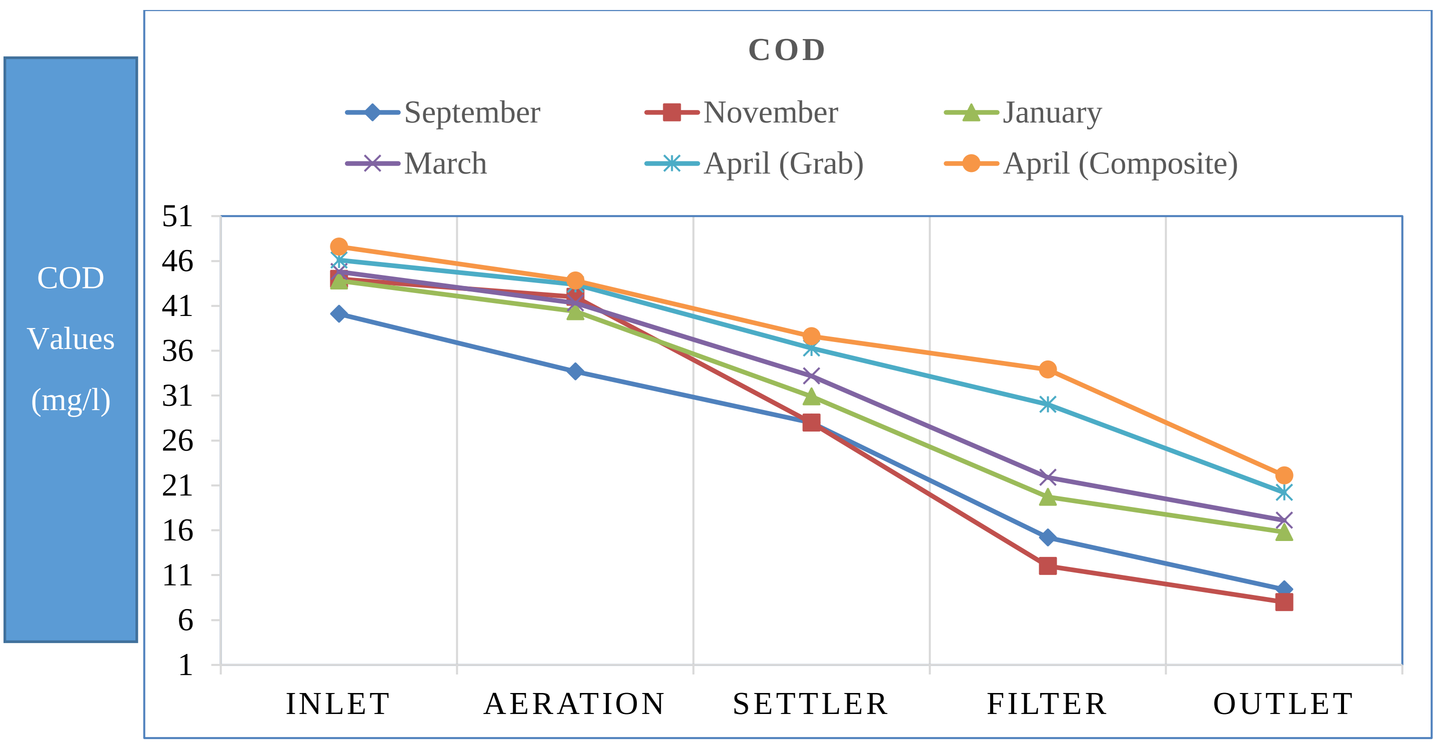

Fig. 3 Variation of COD during the period of data collection

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COD reduction takes place in the STP during the observation period against the expected value of 70-80%. This may be attributed to insufficient number of microorganisms present in the aerobic unit. The tolerance limit for sewage effluent discharged into surface water sources and Public Sewers as 250mg/l [6]. However, sewage from JUET campus has been observed maximum value of COD as 47.6 mg/l indicates does not require any treatment.

3.3 TSS & TDS

The average values of TSS and TDS in the influent sewage are 12.2 mg/l and 293 mg/l respectively. Table 1 shows TSS are removed by 14.7%, 33.33%, 38.57%, and 40.43% at the end of aeration unit, settler unit, pressure filter unit and outlet unit respectively. The maximum reduction in TSS is 40.43% against the expected value of 85-90%. The TDS are removed by 2.93%, 5.8%, 9.69%, and 11.54% at the end of aeration unit, settler unit, pressure filter unit and outlet unit respectively. The percentage reduction in TDS is only 11.54% is much below the expected removal of 70-80% indicating poor efficiency in terms of TDS removal. The sewage contains more quantity of dissolved solids and meager amount of suspended solids. Bouwer [7] reported that removal of TDS is of greater concern as it affects the reuse of wastewater for agricultural purposes, by decreasing the hydraulic conductivity of irrigated land if TDS content in the water exceeds 480 mg/l. The tolerance limit for sewage effluent discharged into surface water sources and Public Sewers for TSS as 30 mg/l [6]. However, influent sewage from JUET campus has been observed maximum value of TSS as 12.2 mg/l indicates does not require any treatment.

3.4 pH

Fig.4 represents variation of pH pattern during the observation period. This figure illustrates the increasing of pH values of influent at end of different treatment units. The minimum value 5.36 observed in the month of April (Grab) and maximum value of 7.7 observed in the month of November. At initial stages, the organic matter in the sewage starts decomposition and release various acids. That is the reason to observe pH values at inlet is between 5.36 and 5.7, indicates in acidic range. Later on the sewage starts stabilization at various treatment units and finally pH values observed on alkaline range.

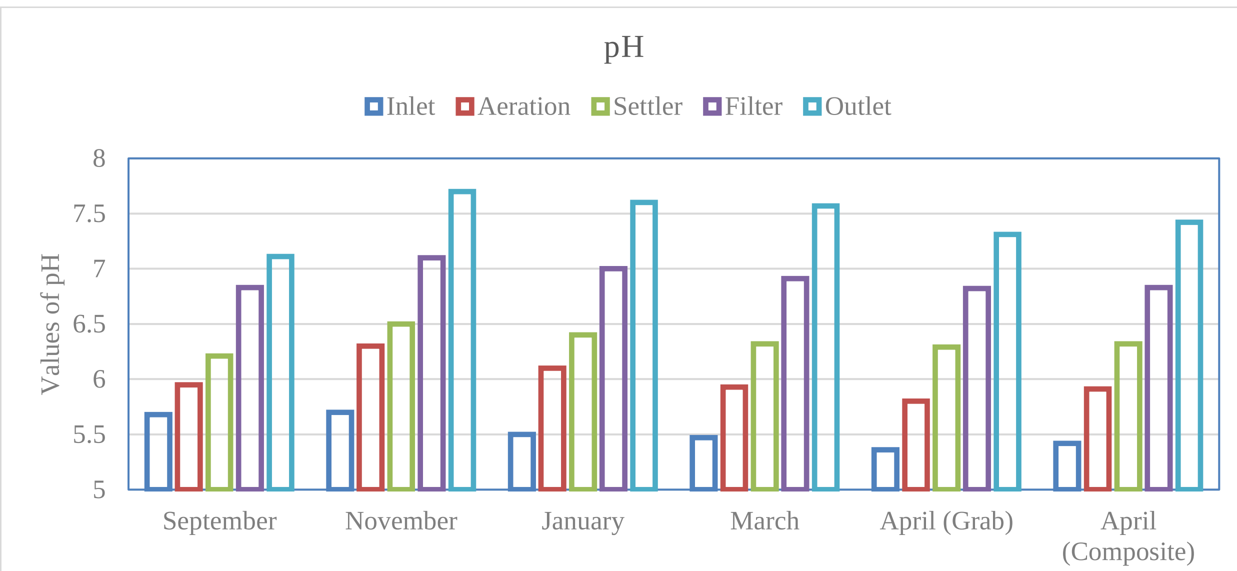

Fig. 4 Variation of pH during the observation period

IV. CONCLUSIONS

The performance studies on the STP located at JUET campus accompanied for a period of eight months indicated overall performance was satisfactory. The BOD, COD, TDS, and TSS average removal efficiency were observed to be 57%, 68%, 12% and 40.43% respectively. In order to achieve better performance, fresh sludge with higher microorganism populations should be recycled and the aerators must be operated continuously. The treated effluent can be safely reused for gardening, and irrigation purposes.

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