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Assessment of waste water quality of sewage treatment plant– A case study

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ABSTRACT

The present study was conducted to evaluate the efficiency and performance of the wastewater treatment plant at JMIT, Radaur. The performance of this plant is an essential parameter to monitor because the treated effluent is discharged for irrigation purposes. Wastewater samples were collected from different unit operations of the plant i.e, the main untreated outlet, primary treated outlet and the final outlet. These samples were analyzed for various physico-chemical characteristics such as pH, TDS, TSS, TS, hardness, alkalinity, DO, BOD. The results obtained have concluded that the waste water treatment plant is efficient in the treatment of waste water. After the final treatment, it is found that the treated water is satisfactory for irrigation. Dissolved oxygen was increased from zero (waste water) to 7.8 mg /litre after secondary treatment. Total alkalinity and biochemical oxygen demand totended to decreased with secondary treatment. Total suspended solids and hardness decreased in treated water.

Keywords: Waste water pollution, physico-chemical parameters, waste water quality

INTRODUCTION

Water is one of the most vital and extensive compounds in the ecosystem. All living organisms on earth need water for their existence and growth. Water is increasingly contaminated by various toxic pollutants due to the increase in the human population, industrial development, the use of fertilizers in agricultureand many other man made activities. It is difficult to fully understand the biological phenomenon because the chemistry of water feeds much of the metabolism of the ecosystem and explains the general hydro-biological relationship (Basavaraja et al, 2011). Sewage makes up almost 99% of the wastewater characterized by the volume or flow velocity, the physical conditions, the chemical components and the bacteriological organisms it contains. Waste water consists essentially of substances such as human waste, food waste, oils, soaps, chemicals and household waste. The assessment of wastewater quality is very crucial to provide safeguards for public health and the environment (Sarswat *et al.* 2015). To minimize risks to health and the environment, these harmful pollutants should be reduced to the allowable limits for safe disposal of waste water. As the availability of fresh water is gradually reduced, the use of wastewater and other industrial waste to irrigate agricultural land increases. For farmers, there are opportunities because the effluents of wastewater of domestic origin are rich in organic matter and also contain appreciable quantities of micronutrients. The pollution and quality of irrigation water are the main concern, especially in regions with limited water resources. In this region, not only, water resources must be used in a prudent manner at the same time, but contamination must be avoided. The changing characteristics of wastewater, due to the discharge of many pollutants, are responsible for the many changes that are taking place today in wastewater treatment. The treatment of wastewater is one of these alternatives, where many processes are designed and managed to simulate natural treatment processes to reduce the pollution load to a level that nature can handle. In this sense, special attention is needed to evaluate the environmental impacts of the existing wastewater treatment plants. With this in mind, the present study was conducted to evaluate the efficiency of the wastewater treatment plant and the quality of wastewater by analyzing the different physico-chemical properties.

MATERIALS AND METHODS

All the samples were collected from the JMIT, Radaur wastewater treatment plant in plastic bottles. During the study, wastewater samples were collected from untreated units, primary treatment and secondary treatment units of STP.

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Seth Jai Parkash MukandLal Institute of Engineering & Technology (JMIT) is located in rural and pollution free green habitat of Radaur, Yamuna Nagar (Haryana). The experimental site of JMIT, Radaur is situated at geographical location of coordinates 30.03^0 N and 77.15^0 E.All the samples were taken to the laboratory and then analyzed for various physico-chemical parameters such as pH, TDS, TSS, DO, BOD, alkalinity, hardness as per the standard methods (APHA, 1998). All analyzes were performed on the same day of the sample collection.

RESULTS AND DISCUSSION

Table 1 showed the physicochemical properties of secondary treated wastewater collected by JMIT, the Radaur wastewater treatment plant.

Table 1: Mean values of different physic-chemical characteristics of waste water

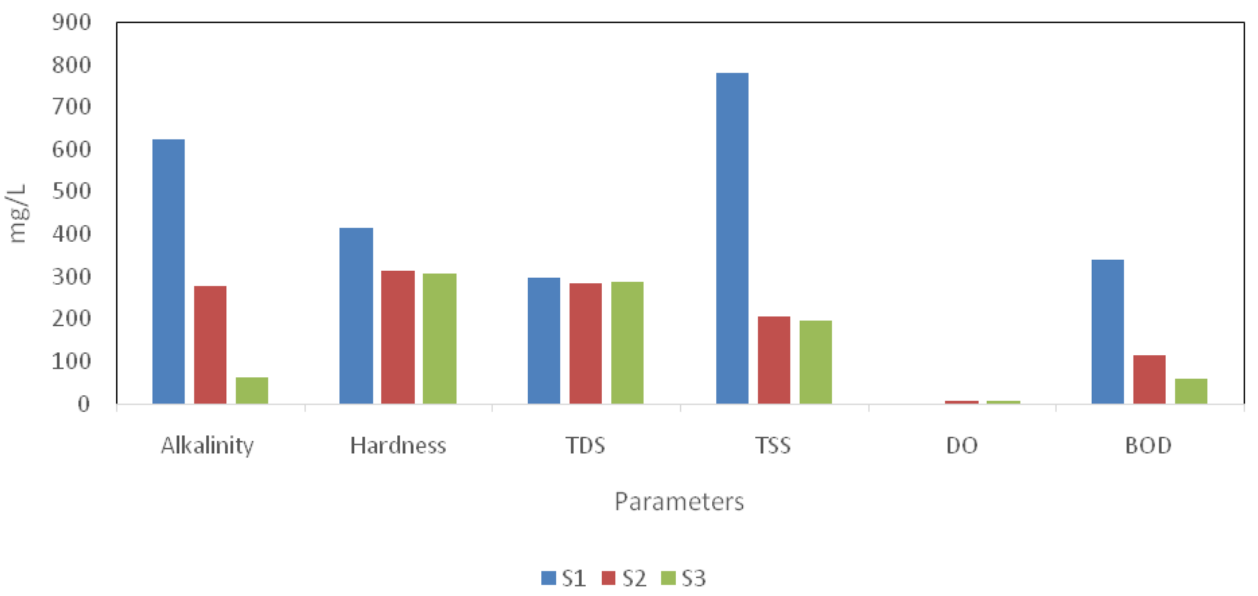
Test Conducted	Untreated Sewage (S1)	Outlet of Primary sedimentation tank (S2)	Treated Effluent (S3)
pH	6.2±0.13	6.0±0.13	5.9±0.14
Alkalinity (mg/l)	623±6.03	278.8±4.86	63.2±3.36
Total Hardness (mg/l)	413.3±3.35	314.18±2.13	306.25±2.33
TDS (mg/l)	297±4.46	284.8±3.16	286.2±3.7
TSS (mg/l)	771.7±4.26	204.5±3.95	194.9±4.3
DO (mg/l)	0	7.3±0.52	7.98±0.44
BOD (mg/l)	338.9±15.41	113.08±5.85	59±5.20

The observed pH values were within the allowed range between 5.9 and 6.2. The wastewater treatment makes it suitable for irrigation on agricultural land. These values are below the allowed limit of the CPCB for irrigation water (5.5-9.0) [Table 2].

Table 2: CPCB Standards for discharge of environmental pollutants

S.No	Parameter	Inland Surface Water	Public Sewer	Land for Irrigation
1.	pH	5.5-9.0	5.5-9.0	5.5-9.0
2.	TSS (mg/l)	100	600	200
3.	BOD (mg/l)	30	350	100

Fig 1 : Parameters of water before and after treatment (S1, S2 & S3)



It was found that the value of the dissolved oxygen obtained in all the untreated samples was zero and after the primary treatment, it increased to 7.3 mg / l, which finally reaches 7.98 mg / l after the secondary treatment. At levels of approximately 5 mg / l of dissolved oxygen, irrigation water is generally considered marginally acceptable for the health of the plants. Most greenhouse crops, however, will work better at higher levels. Levels above 8 mg / l are generally considered good for greenhouse production and much higher levels, up to 30 mg / l or more are obtainable and may be useful. If DO levels are less than 4 mg / l, water is hypoxic and becomes very harmful, possibly fatal, to plants and animals. If there is a serious lack of DO, less than about 0.5 mg / l, the water is anoxic. No plant or animal can survive in anoxic conditions. Irrigation water in many greenhouses has surprisingly low levels, often in the dangerous hypoxic range.

Dissolved oxygen in wastewater is of great importance to all those who support aquatic life and is considered the factor that reflects the biological activity that takes place in water bodies and determines the biological changes caused by aerobic or anaerobic organisms. . In the present study we obtained a zero value of dissolved oxygen influenced in the wastewater treatment plant. This may be due to the mixture of industrial effluents and the discharge of municipal solid waste into waste water. The zero values of dissolved oxygen can also be due to stagnation and lack of rinsing conditions with increasing waste loading through the regular addition of food and pesticides. The DO values obtained from this study are similar to those reported in other cases. The value of dissolved oxygen was found to be low, mainly in the lower layer due to the low production of oxygen and the higher consumption of oxygen dissolved by microbial activity,

Total alkalinity (TA) constitutes an important factor in determining the buffering capacity of a water body. Alkalinity is also significant in determining the suitability of water for irrigation. It is the measure of the water's ability to neutralize acidity. The desirable range for irrigation water is zero to 100 ppm calcium carbonate. Levels between 30 and 60 ppm are considered optimum for most plants. In present study, the average alkalinity value in all untreated wastewater samples was 623 ppm, which decreased to 278.8 ppm after primary treatment which is above the desirable alkalinity limit for irrigation water (0-100 ppm) but after secondary treatment this value is finally reduced to 63.2 ppm.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. Biochemical oxygen demand is determined by incubating a sealed sample of water for five days and measuring the loss of oxygen from the beginning to the end of the test. The main focus of wastewater treatment plants is supposed to reduce the BOD in the effluent discharged to natural waters. Wastewater treatment plants are designed to function as bacteria farms, where bacteria are fed oxygen and organic waste. The excess bacteria grown in the system are removed as sludge, and this "solid" waste is then disposed of on land. During study the authors found that the value of BOD obtained at the entrance is 350 mg / l and after primary treatment it falls to 115 mg / l, which is finally reduced to 65 mg / l. The mean value of BOD after secondary treatment was found within the desired limit (0-100 ppm) of CPCB. BOD was higher in the tributary than the effluent of the water. This could be due to the algae biomass present in the treated effluents. BOD is an indication of the organic wastewater load. The high value of BOD may be due to the extensive use of organic nutrients in untreated wastewater. In general, microorganisms require more oxygen to reduce the high organic nutrients present in wastewater. BOD measures the amount of oxygen required by bacteria to decompose the decomposable organic matter present in any water, wastewater or effluent treated to similar substances.

The magnitude of the total suspended solids and total dissolved solids depends on factors like the type of filter and its pore-size, the physical nature and the particle size of the suspended impurities. etc. The amount of TDS in STP effluent was found to be 284.8 ppm which were less than the desirable limit (< 300 ppm) of Noble Research Institute. The water having TDS value in this range is suitable for all crops, whereas, for TSS the value of untreated sewage is 781.4 mg/l which get reduced to 210.2 mg/l at primary outlet and falls down to safe limit of CPCB i.e. 201.3 mg/l at outlet (0-200 ppm). Hardness does not indicate much about degree of pollution of samples of sewage water. The mean value as obtained at inlet is 413.3 ppm and after primary treatment it falls down to 314.18 ppm which finally reduced to 306.25 ppm.

The results were subjected to statistical analysis using one way ANOVA. The data obtained are summarized and presented here highlighting its variance. Table 3 indicated that except pH, mean values of other physico-chemical properties were significantly different after each treatment (p<0.01). The values of BOD, TDS and TSS are much higher in all samples of untreated waste water which were reduced significantly after the treatments whereas DO values in all the untreated samples were found to be nil. Primary treated samples had considerably higher DO levels and significantly increased (p<0.01).

Table 3: Comparison among waste water samples of various treatment steps using One Way ANOVA test

S.No.	Parameter	P
1.	pH	0.283
2.	Alkalinity	<0.001
3.	Total Hardness	<0.001
4.	TDS	<0.001
5.	TSS	<0.001
6.	DO	<0.001
7.	BOD	<0.001

The treatment efficiency was calculated by using the following formula –

$$\frac{\text{Inlet value in mg/l}}{\text{Outlet value in mg/l}} \times 100$$

The efficiency was calculated by considering BOD, alkalinity, TDS, TSS, DO and hardness of the influent and the final effluent from the STP. The reduction in alkalinity, TSS and BOD was 90 %, 75 % and 83 %, respectively and were changed significantly (p<0.01). The total efficiency of STP for hardness and TSS reducing were 26 % and 04 % respectively which is poor in terms of removal of both of these parameters, however, they changed significantly (p<0.01).

Table 4: Treatment Efficiency

Parameter	Treatment Efficiency (%) except DO
Alkalinity	90
Total Hardness	26
TDS	4
TSS	75
DO	7.98±0.44
BOD	83

From the results, it may be concluded that the treated water can be used as a basis for irrigation without further treatment, since all the standard values for irrigation are justified with the treated values. This study indicates an efficient elimination of certain physico-chemical parameters for STP wastewater, which demonstrates its capacity and effectiveness to maintain the quality of the effluent. The study also reveals that effluents treated with STP can be used for secondary purposes such as irrigation, gardening and safe disposal in bodies of water.

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