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Study of physico chemical parameters before and after sewage treatment by using novel method from an urban town

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Abstract

Sewage is 99 % water carrying domestic wastes originating in kitchen, bathing, laundry, urine and night soil. It is a major point source of water pollution. Current and future fresh water demand could be met by enhancing water use efficiency through treating the sewage. The objective of the study was to develop a novel sewage treatment method and assess and monitor the physicochemical parameters of untreated and treated sewage of sewage treatment plant at Bhiwandi, Dist. Thane, Maharashtra. Various physico chemical parameters such as water colour, temperature, pH, total dissolved solids, transparency, total hardness, total alkalinity, chlorides, calcium, silica, iron, nitrate, nitrite, phosphates, ammonia, carbonates, chemical oxygen demand, biological oxygen demand were determined by standard protocols. Results showed that all the parameters of treated sewage were in the permissible limits. Therefore, the developed novel sewage treatment technique is efficient enough to treat the sewage and make it usable for different human activities.

Keywords: ***Sewage, novel sewage treatment, physico-chemical parameters, water quality.***

Introduction

Wastewater discharged from residences, institutions, and commercial establishments is referred to as sewage. It contains 99.9% water and 0.1 % suspended, colloidal, and dissolved solids. This waste is organic since it is mostly composed of carbon compounds, such as human waste, paper, vegetable matter, etc. (Gautam et al. 2013). When untreated or improperly treated sewage and its related solids are released into surface water bodies it can cause serious water pollution and also could hurt human health. Thus, sewage waste water should be properly treated before disposal (Sathyanarayanan, 2007).
It is common practice in many countries for domestic sewage to be discharged into nearby water bodies, untreated or partially treated (Jamuna and Noorjahan 2009). In India, rapid urbanization and industrialization produce enormous quantities of wastewater. India has a large gap between the generation of sewage and its treatment. Since sewage is released into surface water bodies, they become polluted, and the risk of water contamination and its sanitation problem is increasing every day in most developing countries. Globally, this growing problem of water scarcity negatively impacts economic development, human wellbeing, and environmental quality. Today, protecting water from pollutant contamination or developing cost-effective

remedial methods for its protection has become an essential need for the environment. This wastewater could be treated to provide fresh drinking water and water for other purposes such as gardening, washing, and toilet flushing (Gautam et al. 2013).

Treatment of sewage is a multi-stage process designed to treat sewage and protect natural water bodies. The first wastewater treatment methods were developed to address the adverse effects caused by wastewater discharge to the environment and the concern for public health. Further, as cities became larger and larger, as the population grew, fewer and fewer areas were available for wastewater treatment and disposal, and the amount of wastewater generated rose rapidly. The deteriorating quality of this huge amount of wastewater exceeded the capacity of streams and rivers to handle this waste (Gautam et al. 2013).

Since ancient times, various conventional methods such as chemical precipitation, carbon adsorption, ion exchange, evaporations, and membrane processes have been used for wastewater treatment, but they are highly expensive and inefficient. It is necessary to introduce advanced new technical methods for wastewater treatment in order to overcome the conventional methods (Narmadha et al. 2012; Shivajirao et al. 2012). The present study focuses on the novel treatment method that have proven superior to conventional methods, in particular the low-cost wastewater treatment methods.

In this regard, an attempt has been made to develop a cost-effective sewage treatment method and to evaluate its efficiency by analyzing the different physico-chemical properties of untreated and treated sewage water in Bhiwandi, Dist. Thane (Maharashtra).

Materials and Method

Study area description

The study was conducted in Bhiwandi city. Bhiwandi city is situated in the Thane district of Maharashtra, in the Konkan division, and is 20 km to the north-east of Mumbai and 15 km to the north-east of Thane city. The exact coordinates of Bhiwandi are 19.296664°N 73.063121°E. Bhiwandi-Nizampur City Municipal Corporation is responsible for administering Bhiwandi city, the headquarters of the Bhiwandi Tehsil. Despite its proximity to Mumbai, it does not serve as part of the Greater Mumbai metropolitan agglomeration. The Bhiwandi-Nizampur Municipal Corporation area had a total population of 709,665 according to the 2011 census.

Novel Sewage treatment Technique

A novel cost-effective technique of sewage treatment was developed in this study, in which raw sewage was firstly entered through a big mesh, which allowed large objects of contamination like plastic bottles, polyethene, etc. to be separated, after which the sewage was passed in a 10 feet deep primary sedimentation tank with separating walls, so the sewage was forced to pass upward. The sludge will collect at the narrow end of the tank, which will be removed by opening the cork of the pipe at the bottom.

There are small pores over these big pipes that will create a vacuum, allowing all the sludge to pass through. Now that the sewage is being passed through a deeper (40 feet) sedimentation tank, it will be able to sediment all of the minute particles that were present in the water. In the end, the water has fallen by a considerable height so the water will get oxygenated and then treated effluent will be collected which can be used for different purposes.

Sample collection

Raw and treated sewage samples were collected in 1L plastic bottles, which were carefully rinsed with the respective wastewater samples before collection and labeled properly. On the same day of collection, samples were transported in ice chests to the laboratory.

Physicochemical Analysis

The physico chemical parameters such as water color, temperature, pH, total dissolved solids, transparency, total hardness, total alkalinity, chlorides, calcium, silica, iron, nitrate, nitrite, phosphates, ammonia, carbonates, chemical oxygen demand and biological oxygen demand of the untreated sewage and treated effluent were measured in this study. pH was measured with a pH meter and TDS was measured using a digital TDS meter immediately after the samples were collected. The temperature was noted using a thermometer and transparency was determined using a secchi disk. All other physico chemical parameters of the wastewater samples were analyzed in triplicate by adapting standard procedures from the manual of Indian standard methods of sampling and test (physical and chemical) for water and wastewater (APHA, AWWA and WEF 2005; BIS 2012).

Results and Discussion

The study of physico-chemical parameters is essential to obtain an accurate understanding of the quality of water and to compare the results between different values of physico-chemical parameters with standard values (Bhutiani et al. 2016). Results of various physico chemical parameters observed in untreated sewage and treated effluent by developed novel technique under the present study are presented in table 1. All Parameters in the treated effluent were within the permissible limits. The results indicate that the treated effluent is non-polluted and can be used for different purposes. The schematic presentation of novel sewage treatment technique used in the present study is depicted in fig1. Fig 2 shows the actual site photos of the sewage treatment plant.
Untreated water was blackish in colour which became colorless after the treatment which indicates that it is now somehow clean. The temperature of water affects the concentration of biological, physical, and chemical constituents in it. Therefore, the high temperatures recorded would hasten the decomposition of organic matter in the water. In the untreated and treated sample, it was found to be 27 °C. Water transparency was increased in the present study.
Hardness in water is influenced by the natural accumulation of salts in soil and in geological formation. It may also be a direct result of pollution from industrial effluents. Total hardness was reduced from 177.6 mg/L to 164.01 mg/L in the treated effluent.
Any mineral, salt, metal, cation or anion dissolved in water is referred to as a dissolved solid. The total dissolved solids (TDS) in water primarily consist of inorganic salts (calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and small amounts of organic matter.
TDS was reduced from 350 mg/L to 328 mg/L in the present study.
pH is important in water quality assessment as it influences many biological and chemical processes within a water body (Chapman 1996). Water with a pH value outside of the normal range could cause nutritional imbalances and contain toxic ions that could harm the growth and development of aquatic plants and animals (Bolawa and Gbenle 2012). In the untreated and treated sample pH was in permissible limits.
The Biochemical Oxygen Demand (BOD) is the amount of oxygen required to oxidize the inorganic compounds in water samples to stabilize the organic matter. It can be used as an approximate index of organic pollution. COD (Chemical Oxygen Demand) is the amount of oxygen required by an organic substance in water to be oxidized by a strong chemical oxidant.
If wastewater with high concentrations of BOD and COD is discharged into the water bodies, the water becomes highly contaminated. Significant reduction was observed in BOD and COD in treated water because of proper oxygenation.
The total alkalinity of water is a measure of the amount of acid it can neutralize. Alkalinity in water is generally contributed by the salts of carbonates, bicarbonates, phosphates and nitrates etc. as well as hydroxyl ions in the free state. In the present study, the average alkalinity value in untreated wastewater sample was 234.75 mg/L, which decreased to 211.27 mg/L after treatment.
Chloride, calcium, nitrates, ammonia and phosphates in both treated and untreated effluent were found under the limit. However, these contents in treated water were increased. Silica and iron content were decreased in the treated effluent. Nitrites were not detected in untreated as well as in treated sewage.

Table 1: Physico chemical parameters of untreated and treated sewage

Sr. No.	Parameter tested	Test method	Limit	Untreated	Treated
1	Water colour	-	Colourless or with green hue	Blackish	Colourless
2	pH	IS 3025 (P-11) 1984	6.5-9.5	7.54	7.38
3	Total Hardness (as $CaCO_3$) mg/L	IS 3025 (P-21) 1983	20-180 mg/L	177.6	164.01
4	Chlorides (as Cl), mg/L	IS 3025 (P-32) 1983	31-50 mg/L	42.2	46.57
5	Total dissolved solids, mg/L	IS 3025 (P-16) 1984	300-500 mg/L	350	328
6	Total alkalinity (as HCO_3) mg/L	IS 3025 (P-23) 1986	50-300 mg/L	234.75	211.27
7.	Calcium (as Ca) mg/L	IS 3025 (P-40) 1991	75-150 mg/L	66.18	80.72

8	Silica (as SiO_2) mg/L	IS 3025 (P-35) 1988	4-16 mg/L	5.6	5.26
9	Iron (as Fe) mg/L	IS 3025 (P-53) 2003	0.3-1.0 mg/L	0.45	0.44
10	Nitrate (as NO_3) mg/L	IS 3025 (P-34) 1997	0.1-4.5 mg/L	1.07	2.75
11	Nitrite (as NO_2) mg/L	IS 3025 (P-34) 1997	0-0.5 mg/L	Not Detected	Not Detected
12	Phosphates (as PO_4) mg/L	IS 3025 (P-31) 1988	0.3-0.5 mg/L	0.43	0.48
13	Chemical oxygen demand (COD) mg/L	IS 3025 (P-58) 2006	300 mg/L	280.9	214.01
14	Biological oxygen demand (BOD) mg/L	IS 3025 (P-44) 1993	100 mg/L	93.2	71
15	Ammonia (as NH_3) mg/L	IS 3025 (P-34) 1997	0-0.1 mg/L	0.01	0.03
16	Secchi disk transparency	-	20-35	28	29
17	Water temperature	-	25-32 °C	27 °C	27 °C

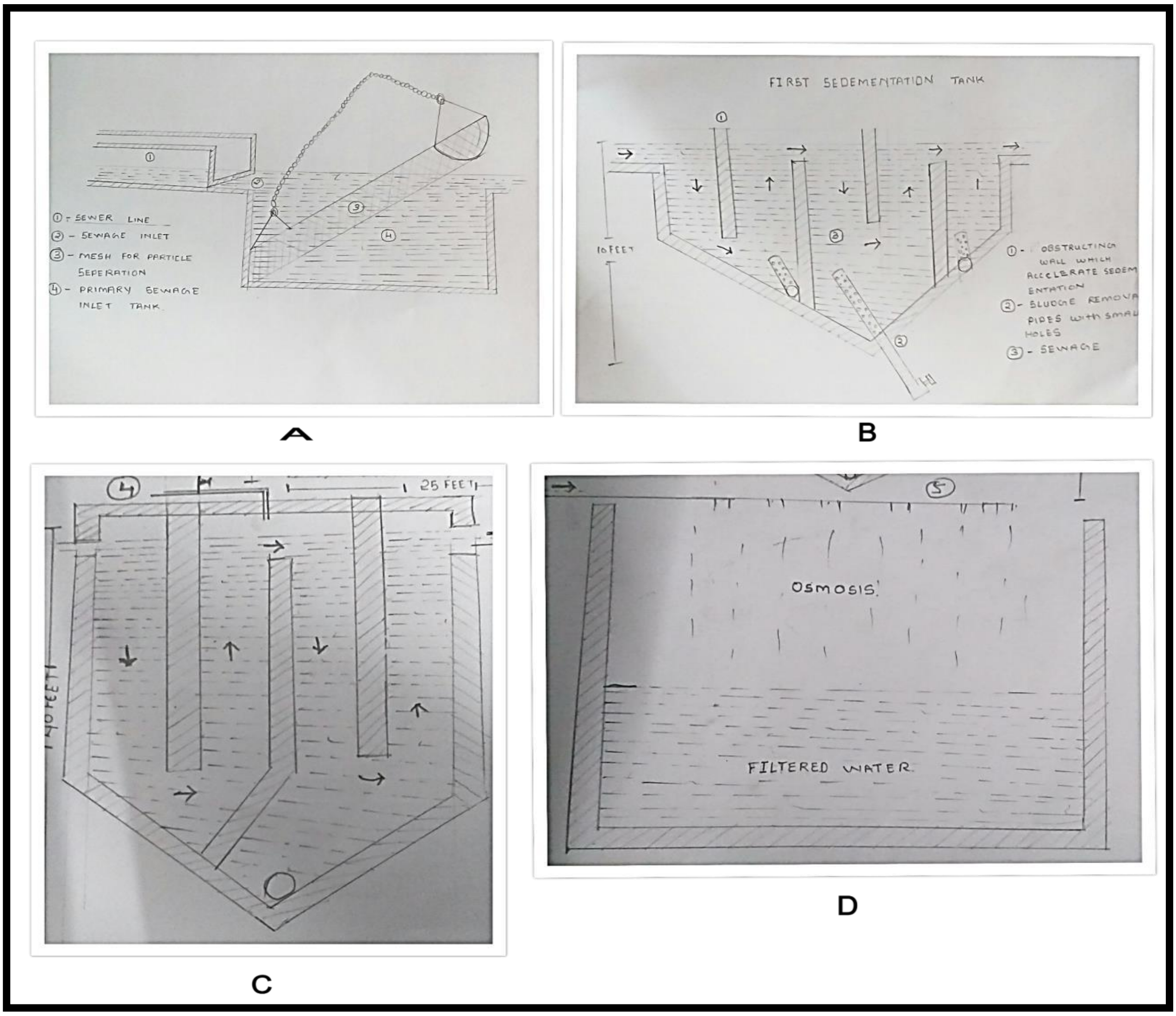

Fig 1: Schematic presentation of novel sewage treatment technique used in the present study

A: Solid particle separation tank
B: First sedimentation tank
C: Second sedimentation tank
D: Final filtered water tank

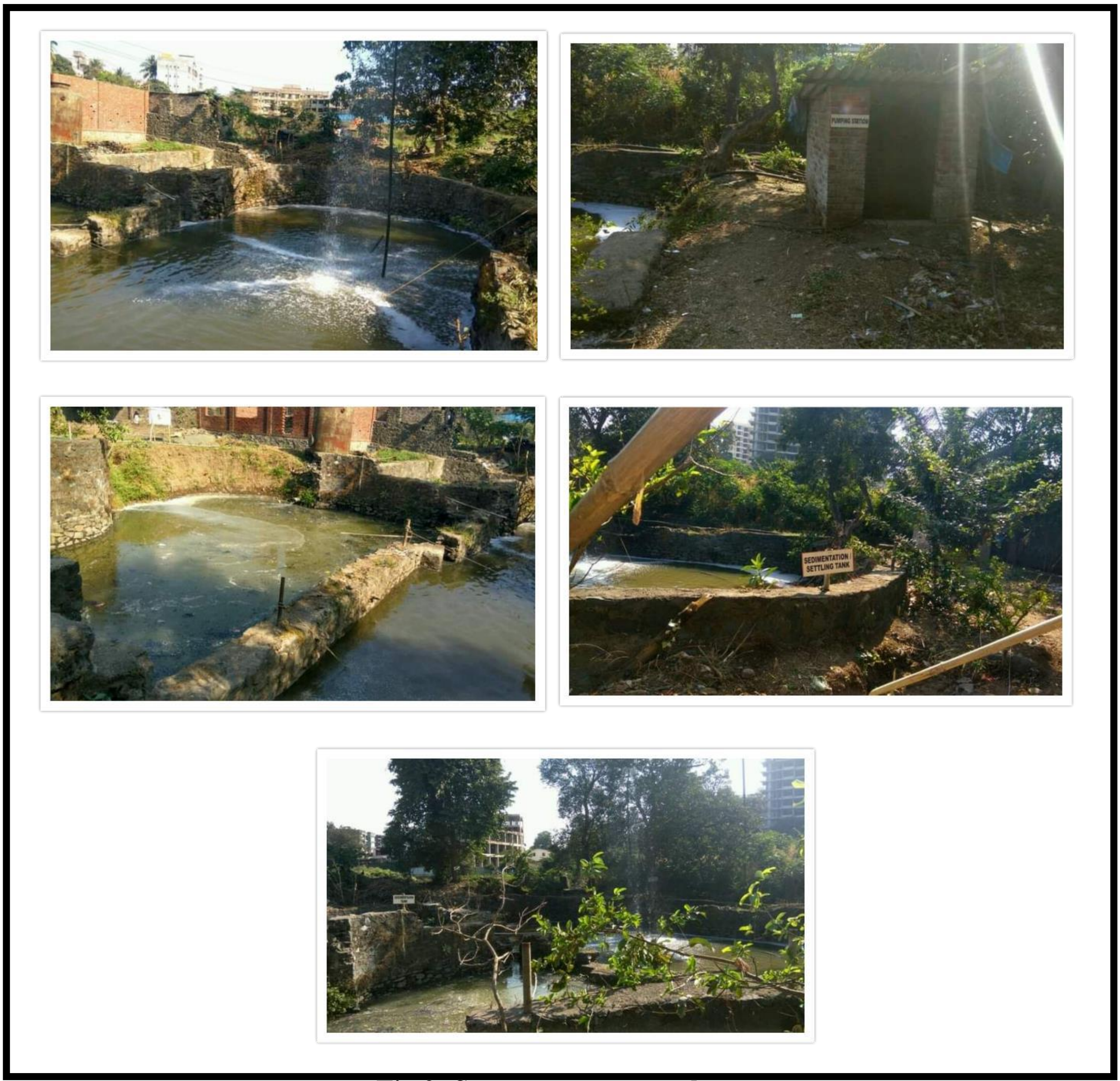

Fig 2: Sewage treatment plant

Conclusion

The availability of clean water is essential for the establishment and maintenance of diverse human activities. Treatment of sewage water can meet the growing demand for water. The treatment of waste water plays an important role and is one of the most effective ways of conserving water, since the treated water can be used for a variety of activities, such as floor washing, irrigation, fish farming, textile processing and gardening, instead of fresh ground and surface water. The results of this study showed that all parameters were within acceptable limits, indicating that the quality of water had been improved. So, the novel technique of sewage treatment is efficient and the treated water can be used for secondary purposes such as gardening, irrigation, and safe disposal in bodies of water. This treated sewage can also replace the ground water used in the textile industry of Bhiwandi which is popularly known as Manchester of India.

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