Environment & Ecology 35 (2A) : 994—998, April—June 2017
Website: environmentandecology.com ISSN 0970-0420

Effluent Quality Assessment at Sewage Treatment Plant (STP), Bhagwanpur, Varanasi

Garima Jhariya, Devendra Mohan, R. M. Singh

Received 28 June 2016; Accepted 25 July 2016; Published online 19 August 2016

Abstract The objective of the present study is to assess wastewater effluent quality from Bhagwanpur STP in Varanasi. Wastewater may be used for agricultural as well as for landscape irrigation purposes therefore, its toxicity potential is quite important. During the course of investigation treated sewage effluents were tested for specific physio-chemical parameters (temperature, pH, EC, TDS, alkalinity, hardness, turbidity, DO, BOD, COD). The findings were compared to relative regulations and guidelines of CPCB regarding wastewater reuse potential. The results of treated water indicate that the wastewater treatment plant is efficient in treating wastewater,and treated water can be used for secondary purposes like industrial cooling and agricultural uses.

Keywords Wastewater characteristics, STP, Effluent and reuse standards, BOD.

G. Jhariya*, R. M. Singh
Department of Farm Engineering, Institute of Agriculture Sciences, Banaras Hindu University, Varanasi (UP) 221005, India

D. Mohan
Department of Civil Engineering, Indian Institute of Technology, Banaras Hindu University, Varanasi (UP) 221005, India
e-mail: gihariya.bhu@gmail.com
*Correspondence

Introduction

Fresh water scarcity is a growing problem in the world and water resources are becoming insufficient to satisfy demand since most of the cases a climate-bound regional problems present all over the world. The demographic growth, urbanization, higher living standards and technological advance have lead to an unprecedented increase in water demand, not only for domestic but also for agricultural and industrial use, thus in many places fresh water is not sufficient to meet high demand; therefore alternative water resources must be found. Taking into account that high water consumption increases the volume of wastewater generated [1, 2] therefore treated municipal wastewater could be significant alternative water resource. Wastewater reclamation and reuse (water recycling) constitutes an increasing practice in areas of deficient water balance [3, 4] such as in European and Mediterranean regions. Reuse projects also exist in Japan, USA and Australia [5]. Benefits apart, reclaimed wastewater is usually of poor quality compared with fresh water depending upon its source and treatment. Reclaimed waste water may contain high concentrations of salts, heavy metals or pathogenic organisms. Common municipal wastewater treatment can remove large fractions of organic matter, suspended solids, nutrients (nitrogen and phosphorus) and trace contaminants (organic and inorganic) [6].

Recycling of wastewater and grey water generated from factories and households into agricultural use could not only save irrigation water but also reduce pollutant load in a basin, and is expected to

contribute to preservation of the water environment [3]. Several decades ago, when sewage-treatment had not popularized, sewage water drained untreated into canals and grey water was reused for irrigation and excreta as manure in agriculture had caused serious water pollution, the most important concerns in the agricultural use of treated urban waters [7] are related to the human and environmental health aspects, in other words, the quality and safety of the produced food [8] and the health concerns of agricultural workers. Other concerns include the salinity and water infiltration rate in the soil [9] as well as heavy metal accumulation and pollution caused by nutrients leaching [10]. In fact, secondary treated municipal sewage contains dissolved solids, heavy metals, pesticides and pathogens that might jeopardize sustainable agriculture, groundwater quality, soil quality and human health, in addition to the nutrients that are beneficial for agriculture up to certain concentrations. However, the existence of such techniques is not enough to guarantee that proper application of treated effluent for reuse purpose. The quality of the water treated through the treatment plants should match with the standards before realizing it for irrigation or disposed of in any system. Therefore an attempt has been made to analyzed the quality of treated sewage effluent (TSE) to avoid any ill effects to crops, human beings and the environment.

Materials and Methods

The study conducted at Bhagwanpur sewage treatment plant (STP), situated in the southern part of Varanasi near Banaras Hindu University and the river Ganges, which comes under Ganga Action Plan. This Bhagwanpur STP were designed to treat 8 MLD sewage daily using activated sludge process. The quality of the water treated through the treatment plants should matches with the slandered CPCB/BIS before realizing it for irrigation, industrial purpose in discharge in to the river system.

Sample collection and analysis

The manual sampling of secondary treated municipal sewage carried out on monthly basis from May 2014 to June 2015 in a plastic bottle from Bhagwanpur STP. The container was washed with 20% nitric acid (HNO_3) followed by distilled water and rinsed twice with the sample to be collected before being finally filled. Five thousand mL of sewage sample was collected and transported in an icebox immediately brought to the laboratory for analysis using standard techniques for physio-chemical parameters.Samples were stored in polyethylene bottles with 2 or 3 drops of toluene to stop microbial activity. The pH and electrical conductivity (EC) were determined immediately after bringing the samples to the laboratory, physio-chemical parameter like pH, electrical conductivity, TDS, total hardness, calcium, chloride and alkalinity were determined as per standard method [11], the measurements were made in triplicate. Date obtained from the analysis were statistically analyzed for mean, standard deviation (SD), maximum and minimum of all parameter.

Results and Discussion

It is fact that maintenance of healthy ecosystem is dependent on the physio-chemical properties of water. In the present study, a comparative analysis of physio-chemical characteristics of secondary treated municipal sewage from Bhagwanpur STP, physical characteristics (Temperature, pH, turbidity, conductivity and total dissolved solids (TDS) in conjunction with chemical characteristics such as DO, BOD, COD, hardness, and alkalinity of the water quality has been assessed and the results of analysis were summarized in Table 1 temporal variations of phyiso-chemical characteristics of TSE are sowing in Figs 1 to 6.

Temperature

In an established system the water temperature controls the rate of all chemical reactions. Mean value of temperature in the study period found to be 30.217 with the standard deviation of 6.14. The minimum and maximum values were recorded as 19.5^{o}C and 38.6 ^{o}C respectively in the month of Jan and May (Fig. 1). This higher temperature is due to greater heating, variation is mainly related with the atmosphere temperature and weather conditions.

pH

Measurement of pH is one of the most important and frequently used tests in water chemistry, during the

Table 1. Physico-chemical characteristics of analyzed wastewater.

Parameter	Mean	Standard deviation	Minimum	Maximum	CPCB/IS permissible limits
Temp (^{0}C)	30.22	6.14	19.50	38.60	40[a]*
pH	7.45	0.33	6.87	7.93	6.0-8.0[b]
Turbidity (NTU)	10.09	3.12	5.50	15.00	5
EC (dS/m)	0.71	0.15	0.50	0.98	2.25
TDS (mg/L)	454.00	96.54	318.00	624.00	2,100.00[a,b]
Alkalinity (mg/L)	189.92	14.87	163.00	211.00	600
Hardness (mg/L)	164.67	14.62	143.00	182.00	600
BOD (mg/L)	12.50	2.77	9.20	17.60	100[a]
COD (mg/L)	65.44	6.83	54.00	78.00	250[a]
CI- (mg/L)	34.75	10.16	19.00	49.00	500[b]

period of investigation mean value of pH of TSE recorde 7.45 with minimum and maximum value of pH are 6.87 and 7.93 respectively in the month of Jan and August (Fig. 2). There are not any major industries or mining activities in the area that could cause extreme changes in the pH of the effluents or of the receiving water. Thus, the results obtained for pH measurements in the water and in the effluent discharges were as expected.

Turbidity

Turbidity is the amount of particulate matter that is suspended in water, mean value of turbidity of wastewater found to be 10.09 NTU with the standard deviation of 3.12 and the minimum value is 5.5 NTU in the month of May and the maximum value is 15 NTU in the month of August (Fig. 3). The turbidity values were found higher than WHO standard of 5 NTU [12]. The extreme turbidity in water can cause problem with water purification processes which may increase treatment cost. Furthermore, the months of July to October, gave higher turbidity values, as more water volume flow due to rain and also mixing of colloidal, suspended matter and plankton through the runoff sewage.

Electrical conductivity

Wastewater effluents often contain high amounts of dissolved salts from domestic sewage and the EC of water is a useful and easy indicator of its salinity or total salt content. The mean value of EC found to be 0.711 dS/m with the standard deviation of 0.152 and the minimum and maximum values of EC were observed as 0.5 and 0.98 dS/m respectively in the months of July and Dec (Fig. 4).

Total dissolved solids

Mean value of TDS of wastewater founds to be 454 mg/L with the standard deviation of 96.54 and the minimum and maximum values are 318 mg/L and 624 mg/L respectively in the months of Jun and Dec (Fig. 5). High values of TDS indicate that the pretreatment done to the wastewater is not enough and it needs to be improved.

Alkalinity

Mean value of alkalinity of TSE founds to be 189.92 mg/L with the minimum and maximum values of alkalinity were 163 mg/L and 211 mg/L respectively in the months of July and Jan (Fig. 5). Here the higher variation in alkalinity of wastewater found throughout the year.

Hardness

Presence of calcium, magnesium and chlorides in the domestic wastes is the major contributor of hardness [13]. Mean value of hardness of TSE founds to be 164.67 mg/L with the standard deviation of 14.618 which is very high shows higher variation in hardness of wastewater throughout the year. The minimum and maximum values of hardness are 143 mg/L

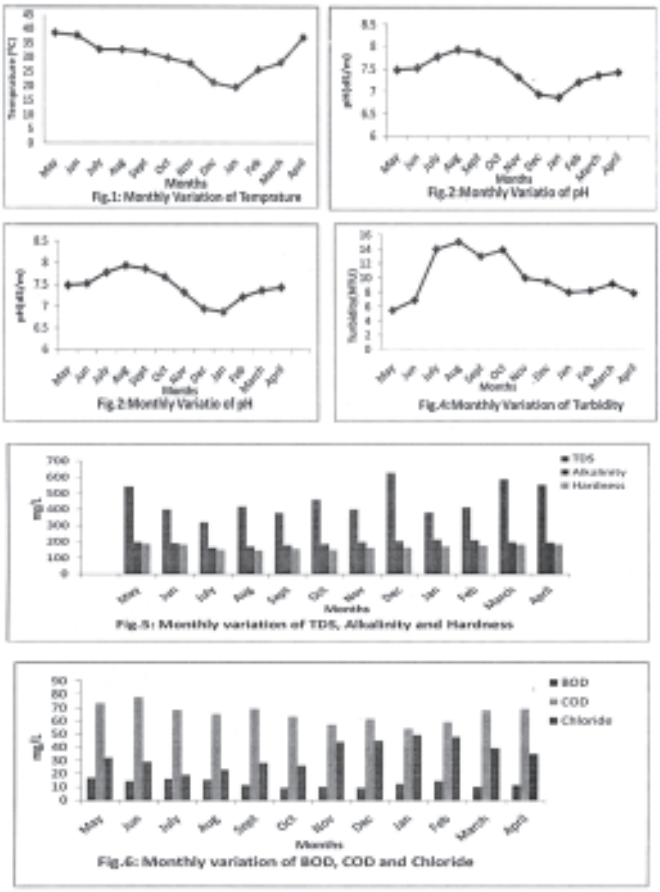

Fig. 1. Monthly variation of Temprature. **Fig. 2.** Monthly variation of pH. **Fig. 3.** Monthly variation of pH. **Fig. 4**. Monthly variation of Turbidity. **Fig. 5.** Monthly variation of TDS, Alkalinity and Hardness. **Fig. 6.** Monthly variation of BOD, COD and Chloride.

and 182 mg/L respectively in the months of Aug and May (Fig. 5). Furthermore, generally the water can be said to be hard and therefore unsuitable for both domestic and industrial use as there exists possibility of scale formation in boilers and pipes.

Chloride

Like other ions, high levels of chloride can have negative effects on an ecosystem and is also one of the important indicators of fecal pollution present in sewage, effluents and farm drainage [14]. The result of analysis shows the mean value of chloride of wastewater from Bhagwanpur STP is 34.75 mg/L with the standard deviation of 10.16 (Fig. 6).

Biochemical oxygen demand

BOD determination is an empirical test in which standardized laboratory procedures are used to determine relative oxygen requirements of wastewater. Mean value of BOD of the treated sewage effluent was recorded as 12.5 mg/L with the standard deviation of 2.77 and the minimum and maximum values of BOD are 9.2 mg/L and 17.6 mg/L respectively in the months of May and Dec (Fig.6).

Chemical oxygen demand

COD test is used to measure the content of organic matter of both wastewater and natural water. Mean

value of COD were found to be 65.44 mg/L with the standard deviation of 6.828 having minimum and maximum values of COD are 54 mg/L and 78 mg/L respectively in the months of Jan and June (fig. 6). COD changes according to season and values found to be beyond the permissible limit in the investigation period.

Conclusion

The quality evaluation of secondary treated municipal sewage from Bhagwanpur STP revealed that the temperature, pH, EC, TDS, alkalinity, hardness, DO, BOD and COD contents were found mostly within the limits set by both national and international standard regulatory bodies (CPCB, ISI) for water reused potential. Therefore the study recommends the treatments of municipal sewage effluent before letting into the open drainage or releasing it for agricultural use sewage wastewater, if treated properly with reduced BOD and turbidity can be provided as alternate source of water for irrigation. The Bhagwanpur STP is efficient in treating wastewater and treated municipal wastewater could be significant alternative water resource.

References

1. Quadir M, Wichelns D, Raschid-Sally L, McCornick PG, Drechsel P, Bahri A, Minhas PS (2010) The challenges of wastewater irrigation in developing countries. Agric Water Manag 97 : 561—568.
2. Menese M, Pasqualino JC, Castelsa F (2010) Environmental assessment of urban wastewater reuse: Treatment alternatives and application. Chemosphere 81 : 266—272.
3. Angelakis AN, Bontoux L, Lazarova V (2003) Challenges and prospectives for water recycling and reuse in EU countries. Water Sci and Technol : Water Supply 3: 59—68.
4. Oron G (2003) Agriculture, water and the environment: Future challenges. Water Sci & Technol : Water Supply 3 : 51—57.
5. European Commission (2004) Water reuse system management manual AQUAREC. Office for Off Publ of the Euro Commun.
6. National Research Council (1996) Use of reclaimed water and sludge in food crop production. Nat Acad Press, Washington, DC, pp 1—119.
7. Dobrowolski J, Neill M, Duriancik L, Throwe J (2008) Opportunities and challenges in agricultural water reuse: Final report. USDA-CSREES 89.
8. Pedrero F, Kalavrouziotisb I, Alarcon JJ, Koukoulakisb P, Asanoc T (2010) Use of treated municipal wastewater in irrigated agriculture – review of some practices in Spain and Greece. Agric Water Manag 97 : 1233—1241.
9. Westcot T (eds). Irrigation with reclaimed municipal wastewater a guidance manual. Lewis Publ, Inc, Chelsea, MI.
10. Fatta-Kassinos D, Kalavrouziotis IK, Koukoulakis PH, Vasquez MI (2011) The risks associated with wastewater reuse and xenobiotics in the agroecological environment. Sci of the Total Environ 409 : 3555—3563.
11. APHA (2005) Standard methods for examination of water and waste water 21 edn. Am Publ Hlth Assoc Washington, DC, USA.
12. World Health Organization (WHO) (1989) Technical Report Series 778.
13. Murali M, Satyanarayana T (2001) A study on source of water pollution at Machilipatnam AP. Poll Res 20 : 471—473.
14. Agarwal AK, Rajwar GS (2010) Physico-chemical and microbiological study of tehri dam reservoir, Garhwal Himalaya, India. J Am Sci 6 : 67—71.
15. Indian standards for water quality (2009) Implemented under Eco-housing mainstreaming partnership by IIEC with funding support from USAID, pp 11624—1986.
16. CPCB Environm building guidelines for greater Hyderabad-Ver 1.2 (2010).