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Study of Physico-Chemical Parameters of the Effluent from the Wastewater Treatment Plant Hetauda and Karra River Water

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KEYWORDS

Wastewater treatment plan
Effluent
Total suspended solids
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ABSTRACT

The outcome of the wastewater treatment plant (WWTP) on its usual operation was evaluated in the month of December with the help of its comparison with the running water of Karra River and with the influent from the industries located at Hetauda Industrial District (HID) area. The comparative study of water quality on the basis of their Physico-chemical parameters were carried out for final industrial waste water (S1) before entering the treatment process, waste water after the final treatment procedure (S2) and water sample from the downward stream of Karra river after the mixing of the effluent from the treatment process (S3). The sampling and other experimental processes were carried out. The parameters like temperature of the sample, turbidity, colour, odour and PH values were calculated at the respective sites while the remaining ones were carried out in the chemistry laboratory of Makawanpur multiple campus, Hetauda. The parameters like conductivity, total suspended solids, Hardness and chemical oxygen demand were calculated following standard procedures.

1. INTRODUCTION

The river flowing through the juncture of industrial estate and human residential area suffers a great deal of pollution. One of the key factors affecting the pristine nature of river water is industrial wastes in such areas. In order to minimize the probable hazard of this type of contamination is to treat the industrial waste water in waste water treatment plant. Human actions on freshwaters are deliberately causing the detrimental effects and as a result, water resources on earth are diminishing (perks A.R., 2004). The level of contamination for waste water occurs in physical, chemical and biological composition which can damage many ecosystems and habitations of various animals (Tee, et al., 2015). Many countries face the problem of direct discharging industrial effluents in water (AK, 2001). The study of river water sample is required for understanding the factors that influence the quality of water such as hydrological and anthropogenic (Venugopal, Giridharan, Jayaprakash, & Velmurugan, 2009). A waste water treatment plant comprises generally three sections- catchment area (households, industry, etc.), a sewer system and receiving water (Dominguez & Gujer, 2006).

The current study fits the understanding of impact of wastewater treatment plant in minimizing the rate of pollution and thereby supporting the persistence of aquatic ecosystem. The wastewater from the Hetauda Industrial District (HID) which was established in 1963 used to be discharged directly in Karra river because of the unavailability of such treatment plant (Ghimire, 1985). There are also a few numbers of wastewater treatment plants in Kathmandu valley (R, Haberl, Laber, Manandhar, & Mader, 2001). The effluents from the wastewater treatment plant contains various gaseous solutions of oxygen, carbon dioxide and chlorine as well as salts of calcium, magnesium, sulphur and other bicarbonates (Kalavrouziotis & Apostolopoulos, 2007). The natural wastewater treatment plant in Hetauda, established in 2002-2003 at HID area, by the Government of Denmark, consist the combination of both anaerobic and aerobic flow through lagoons systems. This WWTP involved self-mixing and natural aeration system along with the longer retention time and sunlight UV sterilization process for its operation. The WWTP proceeds in three ways – mechanical treatment, biological treatment and sludge treatment. However, the wastewater treatment plants are with the new challenges due to the tighter wastewater discharge limits (Corona, Mulas, Haimi, Sundell, Heinomen, & Vahala, 2013) . The requirement of comparative study ensures the improvement of treatment system and aids the value for the sustenance of freshwater ecosystem. Every year one and a half million children die especially because of diarrhea due to the lack in safe drinking water (WHO, 2009) . This disease is also being problematic in Nepal in case of children (Diwakar, Yami, & Prasai, 2008). Therefore, there is a dire need of study in this area.

2. METHODOLOGY

2.1 SAMPLE COLLECTION

The three water samples – S1, S2 and S3, were collected from the industrial sewages that initially enters the wastewater treatment plant(S1), effluent from the plant(S2) that is about to enter the river finally and the river water that is mixed with wastewater (S3) after the treatment process respectively. The collection is carried out with sterilized and airtight bottles. The wastewater treatment plant in HID and Karra River were selected in the month of December for such procedure. Time difference for each sample collection was found 10 minutes.

2.2 PH AND CONDUCTIVITY

In order to calculate the hydrogen ion concentration present in the corresponding water samples, their respective pH values were calculated using the calibrated digital PH meter (HANNA instruments) on the sites. The conductivity measurements were carried out using the digital conductivity meter (Y.P. scientific industry). The conductivity tests were carried out based on standard protocol (Gupta, 2002).

2.3 TOTAL SUSPENDED SOLIDS (TSS)

The gravimetric method (Gupta, 2002) was carried out to calculate the total suspended solids value. This experiment comprised the usage of a known weight of Whatmann filter paper (no.41) to filter the known volume of the sample. The residue was dried in an oven at about 80°C for about 24 hours. The final weight of filter paper was calculated and TSS value was calculated as follow: -

$$TSS = \frac{(W2-W1)}{V1}$$

Where, W2 = final weight of the filter paper.
W1 = initial weight of the filter paper.
V1 = volume of the sample in mL.

2.4 CHEMICAL OXYGEN DEMAND

The calculation of Chemical Oxygen Demand was carried out based on standard procedures (J, Denney, Barnes, & Thomas, 2000). The method involves the titration of sample with Mohr's salt using ferroin as an indicator. The indicator was added 2 drops and the endpoint was determined by the colour change from bluish green to reddish blue. For each sample, 20 mL sample was added with 10 mL $K_2Cr_2O_7$ solution along with 30 mL of H_2SO_4 and a pinch of $AgSO_4$ and $MgSO_4$ was added finally. The mixture was heated in a water bath for about 2 hours by connecting with a reflux condenser. The final step involved the cooling of the heated mixture and dilution to 150 mL with distilled water. For every sample a blank titration of Mohr's salt was carried out. The calculations were done using the following relation: -

Chemical oxygen demand (COD)= $\frac{(V1-V2)XNX1000X}{V3}$

Where, V1 = volume of Mohr's salt for blank titration in mL.

V2 = volume of Mohr's salt for sample mL.

V3 = volume of sample in mL.

N = normality of Mohr's salt.

2.5 TOTAL DISSOLVED SOLID

The total dissolved solids present in the given sample were calculated using the standard procedure (Gupta, 2002). The filtrate from the TSS test was evaporated in an oven at 105°C for 24 hours and the final weight of the crucible was noted. The TDS value was calculated as follow: -

TDS = $\frac{(final\ weight-initital\ weight)}{volume\ of\ sample\ taken\ in\ mL}$

3. RESULTS AND DISCUSSION

Table 1: *Different parameters of sample 1 (S1)*

Parameters for sample from industries (S1)	National drinking water quality standard 2079 B.S.	Lab test results
PH	6.5-8.5	7.5
Electrical Conductivity	1500 µS/cm	1359 µS/cm
Total suspended solids (TSS)		44 mg/L
Total Hardness	500 mg/L	132 mg/L
Chemical Oxygen Demand (COD)	mg/L	214 mg/L
Temperature (°C)		23
Colour	5 TCU	Yellow
Odour	Non-objectionable	Objectionable
Turbidity	5 NTU	
Total Dissolved Solids (TDS)	1000 mg/L	556 mg/L
Total solids (TS)		600 mg/L

Table 2: *Different parameters of sample 2 (S2)*

Parameters for sample (effluent) from WWTP (S2)	National drinking water quality standard 2079 B.S.	Lab test results
PH	6.5-8.5	7.3
Electrical Conductivity	1500 µS/cm	1640 µS/L
Total suspended solids (TSS)		100 mg/L
Total Hardness	500 mg/L	652 mg/L
Chemical Oxygen Demand (COD)	mg/L	180 mg/L
Temperature (°C)		19
Colour	5 TCU	Light yellow
Odour	Non ojectionable	Odourless
Turbidity	5 NTU	
Total Dissolved Solids (TDS)	1000 mg/L	400 mg/L
Total solids (TS)		500 mg/L

Table 3: *Different parameters of sample 3* (S3)

Parameters for sample from Karra river mixed with effluent (S3)	National drinking water quality standard 2079 B.S.	Lab test results
PH	6.5-8.5	7.2
Electrical Conductivity	1500 µS/cm	283 µS/L
Total suspended solids (TSS)		1300 mg/L
Total Hardness	500 mg/L	120 mg/L
Chemical Oxygen Demand (COD)	mg/L	254 mg/L
Temperature (°C)		22
Colour	5 TCU	Colourless
Odour	Non-objectionable	Characteristic smell
Turbidity	5 NTU	
Total Dissolved Solids (TDS)	1000 mg/L	100 mg/L
Total solids (TS)		1400 mg/L

The comparison of the PH values of the three samples shows that the PH shows a descending order from S1 to S3. The highest pH of the industrial sewage is probably due to the higher concentration of hydroxide (OH-) ions in the water. Besides, there is no significant drop in pH in the other samples referring to the mild process of ammonia removal from the sample.

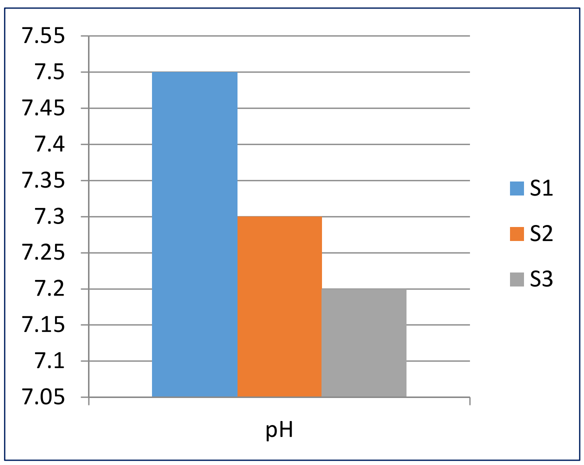

Figure 1: *Comparative chart for PH from different samples*

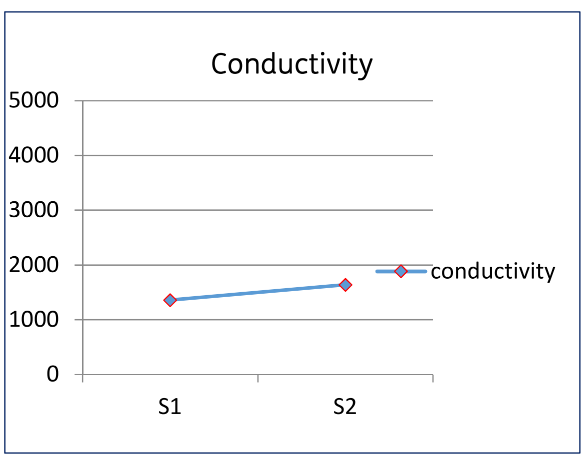

Figure 2: *Comparison of electrical conductivity (µS/cm) of various samples*

The conductivity of the solution describes the presence of free ions which allows the electrical conductance through it. The conductivity of the effluent (S2) is increased which referred the presence of ions in it. The presence of free ions in the sample occurred may be due to adsorption of ions, presence of heavy metal ions and nitrification process.

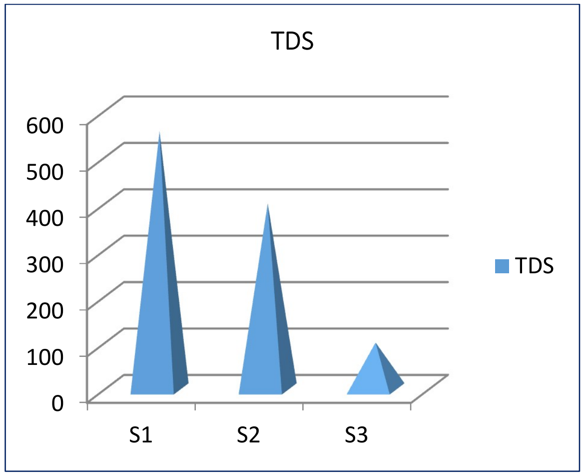

Figure 3: *Comparison of TDS among three samples S1, S2 & S3.*

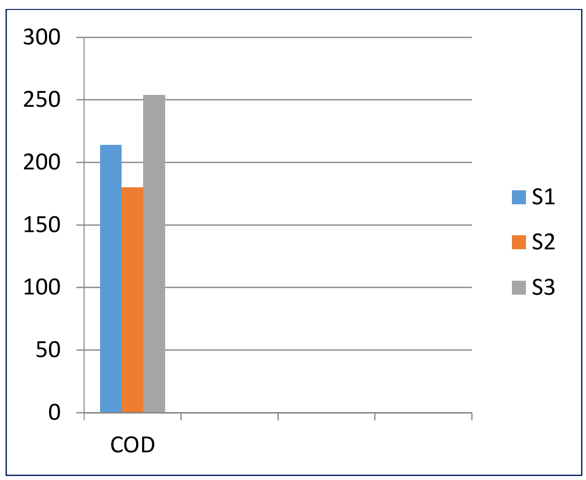

Figure 4: *Comparison of COD of samples S1, S2 & S3*

The chemical oxygen demand (COD) of the sample S1 which is the industrial sewage is higher than that of S1 (effluent). It is because of presence of oxygen as well as other contaminants in the sample. The higher COD value of the river water indicates the polluted condition of the river because of nearby residence and may be the contamination of household and municipal sewages on it.

Table 4: *Statistical view of three samples S1, S2 & S3*

parameters	Mean value	Standard deviation	Relative standard deviation (RSD)	Coefficient of variation (CV)	Standard error
PH	7.17	0.15	0.0209	2.09%	±0.086
TDS	352	231.76	0.66	66%	±134
Electrical conductance	1094	910.51	0.83	83%	±526.30
TSS	481.33	709.54	1.47	147%	±410.14
COD	216	37.04	0.17	17.14%	±21.41
TS	833.33	493.30	0.59	59%	±285.14

Table 5: *Comparison of removal efficiency percentage of various parameters from the wastewater treatment plant at HID*

parameters	Removal efficiency (%)
TDS	20.67
COD	15.89
TSS	127.27
TS	16.66

4. CONCLUSION

The wastewater treatment plant at HID in Hetauda removes the unwanted contaminants, heavy metal ions and minimizes the level of pollution in Karra River. Although it showed the usage of physical removal methods but still it demands the further improvement in methods so as to maximize its removal efficiency. The COD value of effluent from the industrial sewage and that from the wastewater treatment sample effluent is not satisfying and requires further removal steps for contaminants. The electrical conductivity value of S2 sample is astonishingly higher than that of S1.although the results in agreement with the previous researches with the same site water sample (Janardan, Bimal, Nishant, & Sudeep, 2011). However, this anomaly reveals the insufficient removal of the dissolved components. The study resulted that the removal efficiency is highest for the total suspended solids and least for total solids. This clarifies the inefficient removal mechanism for dissolved solids and hence, the river has to suffer a lot more contaminants. There are other treatment plants in Nepal that could be studied comparatively and new technology should be upgraded to operate in its full potential value. The Karra river water is polluted to a degree that it soon reaches the alarming state. There is a need of sewage management from the Hetauda sub-metropolitan municipality as well as from residents nearby river in order to sustain the aquatic ecosystem. The water from the river could not be used for any household purpose because of great chance of water borne disease.

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