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The Impacts of Leather Industry Effluents on The Water Quality of Bhairab River

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Abstract

A river is an important component of the environment that carries fresh water and keeps a boundless significance for harmonizing a suitable environment on this earth. But, most of the rivers of Bangladesh especially near the cities are being polluted through discharging various wastes such as industrial and household wastes without any measure or treatment into it. Bhairab River is one of them which is being extremely polluted. As a result, it has greatly affected the fish culture and irrigation purposes. This study is carried out to investigate the impacts of leather effluents discharging on surface water around the discharged area located at Noapara thana in Jashore of Bangladesh. The water samples are collected at five different sampling points from discharging point to the downstream at a 30-meter distance from one point to another sampling point. Then it is analyzed for various physico-chemical characteristics such as BOD, COD, pH, alkalinity, EC, chromium, nitrate, TS, TSS, TDS, turbidity, etc. using standard method for analysis of water & waste water, 20th edition, APHA, AWWA, WEE, 1998. The maximum value of BOD, COD, pH, turbidity, alkalinity, EC, chromium, nitrate and TSS are 17 mg/l, 22 mg/l, 8.2, 30 NTU, 150 ppm, 800 micromhos/cm, 0.19 mg/l, 4.678 ppm and 57 mg/l respectively. Most of these parameters exceed the WHO and Bangladesh Standard Limit. So, it can be suggested that the collected water is unsuitable for fish culture and irrigation purposes.

Keywords: *Bhairab River; leather effluents; physico-chemical characteristics.*

1 Introduction

The tannery industry belongs to one of the most polluting industrial sector. Almost every tannery industry uses significant amounts of chemicals in the process of transforming animal hides into leather (Dargo and Ayalew, 2014). In Bangladesh, about 90% of tannery industries are engaged in the chrome tanning process because it is simple in operation and renders excellent properties to the leather. The tanning process is almost completely a wet process that consumes significant amounts of water, and generates about 90% of the used water as effluent (Chowdhury et al., 2013). Tannery effluents carry heavy pollution loads due to a massive presence of highly colored compounds, sodium chloride and sulphate, various organic and inorganic substances, toxic metallic compounds, different types of tanning materials which are biologically oxidizable, and large quantities of putrefying suspended matter (Akan et al., 2007; Khan et al., 1999). The tannery effluent damages the normal life of the receiving water bodies and land surface (Cooman et al., 2002). Generally, water consumption is the highest in the pre-tanning areas, but significant amounts of water are also consumed in the post-tanning processes. The soaking stage, the most polluting stage of the tanning process, contributes around 50–55% of the total pollution load of the tanning industry. In the liming stage, protein, hair, skin and emulsified fats are removed from the hides, then are released in the effluent and increase its total solids contents (Chowdhury et al., 2003). The effluents from the tan-yard processes, de-liming and bating contain sulphides, ammonium salts, and calcium salts, and the effluent is slightly alkaline. The pickling and chrome tanning effluents contain sulphuric acid, chrome, chlorides, sodium bicarbonate and sulphates. Several reports show that beam house process effluents contain high concentration of total solids (Gupta 2003; Junior et al., 2006; Bajza and Vrcek, 2001). Worldwide, it is estimated that discharged tannery effluent contains 300–400 million tons of heavy metals, solvents, toxic sludge and other wastes, which are dumped into water bodies each year (UNEP 2010; Wosnie and Wondie, 2014). Human health can also be affected by toxic hazards generated through the unskilled and unprotected handling of pesticides, tanning chemicals, and treated hides and skins (Cooman et al., 2003). The final composite tannery effluents (wastewater) contain high load of organic matter, dissolved and suspended solids, organic nitrogen and chromium, and possess high pH (Cooman et al., 2003, Boshoff et al., 2004). The

lack of effective implementation of legislative control, poor processing practices and use of unrefined conventional leather processing methods have further aggravated the pollution problems. It is unfortunate that there are no reliable estimates of the quantity and types of hazardous wastes generated in most developing countries, like Bangladesh, and in some cases proper documentation is not available. A few reports have been found on composite and unit–wise tannery effluents, in particular. Under this context, particular emphasis is placed on the status of toxic pollutants in effluents. Though tanneries are revenue and job generating sector, the pollution from their effluent is of major concern. All the pollutants, including heavy metals, causes serious health hazards due to unsafe disposal of untreated effluents on soil and water.

2 Methodology

The water of the study area is not equally polluted by the all parameters. Pollution level varies place to place and time to time. To measure the water pollution and its harmful effect on environment and human health the selection of sampling site is very important. In locating sampling stations or points on a river it is necessary to determine a suitable point on the longitudinal section, taking into consideration the distance from the river bank and the depth, usually measured from the water sample. The following points are kept in mind during selecting sampling points:

1. The sampling stations are located at points where the measured parameters show a distinct gradient.
2. The selected Sampling points are therefore the representative, as far as possible, of a whole water body.
3. Some practical constraints are considered, for example, river traffic condition or the access to the sampling station.

The sampling stations are shown in the figure 1. It is clear that the first sampling point is located at 30 m to downstream from the leather industry. The other stations are selected in such a way that they are located 30m away from each other towards the downstream.

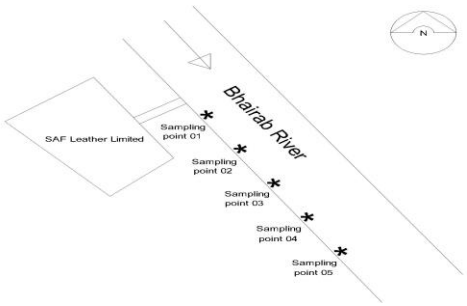

Figure 1. Location of sampling points

Samples of waste water collected from different sources should fairly represent the body of the waste from which they were collected. There are three main methods of sampling viz. grab sampling, composite sampling and continuous monitoring sampling. However, sampling for ordinary chemical analysis requires no specific methods and precautions other than collecting it in a clear glass container of good quality having glass stopper. Samples for bacterial analysis must be collected in a sterilized bottle with stopper. For this study grab sampling method is employed and samples are collected in plastic containers with stopper from 20 cm below the top of the water surface from the sampling point 1, 2, 3, 4 & 5. Water quality is a value judgment that is related to the intended purpose of the water body and based on the physical, chemical attributes of the water body. Water quality may be defined by a single or multiple characteristics. The study requires physicochemical characteristics of the effluent discharged from the factories and the river water quality data of the downstream side of the discharged point over a certain period of time. Wastewater samples are tested at the Environmental Engineering Laboratory of Rajshahi University of Engineering and Technology (RUET) for analyzing the Total Chromium, BOD, COD, TS, TSS, TDS & pH using standard methods for analysis of water & waste water, 20th edition, APHA, AWWA, WEE, 1998. In this study, the impact of leather industries effluents on the Bhairab River are evaluated by the analyses of water sample of sampling point 1, 2, 3, 4 & 5.

3 Results and Discussion

Effluent is liquid waste product (whether treated or untreated) derived from an industrial process or human activity that is discharged into the environment which is very much harmful. In this study, leather industry effluents are tested and analyzed, then the obtained values of different parameters such as pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total chromium, Total Suspended Solids (TSS), are represented in the following figures and then discussed.

3.1 Biochemical Oxygen Demand (BOD)

From figure 2, the highest amount of BOD (17 mg/l) is found at the discharging point of waste into the Bhairab River. For the dilution factor, the BOD reduces in the sampling point 2, 3, 4 & 5 is 15mg/l, 14 mg/l, 12 mg/l and 11 mg/l respectively. According to Bangladesh standards, the BOD concentration limit is 10 mg/l for fish culture and irrigation purposes. This implies that the concentration of BOD of the Bhairab River water is not suitable for fish culture and irrigation purposes.

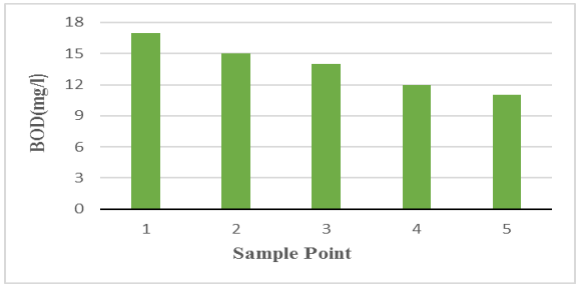

Figure 2. Variation of BOD in mg/l at different sampling points of leather industry.

3.2 Chemical Oxygen Demand (COD)

Figure 3 represents the highest amount of COD (22 mg/l) in the sampling point 1 due to discharge of effluent from leather industry into the Bhairab River and the values of COD have decreased with the increasing distance at the down streams. From the following figure it is clear that in all sampling points the value of COD exceeds Bangladesh standards limit which indicates that the concentration of COD of the Bhairab River water is not suitable for fish culture and irrigation purposes.

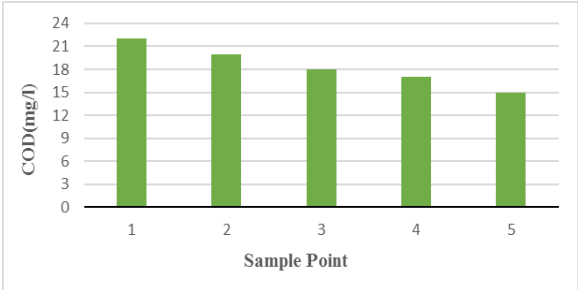

Figure 3. Variation of COD in mg/l at different sampling points of leather industry

3.3 pH

Figure 4 illustrates that the level of pH is 8.2 in the sampling point 1 due to discharge of effluent from leather industry and pH reduces in the sampling point 2, 3, 4 & 5 was 8, 7.7, 6.9 and 6.6 respectively. As the collected water from the sampling points represents the quality of whole water body, which is not suitable for fish culture and irrigation purpose due to the higher value of pH.

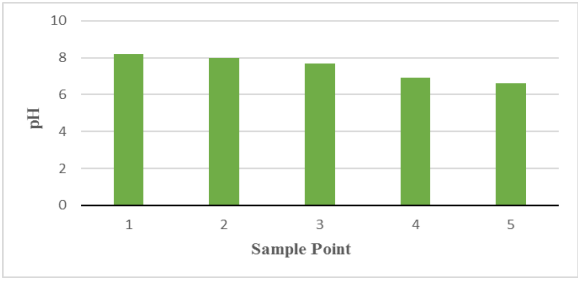

Figure 4. Variation of pH at different sampling points of leather industry

3.4 Total Chromium

Figure 5 denotes the highest amount of total chromium (0.19 mg/l) at the discharging point (sampling point 1) of waste into the Bhairab River and in the sampling point 2, 3, 4 & 5 is 0.16 mg/l, 0.13 mg/l, 0.12 mg/l and 0.11 mg/l respectively. According to Bangladesh standards, the total chromium limit is 0.05 mg/l. This denotes that the total chromium of the Bhairab River water is not suitable for fish culture and irrigation purposes.

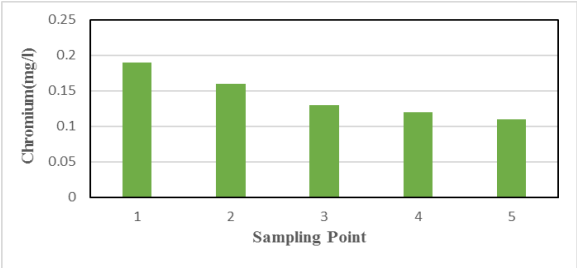

Figure 5. Variation of total chromium in mg/l at different sampling points of leather industry

3.5 Nitrate

Figure 6 shows that level of nitrate is 4.678 ppm in the sampling point 1 due to discharge of effluent from leather industry. For the dilution factor, the nitrate reduces in the sampling point 2, 3, 4 & 5 is 4.12 ppm, 3.763 ppm, 3 ppm and 2.848 ppm respectively. But, the value of nitrate in each sampling point exceeds Bangladesh standards limiting value which is 1 ppm. This indicates that the nitrate of the Bhairab River water is not suitable for fish culture and irrigation purposes.

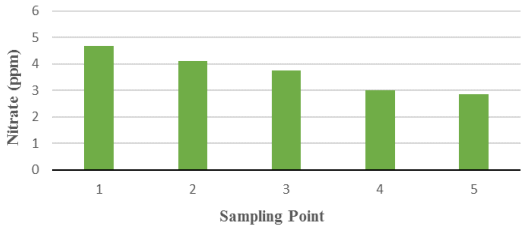

Figure 6. Variation of nitrate in ppm at different sampling points of leather industry

3.6 Total Suspended Solids (TSS)

Figure 7 represents the concentration of total suspended solids is 56 mg/l in the sampling point 1 due to discharge of effluent from leather industry. In the sampling point 2, it is decreased to 52 mg/l. Total suspended solids in the downstream are increased in the sampling points 3, 4 & 5 and it is 55 mg/l, 56 mg/l & 57 mg/l respectively. According to Bangladesh standards total suspended solid limit is 10 mg/l, which denotes that total suspended solid of the Bhairab River water is not suitable for fish culture and irrigation purposes.

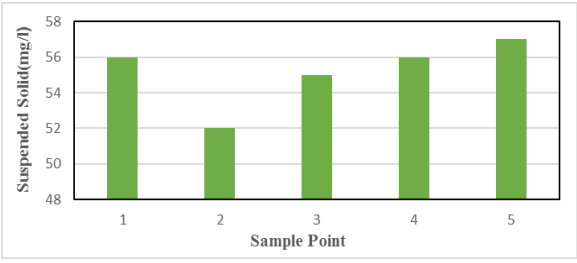

Figure 7. Variation of total suspended solids in mg/l at different sampling points of leather industry

3.7 Turbidity

Figure 8 indicates the highest level of turbidity is 30 NTU in the sampling point 1 due to discharge of effluent from leather industry. For the dilution factor, the turbidity reduces in the sampling point 2, 3, 4 & 5 was 27 NTU, 25 NTU, 22 NTU and 20 NTU respectively. According to Bangladesh standards & WHO standards the turbidity

is 10 NTU & 5 NTU respectively. This implies that the turbidity of the Bhairab River water is not suitable for fish culture and irrigation purposes.

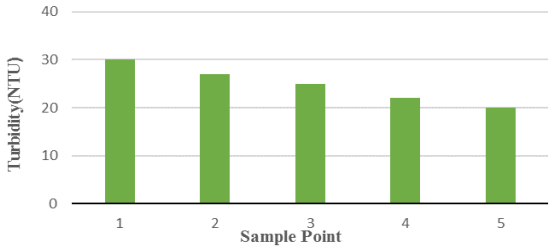

Figure 8. Variation of turbidity in NTU at different sampling points of leather industry

3.8 Electro Conductivity (EC)

According to Bangladesh standards, the limit of the electro conductivity is 2250 micromhos/cm for irrigation purposes. But, from figure 9 it is clear that the level of electro conductivity is 800 micromhos/cm in the sampling point 1 due to discharge of effluent from leather industry. After that, the electro conductivity reduces in the sampling point 2, 3, 4 & 5 is 780 micromhos/cm, 760 micromhos/cm, 650 micromhos/cm and 580 micromhos/cm respectively. So, it is clear that the electro conductivity of the Bhairab River water is suitable for irrigation purposes only.

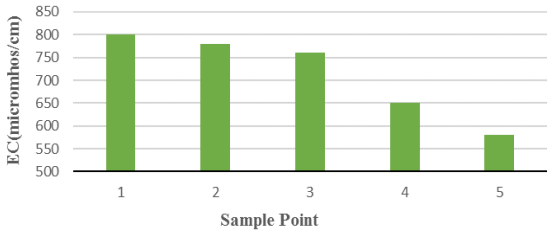

Figure 9. Variation of electro conductivity in micromhos/cm at different sampling points of leather industry

3.9 Alkalinity

Figure 10 implies that the level of alkalinity was 150 ppm in the sampling point 1 due to discharge of effluent from leather industry. For the dilution factor, the alkalinity reduces in the sampling point 2, 3, 4 & 5 was 130 ppm, 125 ppm, 110 ppm and 90 ppm respectively. According to Bangladesh standards the alkalinity is 100 ppm. This implies that the alkalinity of the Bhairab River water is not suitable for fish culture and irrigation purposes.

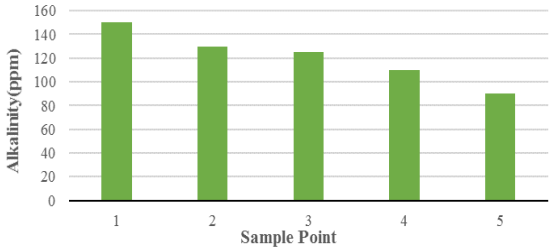

Figure 10. Variation of alkalinity in ppm at different sampling points of leather industry.

Conclusion

The main focus of this study is to determine the physiochemical characteristics as well as to analyze the quality of water of the Bhairab River to assess the impact of leather industry effluent. The study has assessed the current status of water quality in Bhairab River and it is hoped that the results of this study will assist the relevant industries and authorities in designing appropriate preventive measures to ensure that the water quality in the river will be improved. From the experimental data, it was observed that in all the selected sampling stations the physiochemical characteristics of wastewater such as the BOD, COD, turbidity, chromium, alkalinity and TSS exceeded the Bangladesh standard limit but pH and EC are within the standard limit. So, it can be said that the water of Bhairab River is unsuitable for fish culture and irrigation purposes.

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