



P-ISSN: 2706-7483
E-ISSN: 2706-7491
IJGGE 2021; 3(1): 31-33
Received: 15-11-2020
Accepted: 21-12-2020

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Surface Water Pollution due To Hazardous Waste from Leather Tanning Industry in Colombo District- Sri Lanka

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Abstract

Surface water pollution has many sources and it is generally induced by anthropogenic activities. This study revealed on industrial hazardous waste which is generated by Chromium based leather tanning industry in Colombo District. The research study was conducted to identify industrial hazardous wastes which are generated by Chromium base leather tanning industry in the Colombo District. There are two types of tanning systems namely vegetable tanning, which does not contain chromium, and chrome tanning. Chromium salt Sulphates are the most widely used tanning substances today. At high concentrations chromium is toxic, mutagenic, carcinogenic, and teratogenic. Chromium exists in oxidation states of +2, +3, and +6. This study revealed on industrial hazardous waste which is generated by Chromium based leather tanning industry in Colombo District. According to the Central Environmental Authority (CEA) 2015, there are only two Chrome based tanneries are in operational level in Colombo District and others have closed or suspended due to non-compliance of CEA (Central Environmental Authority) regulations hence those two tanneries were selected for the study. Selected tanneries discharge their wastewaters through the one discharging point in to the Kelani River at Mattakkuliya area and use common chromium recovering facility to recover Chromium ions from the wastewater before discharge. Moreover untreated and treated wastewaters were analysed for total Chromium, by testing five hundred and thirty two wastewater and surface water samples at the laboratory during the 2015 -2016. Accordingly, the main pollutants were identified during the leather processing include, NaCl₂ (Sodium Chloride) and pesticides, strong alkalines and sulphides, inorganic residual compounds, dissolved matter and chromium salts. Also total Chromium in untreated wastewater was detected 10.32 mg/l as average and 15.81 mg/l as maximum levels although Chromium was detected in 0.028 mg/l as maximum level in discharging effluent after the Chrome recovery.

Keywords: Leather tannery, Pollutants, Wastewater, Chromium ions, Kelani River

Introduction

Waste products rise from our methods of life and they are generated at every degree of technique of manufacturing and development all around the international in which the era of stable waste is an inevitable effect of production and consumption activities in any economy (Jakab, 2011) [6]. Statistics.gov.lk (2019) [10] also suggested that fast growth of urban, agricultural and commercial activities encouraged by means of speedy population development, has produced a huge amount of stable waste that contaminates the ecosystem and damages resources. Volume of waste technology configuration of solid waste management in a selected city or country that depends on the financial and market popularity, population density, town life, mealtimes behaviors, and environmental situation (Friedman, Ritchie and Gallery, 1999) [4]. Consequently, the technology of strong waste has end up an essential international difficulty above the previous decades because of increasing progress of the population (Juhasz, Magesan and Naidu, 2004) [7].

Surface water pollution has many sources and it is generally induced by anthropogenic activities. The main pollution factors of them are the city sewage and industrial waste which discharged into the rivers. Industrial waste is defined as waste generated by manufacturing or industrial processes and types of industrial waste are divided into hazardous and non-hazardous waste. Industrial solid waste which are solid, liquid or gases is held in containers, generated from the industrial production process. Leather tanning is named as a high polluting industry due to emission of hazardous waste including heavy metals. Industrial waste has been a problem since the industrialization of the country with introducing Export

Processing Zone in 1970's. (Madani 1999) [8].

The study is based on the industrial hazardous waste which are generated by Chromium base leather tanning industry in the Colombo District, which is the act of converting animal hides and skins into leather. There are two types of tanning systems namely vegetable tanning, which does not contain chromium, and chrome tanning. Chromium salt Sulphates are the most widely used tanning substances today. At high concentrations chromium is toxic, mutagenic, carcinogenic, and teratogenic (Belay, 2009) [2]. According to the records of Central Environmental Authority (CEA), there are fourteen tanneries established in the Western province, though none of them have Environmental Protection license or Scheduled Waste Management License which is issued under provisions of National Environmental Act (No.47 of 1980 and No.01 of 2008), since of their poor conscious of hazardous waste management. Although CEA has entered into an agreement with the Ministry of Industries not to take legal action against tanneries until a suitable re-location plan is worked out (CEA 2009). According to the CEA EPL (Environment Protection License) Database 2015, there are only two Chrome based tanneries are in operational level in Colombo District and others have closed or suspended due to non-compliance of CEA regulations hence those two tanneries were selected for the study; Ceylon Leather Products (Pvt) Ltd, Kelani Mill Road, Mattakkuliya and Tan Lanka Pvt.Ltd. Kelani Mill Road, Mattakkuliya. Moreover those two tanneries are discharging their wastewater through the one discharge point to the Kelani River.

1. Research Objective

Main objective of this research is to analyse surface water pollution due to heavy metal contaminated wastewater (Cr^{+3} ions) from chrome based leather tanning industries in Colombo District. Also three specific objectives are considered; to analyse potential pollution factors of surface water pollution caused by Leather Tanning Industries, to evaluate deviation of current effluent discharging parameters of the discharge waste water of tanneries from the National standards¹ [National Environmental (Protection & Quality) Regulation No.01 of 2008] and to examine significance of parameter variation in Kelani river with time and water level.

2. Research Design and Method

The study has been mainly based on the Primary data known as a raw data and is collected by sampling and laboratory analysis of selected water bodies. Furthermore raw data has not been subjected to processing or any other manipulation, and are also referred to as primary data. Primary data is collected by field measurements and laboratory measurements of water quality of selected waste water discharge point. Selected leather tanning industries discharge their effluents through one discharging point in the Kelani River at Mattakkuliya area. Solid waste and effluents are generated through the production process and generate mixed wastewater in complete tanning process and composition is not solely the result of separate waste

¹ Standard discharge parameters - According to the Central Environmental Authority's tolerance limits for Waste from being discharged from Leather Tanning Industries into inland waters and seawaters total Chromium concentration is usually limited to 2.0mg/l (CEA Regulation 2008).

streams that merge together. Moreover five hundred and thirty two wastewater and surface water samples were collected for the laboratory analysis including hundred and forty four wastewater samples from two selected leather tanneries and tree hundred and eighty eight samples of surface water of Kelani river. Concentration of Chromium ions of surface water of Kelani River was correlated with water level of the river and time. Sample collection was carried out during the dry season as well as the rainy season of the 2015 August – 2016 March (Annual Weather Report - 2015). Water level of Kelani River from mean sea level was gathered from Department of Irrigation secondarily. Data set is analyzed by using SPSS 16 software and normality and descriptive analysis have been carried out. Both parametric and nonparametric data analysis techniques were employed in this study to identify the variability of water quality with influential parameters. Parametric variables are tested with One- way ANOVA and nonparametric variable are analysed by Kendall's W and Wilcoxon Signed Ranks Tests. Analysis of Variance (ANOVA) is a statistical method used to test differences between two or more means (Penny, *et al.* 2006) [10]. The Wilcoxon signed rank test, also known as the Wilcoxon matched pairs test, is a non-parametric test used to test the median difference in paired data. Secondary data is collected from Ministry of Industry and Commerce, Industrial Development Board (IDB), Central Environmental Authority (CEA), Industrial Technological Institute (ITI), Sri Lanka Leather Tanners Association (SLAT), Department of Irrigation. Other relevant Authorities as University of Colombo.

3. Key Findings

Selected leather tanning industries in Colombo District are discharged their effluents through one discharging point in the Kelani River at Mattakkuliya area. Solid and effluents wastes have generated during the production process. As previously pointed out, throughout the tanning process at least 300 kg of chemicals (lime, salt etc.) are added per ton of hides. Excess of non-used salts has washed out with the wastewater by changing pH and these compounds can be precipitated and contributed to the solid waste or suspended solids in effluents. Tanneries generate mixed wastewater in complete tanning process and composition is not exclusively the result of separate waste streams that merge together. The different pH's and the different compounds influence each other's solubility. In composite wastewater, compounds precipitate while they stay dissolved in the wastewater from the separate processes (Pelckmans, undated). Tannery effluents and surface waters around the discharging point were tested for BOD, COD, Total Chromium (Cr^{+3}), TSS, pH, EC, Turbidity and concentration of Sulphides as Sulfur. Although water quality of Kelani River was tested for pH, COD, DO, EC and Total Cr^{+3} for identify the potential pollution factors.

Table 1: Descriptive Statistics of Untreated Wastewater of Chrome based Leather tanning Industry

Parameter	Average	STDEV	Minimum	Maximum
pH	9.59	0.441	9.1	10.4
TSS	138	84.64	48	206
COD	2426.8	987.79	268	3846
BOD	181	93.23	60	365
Total Chromium	10.32	2.621	6.78	15.814

Table 01 is presenting the water quality results of untreated effluent of selected tannery which is mixed of beamhouse and Chrome tanning processes. The industries have carried out Chrome tanning process in mass scale and vegetable tanning in minor. Hence total effluent is coming only from the beamhouse and Chrome tanning processes plus the samples were collected from the point before the Chromium recovery plant which is used for only Cr^{+3} recovery and the

industry have no total waste water treatment plant (TWWTP). According to the test results of pH, EC, COD, BOD, Turbidity, TSS, TDS, Total Chromium and Sulphide are in above the CEA tolerance limits which are gazetted in 2008 under NEA (National Environmental Act). This study was basically carried out to identify significance of Chromium discharging with the tannery effluent.

Table 2: Descriptive Statistic of Effluent after Chrome Recovery

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
pH	4	7.80	10.44	8.85	1.13
TSS (mg/l)	4	48.00	216.00	1.53	75.34
Temp (°C)	4	27.80	31.50	2.89	1.76
COD (Chemical Oxygen Demand) (mg/l)	4	1030.00	3200.00	1.83	966.14
BOD (Biological Oxygen Demand) (mg/l)	4	55.00	600.00	2.54	243.22
Sulphides (mg/l)	4	16.90	22.30	2.04	2.40
Chromium (mg/l)	4	.010	.028	.01700	.009
Valid N (listwise)	4				

Table 02 illustrates descriptive analysis of treated effluent of leather tanning industry which samples were collected before the discharging point of the Kelani River. Moreover concentration of Cr^{+3} was less than the 0.2mg/l which is the tolerant limit enforced by the CEA and detected maximum Cr^{+3} concentration was 0.028 mg/l and the minimum was 0.09mg/l, in some cases Cr^{+3} cannot be detected at the preliminary sampling. While there was higher concentration of Cr^{+3} was detected in untreated effluent before chrome recovery but it decreased less than 0.02mg/l after the recovery. When the considering water quality of Kelani River at the points of Modara and Glencorse were carried out SLLR & DC in August 2015 and chemical analysis has done by SGS Co. Ltd., free Ammonia, total Phosphate, Chromium, Lead, Copper Arsenic, Mercury, Pesticide residues, PAHs, Amines (Associated with Azo dyes), Chlorinated solvents, other VOCs, Total Coliforms were tested and have not been detected. Modara is the main area which all leather tanning industries are located and all those tanneries release their untreated effluent to the River at the Modara and Mattakkuliya area but considering the secondary data, Cr^{+3} have not detected in Kelani River due to the facility of Chromium recovery which those leather factories used in common.

4. Conclusion

Identification of waste generation points in Chrome based leather tanning process was made and laboratory analysis was carried out on both treated and non-treated effluents for the contents. Especial attention was given to presents of Chromium analysis and laboratory analysis were carried out before and after recovery treatment and it was found that 99.24% of Chromium has recovered the effluent discharged. Furthermore Chromium ions were not detected in the wastewater at the discharge point as same as the Kelani River. Also total Chromium in untreated wastewater was detected 10.32 mg/l as average and 15.81 mg/l as maximum levels although Chromium was detected in 0.017 mg/l as average and 0.028 mg/l as maximum level in discharging effluent after the Chrome recovery but there was no trace of Chromium found in the natural cause. This is the most important finding that was established consequent to the tests and research carried out by the study with regard to the

Chromium concentration in Kelani River contrary to common belief that heavy metals like Chromium are disastrous elements in effluents of this industry which adversely effected the expansion of the industry hence Industrial park that was constructed at Bata-Atha accommodating tanning industry was abounded due the above belief. Hence it is very important to implement strict control, supervision and monitoring by all relevant authorities concern to maintain the discharge of effluent to a total treatment and release the same within the limit of accepted tolerance with regard to all by-products. Furthermore with the strict controls and monitoring of the Chrome based leather tanning industries in Sri Lanka can be turned to the high income generating sector to the Country.

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