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Studies on the Composition of Effluent Wastes of Kot Lukh-pat Industrial Estate (0-400 M), Pakistan

Muhammad Tariq[a], Tahira Shafiq[a], Ghulam Rabbani Khan[b], Muhammad Sajjad[b] and Muhammad Hammad Khan[a*]

[a]Center for Environmental Protection Studies (CEPS), PCSIR Laboratories Complex, Lahore-54600, Pakistan
[b]Department of Chemistry, Division of Science and Technology, University of Education, Township Campus Lahore, Pakistan

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Abstract. The quality of wastewater effluents in the Kot Lukh-pat Industrial Estate main drain, stretched from 0 to 1.1 km ahead was studied. Samples were collected during June and September, 2008 along first 400 m and quality parameters like pH, conductance, TSS, TDS, COD, BOD, chlorides and sulphides were determined. In most of the samples COD, BOD and S^{2-} remained above the recommended limits of National Environmental Quality Standards (NEQS) of Pakistan, while chlorides and TSS were found to be below the limits. The effect of temperature and pH on the quality of wastewater was noted in most of the samples because, it affects the solubility of oxygen, volatile compounds and growth of microbes. The decrease in oxygen content caused by high temperature can shift the microbial community from aerobic to anaerobic and also causes life threatening conditions for the aquatic life in the water body that receives the wastewater. Increase in pH causes the increased efficiency of microbes which consume the organic compounds in wastewater. This study pointed out the alarming condition of the wastewater.

Keywords: wastewater, environmental management, Kot Lakh-pat Industrial drain, COD, BOD

Introduction

Municipal wastewater is a combination of domestic wastewater, small amount of industrial and agro-zoo-technical wastewater, storm water, drain water, surface infiltration, and ground water (Ausubel, 1999). When this drain of a municipal wastewater enters an industrial area, a number of pollutants are expected to be added in it, most of them are toxic in nature. However, city authorities should know the characteristics of the wastewater, the ability of sewage system to handle them, and the effects of the wastewater upon all components of the city disposal system before receiving the wastewater into drain.

Industrial discharge is one of the major sources of water pollution. Each industry has certain pollutants in its wastewater. The physico-chemical properties of a wastewater can be divided into the following categories; diseases causing agents, oxygen consuming agents, plant nutrients, suspended solids and sediments, dissolved solids, toxic substances, thermal pollution, oil, grease and acids (Girard, 2007; Kahloon *et al*., 2003; Kaul and Ashutosh, 2002; Hassan and Bhutta, 1997; Ghafoor *et al*., 1994). Industrial water pollutants such as organic and inorganic compounds, metals and dissolved solids can have serious impacts on environmental quality, depending upon their characteristics and concentration (Qadir *et al*., 2010; Miller *et al*., 2009; Sultan, 1995; Trivedi and Gurdeep, 1992). The textile industry is not only one of the biggest water consumers, but also a great user of chemical products (Soares *et al.*, 2007).

The toxic water pollutant can enter the food chain through crop irrigation and the contamination of aquatic life (Berlin and Briggs, 2005; Boyd *et al*., 2003). These pollutants cause wastewater borne diseases due to lack of adequate finances for wastewater treatment. The nutrients in the wastewater along with soluble salts and heavy metals ultimately reach into water bodies e.g., lakes, river stream, and ultimately ocean. These are consumed by the organisms like algae, causing an excessive growth e.g., red-tide. When these algae die and decay, they quickly deplete the dissolved oxygen in the water body causing life threatening condition for the aquatic life (Ausubel, 1999; Benka-Coker and Ojior, 1995). Appearance and odour are direct indicators of wastewater pollution. Wastewater may be coloured or

*Author for correspondence; E-mail: jawad_frc@hotmail.com

turbid (cloudy), or it may have solids, oil or foam floating on it, or it may have a rotten odour, or smell like industrial chemicals (Bull *et al*., 1982).

Analytical tests for wastewater were carried out in the Centre for Environmental Protection Studies, PCSIR Labs. Lahore in order to assess the nature, strength and turbidity of wastes. This assessment would facilitate the design of treatment procedure to improve its efficiency and quality of final effluents.

Materials and Methods

This study was based on the survey of Kot Lukh-pat Industrial Estate (KLIE), Peco Road, Lahore, to determine the pollution load in the main drain of KLIE, extending to about 1.1km. This drain received huge amount of waste effluents from the industries located in the KLIE.

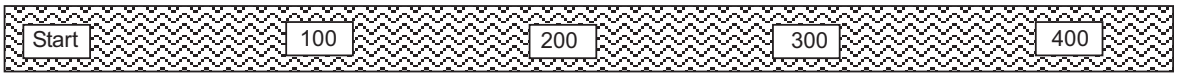
The samples for analysis were taken at 0, 100, 200, 300, and 400 m from the start of the main drain of KLIE. The neighboring industries of sampling points and typical analysis of their wastewaters reported in literature are mentioned in the Fig. 1. The samples were kept at 4 ºC and analyzed within 3 months of sampling. Temperature and pH were checked and recorded at the time of sampling. Analysis for COD and BOD were performed within a week as they change very rapidly over the time.

These samples were analyzed for the TSS, TDS, COD, BOD, chlorides, sulphides, temperature, pH and conductivity by the methods reported in the Standard Methods for the Examination of Water and Wastewater (APHA, 1998).

Results and Discussion

The wastewater samples of KLIE were collected in the months of June and September, 2008. The results are shown in Fig. 2. In these two months, large variations were observed. In some parameters the variation followed specific trend. In the month of September the flow rate of wastewater was higher than in the month of June. The parameters analyzed helped to find out the pollution load in the main drain of KLIE and the variation trends and also the organic load, toxicity and expected effects on the environment of the receiving water body or soil were assessed.

In the month of June 2008, the temperature of water was noted 5 ºC higher than in the month of September, 2008. This 5 ºC temperature difference was sufficient to cause major impact on the water composition. Variations in temperature of wastewater can cause the changes in the solubility of oxygen and volatile materials. In all the samples taken during the month of September



‘S-1’ Dyes	‘S-2’ Food	‘S-3’ Fabrics, Food Pharma-ceuticals	‘S-4’ Food, Dyes, Cosmetics	‘S-5’ Food, Oil, Pharma-ceuticals

Parameters		Dyes	Food					Fabrics	Pharma
	Domestic sewage	Textile industry	Dairy industry	Yeast industry	Fruits & vegetable canning	Beverage industry	Fish canning		Vit B(complex), Antipyrine, Anti TB, Alcoholates
pH	7	6.5	4	5 - 7	5.5	9	11	6 -10	1
TDS (mg/L)	500	17,000	19,000	5,000	1,270	1,290	8,218	500-3,000	86,000
T.S.S (mg/L)	220	1,800	12,150	1,000	2,200	760	565	-	-
COD (mg/L)	500	1,500	21,100	3,400	1,400	1,150	2,350	100-2,000	19,700
BOD (mg/L)	250	840	14,000	3,500	800	620	890	300-1,200	13,000
Oil & Grease	100	155	320	9	94	-	290	-	-
Cl^- (mg/L)	50	-	-	-	-	-	-	100-300	18,500

Fig. 1. Site map of the main drain and the reported results for wastewater of specific industries.

2008, TSS was higher than the month of June, 2008. But in all the samples TSS exceeded the National Environmental Quality Standards (NEQS) (NEQS, 1993) raising the alarms for proper management. Higher temperature favoured the anaerobic microbes more than the aerobic microbes due to low oxygen solubility and higher efficiency of anaerobic microbes near 37 ºC. At lower temperature and increased oxygen solubility the growth of aerobic microbes is favoured over anaerobic microbes. The aerobic microbes produce up to 10 times more sludge than anaerobic microbes (Sayed *et al*., 1993). This caused an impact on the TSS.

COD and BOD were found to be higher in the month of September than in the month of June despite the higher flow rate in September. The variations in COD and BOD were affected simultaneously by addition from different industries and removal by aerobic and anaerobic microbes. Lower COD in June 2008 is expected to be due to higher microbial efficiency favoured at higher temperature. Increased microbial efficiency consumes the organics in water decreasing the total COD in it. Along the flow of drain COD and BOD were found to be affected with the variations in pH (Fig. 2). It was found that COD and BOD decreased more at an optimum pH of 8-9, beyond which increased again. The efficiency of anaerobic microbes is better near the pH of 8-9 therefore, increase in pH increased microbial activity and caused a decrease in COD and BOD. The trends of COD and BOD variations with changes in pH were prominent during the month of June, 2008. During the month of September 2008, a consortia of aerobic and anaerobic microbes is expected therefore, no clear trend of COD and BOD variations with changes of pH was found.

But in both the months the values were found to be higher than NEQS. Higher COD and BOD in the wastewater when reaches a receiving water body is consumed by the microbes as food and nutrients. During this process microbes utilize dissolved oxygen (DO), decreasing it in the receiving water body. This lower dissolved oxygen level creating life threatening conditions for aquatic life disturbing the ecosystem.

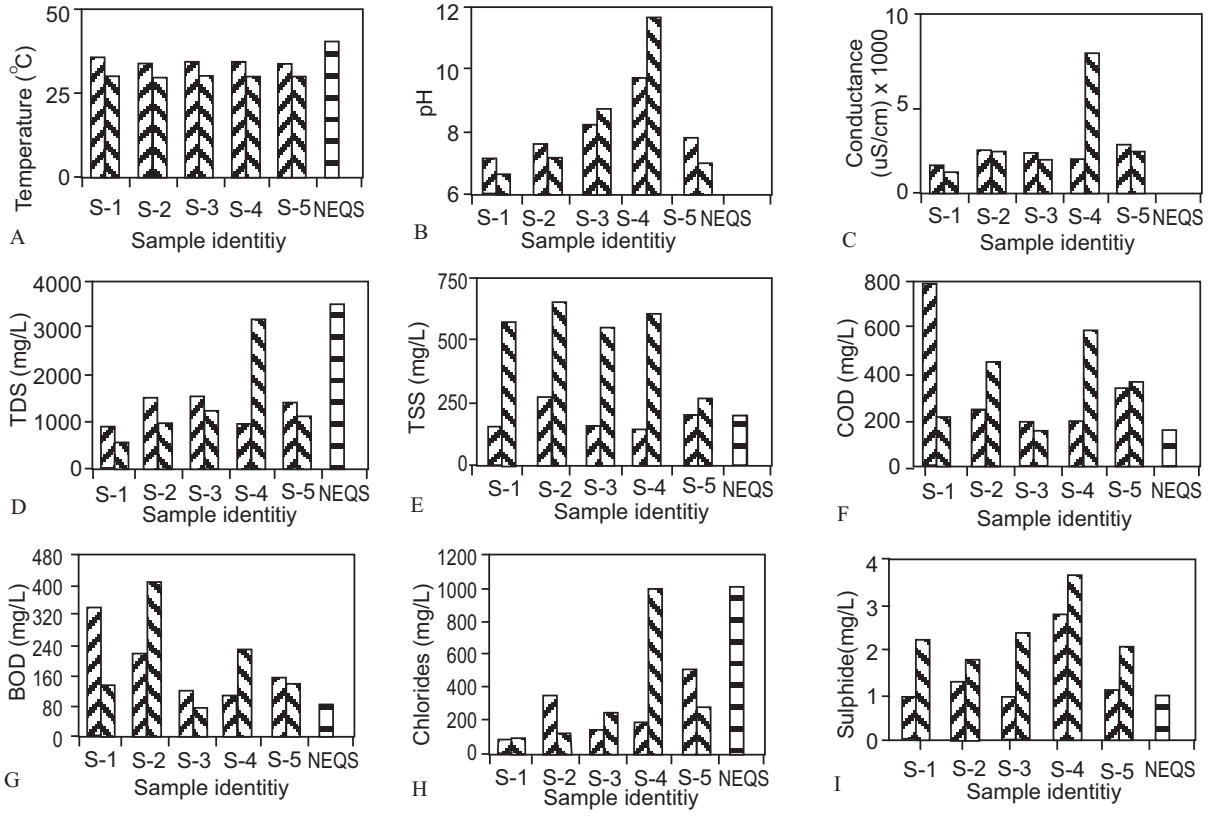


Fig. 2A-I. Different parameters analyzed for the samples taken from the drain during the months of June and September. The graphs are for the following parameters A = Temperature; B = pH; C = Conductance; D = TDS; E = TSS; F = COD; G = BOD; H = Chlorides; I = Sulphides. (□) June, (□) September, and (□) NEQS. S-1 to S-5 for 0, 100, 200, 300 & 400 m distance, respectively for sample collection.

The BOD/COD ratio is an important parameter to consider while estimating the bio-degradability of the organic matter in the wastewater i.e. higher ratio will enhance bio-degradability of the organic matter. In the samples analyzed the S-2 sample has maximum BOD/COD ratio (Fig. 3) due to a food industry located in that area. The wastewater from food industry was expected to be least toxic and most bio-degradable. In other samples the ratio decreased due to two factors; bio-degradation of the organic material and addition of non-biodegradable matter from other industries. The BOD/COD ratio remained above 0.4 indicating that the organic material in the wastewater was not difficult to degrade in biological wastewater treatment plant, if applied.

The parameter most affected by the temperature increase was a decrease in sulphide content in wastewater (Fig. 2-I). In both months sulphide content was higher than NEQS. Sulphide is a toxic chemical both as dissolved in water and in gaseous form (Vismann, 1996). It causes abnoxious odour problem when it escapes from the water. The threshold odour concentration of H_2S in water is between 0.025 - 0.25 μg/L. Gaseous H_2S is very toxic and has claimed many lives of the sewage workers, when present in water it can react with oxygen and oxidize to H_2SO_4 causing corrosion to the metallic pipelines. Whereas, dissolved form is very toxic to the aquatic life (Vismann, 1996).

TDS constitutes the inorganic salts therefore they are not much affected by the microbes or temperature. TDS was found lesser in the month of September, 2008, may be due to higher flow rate causing more dilution.

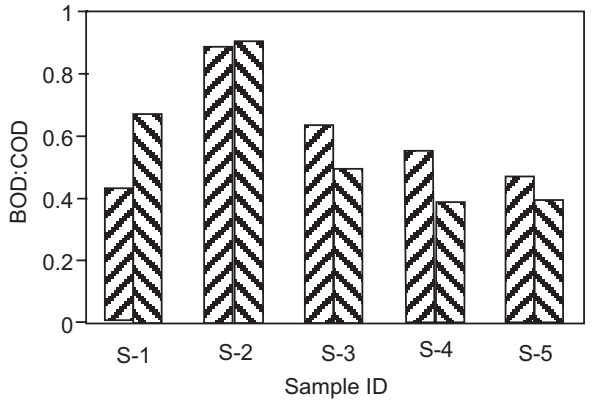


Fig. 3. BOD/COD ration for the samples taken from the drain during the months of June and September. (▨) June, (▧) September. S-1 to S-5 for 0, 100, 200, 300 & 400 m distance, respectively for sample collection.

Chlorides remained below the NEQS except one observation during September, 2008 though it still did not exceed the NEQS. The same trend was found in the cases of TDS, Cl^-, and conductance, as these were dependent on each other. pH was found to be increasing with the increase in distance of the drain especially at 300 m distance. This can be caused by the fabrics industry or washings of other industries by alkaline materials.

Conclusion and Recommendations. In this study, it was tried to evaluate the pollution load in Kot Lukhpat Industrial Estate estimated by analysis of the main drain wastewater for different parameters like; pH, temperature, TDS, TSS, COD, BOD, Cl^-, and S^{2-}. Most of the parameters showed higher values than recommended by NEQS except TDS and chlorides. Large physical and chemical variations were found within these months e.g., increase in temperature during the month of June, 2008. The increase in temperature decreases the oxygen solubility in the wastewater. At lower oxygen concentration in the wastewater, anaerobic microbes predominated giving lower TSS during the month of June, 2008.

To counter act of these alarming conditions of wastewater, following recommendations can be given:

- Each industry must treat their wastewater before disposing off to the main drain. Any violation in this regard must be dealt strictly.
- Pumping of ground water near drains for drinking purpose must be avoided.
- Controlling authorities should regularly monitor the quality of pipelines of sewerage and wastewaters to avoid leaching of toxic wastewater to the underground water.

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