Assessment of Physical Parameters and Heavy Metals in Wastewater of Selected Industries in Industrial Estate Hayatabad Peshawar

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Abstract

The study was conducted in Industrial Estate of Hayatabad Peshawar, Pakistan. Three types of industries were chosen (pharmaceutical, marble and cooking oil). Wastewater of these industries was analyzed for different parameters. It was found that the highest pH value was in marble industry (M1 = 9.94) while the least recorded was in pharmaceutical industry (P1 = 5.94). The highest EC value was recorded in cooking oil industry (C2 = 1520 µS) while the least was recorded in pharmaceutical industry (P2 = 572 µS). The TSS were found highest in cooking oil industry (C1 = 223 mg/L). The TDS was found the most in cooking oil industry (C2 = 3978 mg/L). Similarly, the TS was found highest in cooking oil industry (C2 = 4185 mg/L) and least in pharmaceutical industry (P1 = 2239 mg/L). The sole heavy element detected in every sample was lead (Pb), yet none of them went above the allowable level. The highest Pb was detected in cooking oil industry (C1 = 0.45 mg/L) while the least was detected in marble industry (M1 = 0.21 mg/L). Zn was only detected in cooking oil industry and Fe was present in cooking oil and pharmaceutical industry in small quantity. Overall, the wastewater of cooking oil of both industries were exceeding many permissible limits of National Environmental Quality standards.

Keywords**:** Physical Parameters; Heavy Metals; Wastewater; Selected Industries; Industrial Estate Hayatabad

Introduction

A vital component of life water is a fundamental component of every cell in an animal, human, and plant. Since 80% of living cells' protoplasm is made up of water, water is a necessary component of life. The majority of bodily functions are dependent on water. Men use water

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for a variety of things, including industries, bathing, washing, drinking, and air conditioning. Every human activity uses water in some way. Water that has been utilized returns to the environment altered, which alters every environment's normal level, including water. Pollution is another thing that is disposed of with water these days, and any unfavorable alteration in the chemical or physical state is very concerning. Because industrial discharge contains a lot of harmful materials, it should be controlled before it enters the environment. Some customers are heating water and discharging wastewater into adjacent bodies of water, which raises the temperature of the water and has a positive effect on the aquatic ecosystem since each aquatic species has a unique habitat (Khan et al., 1997).

Every industry releases its raw effluent into the Bara River, receiving 304 cubic feet of discharge daily. The Kabul River is now receiving very contaminated garbage due to the lack of treatment for industrial pollutants. In addition, the industrial wastes contribute to the strain on the Kabul River, changing its quality entirely. Following Nowshera, Kalpani Nullah joins the Kabul River after flowing through Mardan City and combining its effluent (GOP/EUAD.1987).

In the country as a whole and the province of Khyber Pakhtunkhwa (KP) specifically, the industrial sector is now suffering from severe illness. With 1552 operational businesses and 635 closed industries, KP is home to 12 industrial estates. Thus, Rs. 15.74 billion has been given to the province. (Nawaz et al., 2015). Industries are one of the main consumers of water. Water is utilized in a variety of industrial processes, including washing, cooling machines, boilers, cleaning supplies, and many more. The creation of industrial wastewater effluents follows this. In general, materials that are often liquid wastes—particularly chemicals created by factories—or sewage that are frequently thrown from industrial activities or derived from manufacturing processes are what we refer to as industrial effluent. The growing activities of businesses (pharmaceutical, mining, metallurgical, tannery, paint, nuclear, and battery) have raised the risk of industrial effluent contamination of water, which is a severe environmental concern (Adeniyi and Ighalo,2019). Heavy metals are a class of trace elements with an atomic density greater than 4±1 g/cm3. (Landrigan et al., 2018). Ni, As, Co, Ag, Cr, Mn, Fe, Sn, Pb, Cd, Hg, Zn, and Cu are a few of them. (Al-Anber et al., 2008). Due to some of the characteristics of these heavy metals, including their high solubility, stability, and strong migratory activity in aqueous conditions, they have biomagnified, leading to a variety of illnesses in humans as well as detrimental effects on the environment (Akpor et al., 2014). One of the biggest issues facing the world today is water pollution from the release of untreated industrial effluents into bodies of water (Mathuthu et al., 1997).

Both developed and developing nations deal with the issue of water contamination. When different types of materials or trash are introduced into a body of water by human activity, water pollution results. Pathogenic organisms, oxygen-dependent organic compounds, plant nutrients that promote algal blooms, and organic and inorganic poisonous chemicals are a few of the most prevalent forms of pollutants (Cornish et al., 1999). Most manufacturing processes require water, and as a result, a sizable amount of treated or insufficiently treated effluent is released into the environment, adding to the contamination of surface and groundwater issues (Sarker et al., 2013).

Methodology

Description of the Study Area

This study was conducted in a popular industrial zone of Hayatabad in Peshawar, which was founded in 1963. There are 372 installed units in the Hayatabad Industrial Estate. According to recent data, 242 significant industries are operating. There are twenty primary classes within it. Without any prior treatment, solid trash and contaminated industrial effluent are discharged into the Kabul River via the Budni Nallah. This technique harms the quality of river water. (Jan et al., 2010). The seven-phase industrial estate is located in Hayatabad Township and is connected to Peshawar city by Ring Road and Jamrud Road. There are parts within each phase (Khan, 2016). The state's northern region is linked to Khyber Agency. To the west of Warsak Dam, flanked on the east and south by arid agricultural area, is the canal that makes a bend (Khan et al., 2002). In Peshawar city, there are 550 industrial units in total. Five billion rupees have been invested overall across all industries (Directory of Industrial Establishments, 2007). Fig 1 shows the location sampling points of the research area.

Samples Collection

Three distinct industries were chosen randomly for sample collection. From each category of industries, two samples were collected from different industries at different locations. The details of these industries are displayed in Table 1.

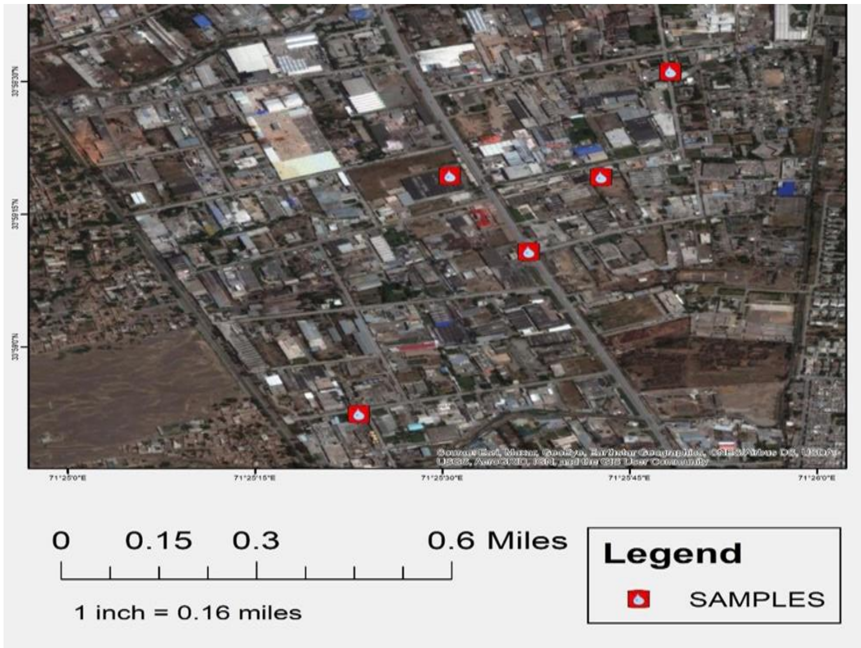

Figure 1: Location and sampling points of Hayatabad Industrial Estate.

Determination of Physical Parameters

All meters were calibrated using KCl and a pH 7 solution before being used. Benchtop meters provided the following results: pH, TDS, and electrical conductivity (EC). The thermometer was submerged in water for two minutes, and the reading was recorded, to determine the temperature. The gravimetric technique was used to determine the TSS (APHA, 1998).

Determination of Heavy Metals

Using an atomic absorption spectrophotometer, the amounts of heavy metals in water samples were ascertained. Lead, zinc, and iron were the elements identified using this approach. The authors' prior work has addressed the step-by-step process (Yusuf et al., 2015).

Table 1: Types of Industries from where water sample were collected.

S.No	Type of Industry	Name of Industry	Code
1	Pharmaceutical Industry	Meri Craft Pharmacy	P1
		Dr. Raza Pharmacy	P2
2	Marble Industry	Mehran Marble	M1
		Ameer Marble	M2
3	Cooking Oil Industry	Gulab Banaspati	C1
		Saqib Banaspati	C2

Results

The detailed analytical results for the physical characteristics and heavy metals in the wastewater of each sample are included in this section.

Table 2: Physical parameters of all industries wastewater samples.

Sample ID	Recorded Values	Permissible Limit	Unit
Temperature			
P1	2	3	^{0}C
P2	1.8	3	^{0}C
M1	1.3	3	^{0}C
M2	1	3	^{0}C
C1	3.2	3	^{0}C
C2	3.3	3	^{0}C
Ph			
P1	5.94	6-9	
P2	6.92	6-9	
M1	9.94	6-9	
M2	9	6-9	
C1	7.56	6-9	
C2	8.2	6-9	
Electric Conductivity (EC)			
P1	640	1000	(µS)
P2	572	1000	(µS)
M1	902	1000	(µS)
M2	872	1000	(µS)
C1	1192	1000	(µS)
C2	1520	1000	(µS)
Total Suspended Solids (TSS)			
P1	105	200	mg/L
P2	112	200	mg/L
M1	139	200	mg/L
M2	131	200	mg/L
C1	223	200	mg/L
C2	207	200	mg/L
Total Dissolved Solids (TDS)			
P1	1876	3500	mg/L
P2	1637	3500	mg/L
M1	2944	3500	mg/L
M2	2778	3500	mg/L
C1	3287	3500	mg/L
C2	3978	3500	mg/L

Physical Parameters

According to the analytical data, the temperature of the cooking oil industries (C1 and C2) was higher than the permissible limit of NEQs.

The highest recorded wastewater temperature was from C2 (3.3C), while the lowest was from M1 (1C). The marble industry (M1) was the only industry whose pH value exceeded the permissible limit; samples from other industries were within the permissible limit. The highest pH recorded was from M1 (9.94), while the lowest was from P1 (5.94). The cooking oil industries were the only ones whose EC and TSS values were higher than those of other industries. P2 had the lowest electric conductivity rating whereas C2 had the greatest. On the other hand, P1 had the lowest reported TSS value while C1 had the highest. Except for one company (C2), which exceeded the limitations, the TDS levels were deemed to be within the allowable limits, varying from 3978 mg/L for C2 and 1637 mg/L for P2. The comprehensive physical parameter results for each sample are displayed in Table 2.

Table 3: Detected heavy metals in wastewater samples of all industries.

Zinc [Zn]			
Sample ID	Recorded Values	Permissible Limit	Unit
P1	0	5	mg/L
P2	0	5	mg/L
M1	0	5	mg/L
M2	0	5	mg/L
C1	0.92	5	mg/L
C2	0.7	5	mg/L
Iron [Fe]:			
P1	0.06	8	mg/L
P2	0.03	8	mg/L
M1	0	8	mg/L
M2	0	8	mg/L
C1	0.6	8	mg/L
C2	0.34	8	mg/L
Lead [Pb]:			
Sample ID	Recorded Values	Permissible Limit	Unit
P1	0.26	0.5	mg/L
P2	0.29	0.5	mg/L
M1	0.21	0.5	mg/L
M2	0.34	0.5	mg/L
C1	0.45	0.5	mg/L
C2	0.34	0.5	mg/L

Heavy Metals

Three heavy metals, namely zinc, iron, and lead, were selected for examination from the wastewater of the selected industries. Zn was not found in samples from the pharmaceutical or marble sectors, according to the analytical results. It was only found, nonetheless, in the cooking oil sectors, where it was 0.92 in C1 and 0.7 mg/L in C2. Fe was nearly completely absent from the marble and pharmaceutical sectors. However, the amounts of Fe contained in cooking oil businesses were extremely low, with 0.6 mg/L for C1 and 0.34 mg/L for C2. In contrast to other heavy metals, lead (Pb) was found in every sample; The Pb content in the sample of M1 was 0.21 mg/L, whereas the sample of C1 had the highest value at 0.45 mg/L. The results indicate that all values of zinc, iron, and lead were determined to be within allowable limits. Table 3 provides a detailed breakdown of the heavy metals that were found in each sample.

Discussion

Physical Parameters

Overall, the results demonstrated that all samples from various industries, with the exception of the cooking oil industries, met the acceptable limits suggested by NEQS requirements for wastewater quality in terms of physical properties, such as temperature, EC, TDS, and TSS. The only samples that did not meet these limits were those from the marble industry. pH, which measures the acidity and alkalinity of water, was found to be between 6.0 and 9.0, exceeding WHO tolerance limits for wastewater discharged from all industries into rivers. The wastewater included 26–29 degrees Celsius of temperature. Within 317–325 µS cm-1, the wastewater sample's electrical conductivity levels were found. There was a range of 3200.0-3480.0 mg/l for TDS and 856.0-1080.0 mg/l for TSS in the wastewater sample (Akan, J. C et al. 2010).

Heavy Metals

Every sample's heavy metal content was measured and evaluated. According to the findings, every heavy metal detection value was found to be within allowable bounds. Zn was found in wastewater from each of the chosen companies between 0.00 mg/L to 0.92 mg/L in concentrations. Zn concentration was found to be 0.00 mg/L. meaning that it was not found in any of the samples from the marble and pharmaceutical sectors. But traces of zinc were found in frying oil industry samples as well; 0.92 mg/L of zinc was found in C1 and 0.7 mg/L in C2. The least harmful substance in the human diet is zinc, which is required for healthy immune system operation, and normal brain function, affecting the fetus's growth and development. On the other hand, high zinc content is poisonous and bad for human health (Helen and Othman, 2014). In the wastewater of every industry that was chosen, Fe concentrations ranged from 0.00 to 0.6 mg/L. The samples from the marble industries had no Fe. Comparing the pharmaceutical and cooking oil industries, however, the presence of Fe was much lower. P1 and P2 have different levels of Fe (0.06 and 0.03 mg/L, respectively). 0.6 mg/L of Fe was found in C1, whereas 0.34 mg/L was present in C2. Overly high iron levels in wastewater cause the soil to become acidic and decrease the availability of molybdenum and phosphorus in the soil after application. High iron wastewater can lower the phosphorus content of the soil and increase its acidity (Abagale et al., 2013) In each of the designated regions, the range of Pb values in wastewater was 0.21 mg/L to 0.45 mg/L. Pb concentrations in P1 and P2 were 0.26 and 0.29 mg/L, in that order. Pb was present in M1 at 0.21 mg/L and M2 at 0.34 mg/L. Regarding the cooking oil industries, 0.45 mg/L of lead was found in the C1 sample and 0.34 mg/L in the C2 sample. Lead is a heavy metal that is not necessary. By upsetting the delicate antioxidant equilibrium in mammalian cells, it induces oxidative stress and plays a role in the pathophysiology of lead poisoning. High amounts of lead deposition in the body can cause anemia, colic, migraines, brain damage, and abnormalities of the central nervous system (Rehman et al., 2013).

Conclusion and Recommendations

According to the results of the examination of wastewater from various businesses, the pharmaceutical industry had the lowest pH (P1 = 5.94) and the marble industry had the highest pH (M1 = 9.94). The pharmaceutical business had the lowest observed EC (P2 = 572 µS), whereas the cooking oil industry had the highest (C2 = 1520 µS) recorded. With C1 = 223 mg/L, the cooking oil industry had the highest TSS was discovered. With C2 = 3978 mg/L, the cooking oil industry had the highest TDS concentration. Similarly, the TS was found highest in cooking oil industry (C2 = 4185 mg/L) and least in pharmaceutical industry (P1 = 2239 mg/L). Pb was the sole heavy element present in every sample, yet none of them went above the allowable limit. The highest Pb was detected in cooking oil industry (C1 = 0.45 mg/L) while the least was detected in marble industry (M1 = 0.21 mg/L). Zn was only detected in cooking oil industry and Fe was present in cooking oil and pharmaceutical industry in small quantities. Overall, the wastewater of cooking oil of both industries exceeded the permissible limits of National Environmental Quality Standards as compared to wastewater from marble and pharmaceutical industries. It is suggested that each enterprise have a primary treatment plant, and that the drainage system be built, covered, and lined correctly to minimize effluent leakage and overflow as well as the addition of solid materials like paper and plastic bags.

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