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Physico-Chemical Analysis of Ceramic Industries Wastewater in Khurja District, Uttar Pradesh (India)

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ABSTRACT

The aqueous discard that is produced by an industrial manufacturing process results in water pollution, having pollutants dissolved or suspended in water. The magnitude of the problem increases many folds if several manufacturing units are concentrated in a small area. Industrial wastewater differs in quality and quantity of substances, causing pollution depending upon the type of industry producing it. The present study deals with an analysis of physicochemical characteristics of wastewater effluents from ceramic industries in Khurja district, Uttar Pradesh. Wastewater samples were collected from five different sites in Khurja district during the study period and analysed for pH, electrical conductivity, alkalinity, acidity, total hardness, dissolved oxygen, and various ions. The results were compared to WHO standards, and it showed that some parameters have higher values while few were within the limit.

KEYWORDS: *Ceramic wares, Ceramic Glaze, Khurja, Heavy Metals, Health Risks*

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INTRODUCTION

Industrial waste water plays an important role in polluting underground water, soil, rivers and other water bodies [1]. Emissions of organic compounds, heavy metals, and chemicals used in the ceramic industry cause significant pollution [2]. This contributes to global warming, greenhouse gas emissions and also becomes a cause of diseases like typhoid, dysentery and cholera [3]. Natural elements and plant supplements like nitrates and phosphates support the growth of algae on the water surface, which further deteriorates the health of a water body. The present study was carried out with an objective to review the quality of water from various ceramic industries in the Khurja District, Uttar Pradesh, India. This small district has around 500 ceramic manufacturing units producing crockery wares, art wares, sanitary wares, tiles, electrical insulators, electric fuse, and other household items [4].

The basic raw material used in the ceramic industry is clay (can be a single clay or a mixture of clays) used to make a body of ceramic ware [5]. Feldspar (Silicates of aluminum-containing sodium, potassium, iron, calcium, barium, or a combination of these elements) is added as flux, and at times quartz is used as filler [5]. Once the bisque ware (ceramic ware after first firing) is ready, a glaze is applied to protect its surface and increase durability. Glazing of bisque ware is done not only to provide a smooth surface but also to make it waterproof and food safe. The basic material of glaze is silica, as it facilitates the fusion of glaze material with clay. Historically, oxides heavy metals like lead, cadmium, and others were used to produce glaze flux to lower the melting point of silica and also to decrease the viscosity of glaze over a wide range of temperatures [6]. Low viscosity results in a better and uniform spread of glaze, giving a smooth finish to the product. Colored glazes and stains are used to enhance the aesthetic of clayware and make them more attractive. Colored glazes contain oxides of chromium, copper, iron, manganese, nickel, cobalt, and other metals. In ceramics, the weight percentage of these oxides may be as high as 24-32% [7]. Zinc, lead, and tin do not produce the color of metal oxides by themselves, but interact with others to develop unique effects. Some of these metals are required by humans and plants for biological functioning, but in large quantities, these are toxic to both plants as well as humans [8, 9].

Materials and Methods

Wastewater samples were collected from five different locations in the Khurja district, having several pottery units around. All the samples were collected in clean and rinsed plastic water cans of 5 litres capacity, with a double stopper facility to its full capacity without entrapping air bubbles. After collecting all samples, a systematic analysis of water was undertaken. Conductivity and pH were measured using a conductometer and pH meter, respectively. Total hardness, alkalinity, and acidity were estimated volumetrically. Dissolved oxygen was estimated using Winkler's method. All the ions were estimated spectrophotometric ally.

Results and Discussion

The Khurja district in Uttar Pradesh supplies a large proportion of ceramics used in the country and hence it is also known as "The Ceramics City". Unfortunately, the raw material and processes used have an adverse effect on the environment. Results obtained during the analysis of wastewater from the ceramic industry are shown in Table 1 and Figure 1. Results were compared with a permissible limit set by WHO as guidelines for drinking-water quality and were found to be alarming [10].

Table 1: Physico-chemical characteristics of wastewater samples of five different sites collected from Khurja District, Uttar Pradesh (INDIA).

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Permissible limit
Temperature (^{o}C)	17	18	18	17	17	–
pH	8.36	7.53	7.69	7.14	7.42	6.5–8.5
Conductivity (μmhos/cm)	3630	3680	2170	3300	1520	< 400 μmhos/cm
Total Hardness(ppm)	520	960	660	280	240	< 200 ppm
Alkalinity (ppm)	212	254	636	196	233	< 200 ppm
Acidity (ppm)	–	17	33	18	9	< 200 ppm
Dissolved Oxygen (ppm)	3.4	3.2	3.6	3.5	3.8	–
Ammonia	0.45	0.56	0.45	0.85	0.45	< 0.5 ppm
Nitrate	–	1.2	2.5	1.0	1.0	< 50 ppm
Chloride	3.0	1.2	1.6	4.3	2.0	< 250 ppm
Sulphate	–	–	2.3	1.1	1.1	< 400 ppm
Calcium	25.3	223.7	59.5	25.3	16.75	< 75 ppm
Iron	1.68	1.67	2.55	1.77	1.69	< 0.3 ppm
Cadmium	2.0	2.0	2.0	2.0	2.0	< 0.003 ppm
Copper	2.35	2.38	3.24	2.38	2.40	< 0.05 ppm
Silver	2.54	2.53	2.58	2.53	2.53	< 0.05 ppm

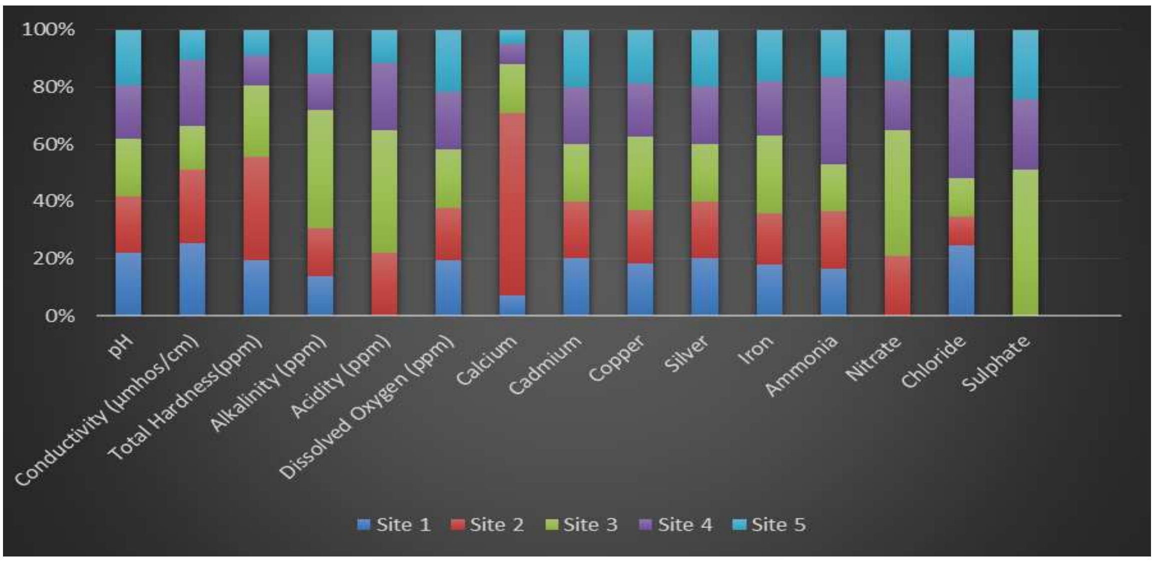

Figure 1: Bar graph of physico-chemical characteristics of wastewater samples of five different sites collected from Khurja District, Uttar Pradesh (INDIA).

Temperature is an important factor for biological activity in water. For all samples, the temperature was in the range of 17-19°C. pH shows the acidic or alkaline nature of water and for samples tested, pH was between 7.14 and 8.36. Though an important water quality parameter, these pH values are not a health concern. Electrical conductivity is directly proportional to the amount of dissolved mineral in any water sample. As anticipated, the observed values of conductivity were in the range 1520–3680 μmhos/cm. Such high values of conductivity suggest excessive ion concentration in samples. Dissolved oxygen was estimated to be in the range 3.2–3.8 ppm, which is the same as in tap water.

Total hardness of water is due to the presence of bicarbonates, chlorides, nitrates and sulphates of calcium and magnesium. All samples tested showed a total hardness in the range 240–960 ppm, which is much higher than a permissible limit of 200 ppm. Excessive hardness does not have any adverse effect on human health but can be a cause of unusual taste, excessive consumption of soap and scaling in water distribution system. For all the samples under study, except sample from site 3, the alkalinity lies near to its permissible limit and the acidity levels are negligible and lied in the range 9–33 ppm.

50 ppm is the maximum permissible limit of nitrate content in drinking water suggested by WHO. Fortunately, the nitrate concentration was found to be too low (1.0–2.5 ppm) and is well below that of health concern. Chloride and sulphate concentrations were also much below the safe limit. Ammonia concentration was in the range of 0.45–0.85 ppm which is close to the permissible limit of 0.50 ppm and is not of health concern.

Calcium: Calcium concentration is within a permissible limit in all samples except sample 2, which has a concentration of 223.7 ppm. This is also reflected in a higher value of total hardness of the same.

Iron: Iron is an essential micronutrient for human beings and its deficiency causes anaemia [11]. High iron content gives an awful taste to water and prolonged consumption can also have an adverse effect on internal organs. Samples analysed were found to have an iron concentration in the range of 1.67 to 2.55 ppm, much above the permissible limit of 0.3 ppm.

Cadmium: Cadmium concentration in all samples was 2 ppm, which is manifold higher than the tolerance limit (0.003 ppm) for drinking water suggested by WHO Cadmium is one of the highly toxic metals for human beings.

Copper: Copper is an integral part of many important biological processes, but overdose has been implicated in many metabolic and neurodegenerative disorders [12]. The concentration of copper was found to be in the range of 2.38 to 3.24 ppm. In all the samples under study, the copper concentration is alarmingly higher than the safe limit of < 0.05 ppm.

Silver: Silver content in water samples was in the range of 2.53–2.58 ppm. Unlike lead and mercury, silver is not toxic to humans and a high concentration in water samples is not a matter of concern.

Conclusion

The alkalinity, hardness and concentration of heavy metals in water samples is manifold higher than the prescribed limit. This suggests that water is highly is polluted and should be treated before discharging into a drain. Ceramic producing units should adopt standard pollution control techniques to minimize the problem.

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References:

[1] Q. Zhang and C. Wang, "Natural and Human Factors Affect the Distribution of Soil Heavy Metal Pollution: A Review", Water Air Soil Pollut., vol. 231, pp. 350 (1-13), 2020.

[2] M. Singer, Climate Change and Social Inequality, Taylor and Francis, London, 2018.

[3] M. Roy and F. Shamim, "Research on the Impact of Industrial Pollution on River Ganga: A Review", Int. J. Prev. Control Ind. Pollut., vol. 6, pp. 43-51, 2020.

[4] A. Rath, Mechanisms to Improve Energy Efficiency in Small Industries. Part Two: Pottery in India and Khurja, Policy Research International, Ottawa, Canada, 2001.

[5] M.S. Tite, "Ceramic Production, Provenance and Use- A Review", Archaeometry, vol. 50, pp. 216–231, 2008.

[6] S.C. Gilfillan, J. Occup. Med., pp. 753-760, 1965.

[7] J.S. Nordyke, Lead in the world of ceramics. American Ceramic Society, Columbus, 1984.

[8] M. Mahurpawar, "Effects of heavy metals on human health". Int. J. Res.– granthaalayah; vol. 3, pp. 2350 (1-7), 2015.

[9] F. Rehman, F.A. Khan, D. Varshney, F. Naushin, and J. Rastogi, "Effect of Cadmium

on growth of tomato". Biology and Medicine, vol. 3, pp. 187- 190, 2011.

[10] Guidelines for drinking-water quality, 4th edition, incorporating the 1st addendum, World Health Organization's (WHO), Accessed on April 29, 2022. https://www.who.int/publications/i/item/9789241549950

[11] A. Mandal, Causes of Anemia, Accessed on April 29, 2022. https://www.news-medical.net/health/Causes-of-anemia.aspx

[12] L.M. Gaetke, and C.K. Chow, "Copper Toxicity, Oxidative Stress and Antioxidant Nutrients". Toxicology vol. 189, pp. 147-163, 2003.

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