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Estimating Heavy Ion Concentrations in the Shatt AlKufa Area and Studying Methods for Recycling Wastewater

Noor Saad Jafar*

Abstract

This study includes practical methods for treating chemical pollution in wastewater. The proper disposal of wastewater is essential for providing a healthy environment for communities, adhering to international standards and utilizing the latest chemical and scientific methods to maintain a surrounding environment free from sewage pollutants. The goal of wastewater treatment is to prepare it for discharge into agricultural drains or for use in irrigation. Treatment removes a large percentage of pollutants, including suspended organic and inorganic solids, colloids, turbidity, odor, and improves color. It also increases dissolved oxygen levels and eliminates microorganisms that cause infectious diseases. The required level of treatment was determined by setting treatment objectives for the project, reviewing all relevant laws and regulations, and finally comparing the wastewater characteristics with legal requirements. This process identified and evaluated available treatment and disposal alternatives. Chemical methods were employed to remove pollutants from wastewater and facilitate reuse. The most suitable alternative, along with optimal conditions and pH levels, was then selected. Pollutants in the wastewater were removed using either physical, chemical, or biological methods, individually or in combination. Engineering and physical treatment methods rely on the natural properties inherent in nature itself, without human intervention. In other words, the forces acting on wastewater are natural forces that humans have observed and discovered within the surrounding environment. Chemical treatment units are always the preliminary and initial units in all wastewater treatment projects. Every project begins with physical treatment units as the first stage of the treatment process. Generally, most pollutants found in industrial wastewater can be removed and disposed of using physical, biological, or chemical methods.

Keywords: heavy metals, Heterogeneous Catalysis, Mechanism of Action, Mixed Oxide Catalysts, Green Chemistry, Density Functional Theory (DFT), Biomass Valorization, Wastewater, Chemical method, Sewage systems, Polluted water

INTRODUCTION

Wastewater is a type of polluted water resulting from various human activities and the diverse uses of water for many purposes. Wastewater carries many pollutants left over from human activities. Humans dispose of this waste through sewage systems as an easy and quick way to get rid of waste. These pollutants in wastewater must be handled carefully to protect the environment, human health, and the well-being of other organisms in the environment [1-3]. Waste water is closely linked to water and soil pollution. Therefore, it is essential and imperative to treat wastewater and liquid waste in general in a comprehensive manner to prevent these pollutants from reaching water sources, whether this water is used for domestic, recreational, or agricultural purposes. The process of treating, purifying, disposing of, and reusing wastewater must be organized and take into account

***Author for Correspondence**
Noor Saad Jafar
E-mail: rababmahdi49@gmail.com

Assistant Lecturer, Department of Chemistry, College of Education for Girls, University of Kufa, Iraq

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all environmental [4, 5], social, human, and economic factors. Good and effective wastewater treatment is one of the most important means and methods of protecting the aquatic and terrestrial environment from pollution, as proper scientific treatment provides safe and correct disposal of this water and its safe recycling within the ecosystem, and achieves human safety and preserves the environment and health. The Shatt al-Kufa area is a significant tourist destination in the city. Due to the large influx of tourists, waste has increased [6-9]. Furthermore, its location in an agricultural area, near factories, and the presence of drainage water have exacerbated pollution levels, particularly heavy ions. Results showed high levels of heavy ions, including cadmium and lead, which contributed to high concentrations [10-14]of pollution in the water. A detailed study was conducted on known methods for recycling polluted water and reusing it in a clean form, but only after confirming its safety and suitability for safe use. We suggested that the recycled water be used for irrigating plants and farms, as it is not entirely free of pollutants [15-18].

PRACTICAL PART

Preparing Samples for Measuring Heavy Metal Concentrations:

After collecting samples from stations or water sources at a depth of 25 cm, they were placed in nylon bags or plastic containers and transported to the laboratory. They were dried, and then the heavy metal concentrations in the sediment samples were estimated according to the method described in reference [23]. A weight of 0.5 g of dry soil was taken and placed in a glass flask. 5 ml of a digestion solution consisting of concentrated sulfuric acid (H2SO4), concentrated nitric acid (HNO3), and perchloric acid (HClO4) in a ratio of 3:1:1 was added. A clock face was placed on top of the flask to prevent evaporation of the concentrated acids. The samples were then heated on a heater at 90°C for two hours inside a hood. Finally, they were diluted by adding 25 ml of deionized distilled water. The absorbance of each sample was estimated using (a specific method) [19-21]. The atomic absorption spectrometer was used, and the absorbance was converted into concentration units by referring to the regression equations of the standard curves for the heavy elements under study, and the results were expressed in the unit (micrograms of metal per gram of dry soil weight).

The area studied is sample contaminated with heavy metals, as well as wastewater, for recycling and reuse, and to rid it of pollutants to make it purer using practical methods that work to remove pollutants. Practical method used include:

Determination of Concentration (Heavy Ions)

The concentration of heavy ions (such as lead, copper, cadmium, cobalt, and other ions) in wastewater is primarily determined through precise laboratory analyses, most notably atomic absorption spectroscopy (AAS) or inductively coupled optical emission spectroscopy (ICP-OES) for metal measurement. Samples are taken, treated with acids (such as nitric acid) to break down organic matter, and the results are then compared to a standard calibration curve to determine the concentration in milligrams per liter (ppm) or micrograms per liter (ppb)., At our study, atomic absorption spectroscopy (AAS) used to measurement to analysis (Shat Alkufa) area indicate that pollution levels, or the concentrations of certain heavy ions in wastewater, were higher than expected in (Shat Alkufa). The concentrations of heavy ions in wastewater (domestic and industrial) vary considerably depending on the source and treatment [19-21], often exceeding safe limits before treatment. High concentrations of metals such as chromium, copper, lead, cadmium and other ions were recorded in industrial wastewater, while studies of wastewater in area of city showed concentrations of (Pb= 8.89, Cr =5.75, Co =3.78 , Cu =7.94 , Cd = 7.63) parts per million.

RESULTS AND DISCUSSION

It is known that water recycling processes to make it usable are very important processes, but they require high accuracy and must be less economically costly and include chemical treatment of all heavy ions in polluted water. The levels of heavy ions in the waters of the Shatt al-Kufa area were high, indicating significant pollution, as shown in the following Table (1) and Figure (1).

Table 1. Assessment of concentrations of heavy metals in selected water Shat Alkufa by Flam atomic absorption spectrometry

Sample	**Concentration of heavy metals (ppm)**				
	Co	***Pb***	***Cr***	***Cu***	***Cd***
Shatt AlKufa	3.78	8.89	5.75	7.94	7.63

Table 2. Data of results for electrical conductivity with (pH) of sample.

Area test	**Conductivity (dsm-1), in (july -month)**	**in (december -month)**	**pH**
Area: (Shatt Al-Kufa)	8.74	4.32	7.62

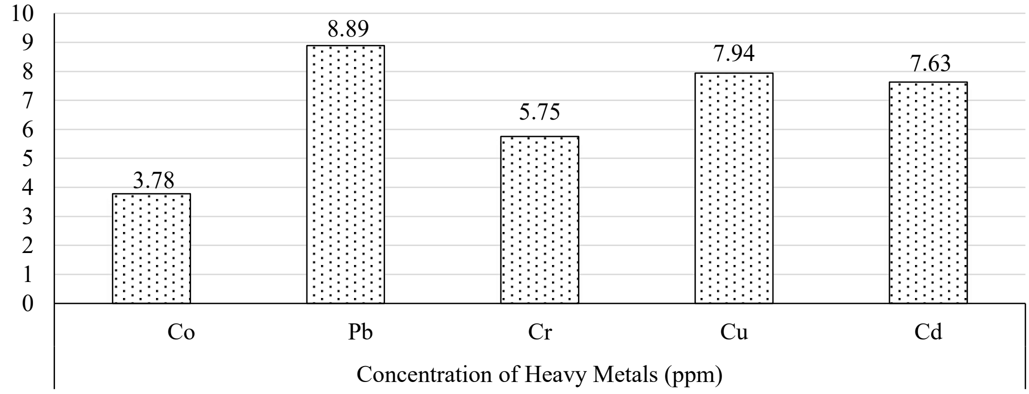

Figure 1. Concentration of (Co ,Cu, Cd, Cr, Pb) in Shat Alkufa

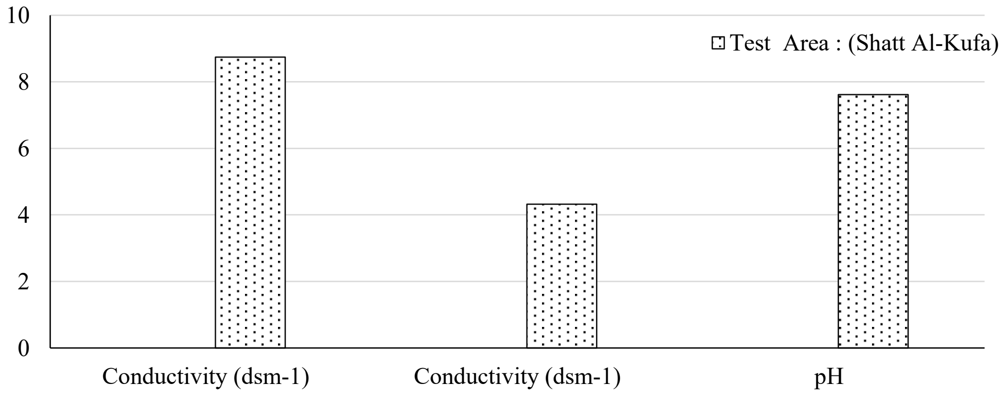

Figure 2. Electrical conductivity of samples through two months.

Electrical Conductivity and pH

The electrical conductivity of water sample was restrained promptly in the test center operating a Sence Eco 300 EC conductivity meter. The results were stated as (ds m) and (1:1) (ds m). The electrical conductivity of test categorization with river was assessed to be employing a conductivity meter the electrical conductivity assessment of the water in the study area ranged from [8.74 to 4.32 (ds m)]. The maximum data was noted in the water sample in (July 2025), and the minimal data was noted in the same sample through (December 2025). The results point to a reduction in the electrical conductivity data [22-25] of area compared to the two seasons. Data in table (2) and Figure (2):

Also treatment processes involve removing or converting pollutants from liquid waste by adding chemicals or through chemical reactions. Examples of these chemical processes include chemical precipitation, adsorption, and disinfection. These processes are among the most common in wastewater treatment.

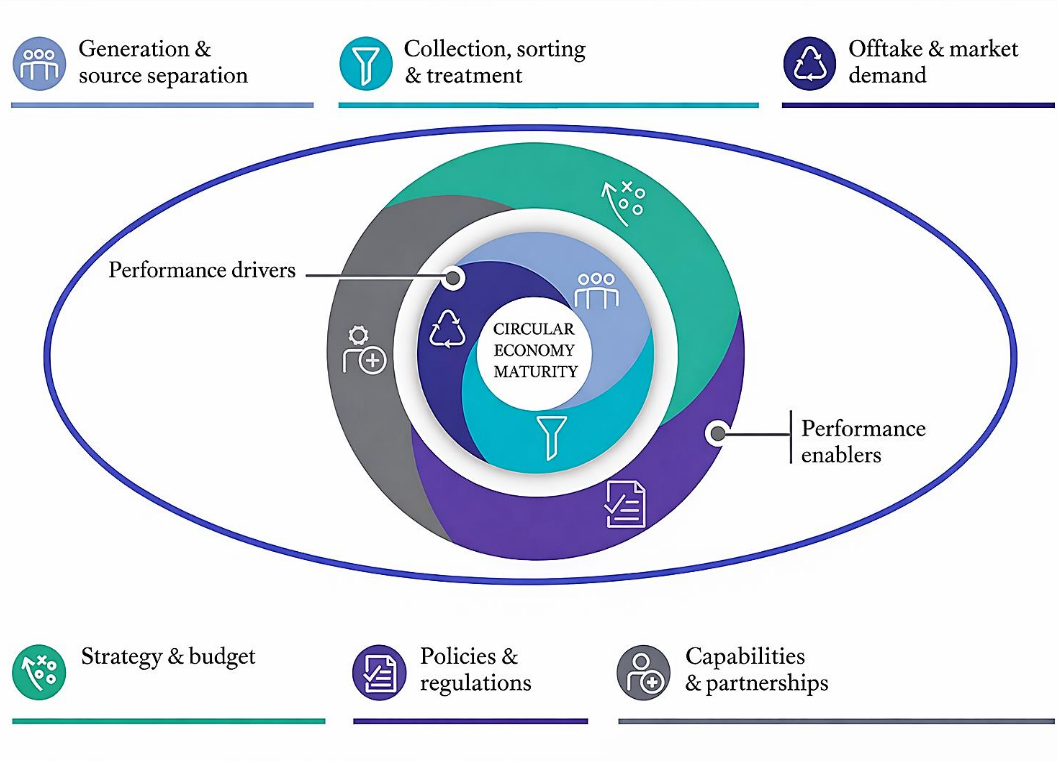

Figure 3. Treatment units for wastewater.

For example, chemical precipitation (using chemicals) involves using chemical precipitators to activate and accelerate the sedimentation process, where both the precipitator and the material to be precipitated are deposited. Adsorption, another example of chemical treatment, removes pollutants from contaminated water by adsorbing them onto the surface of the adsorbent material through the forces of attraction between the particles. In some wastewater systems, chemical treatment includes disinfection processes such as adding chlorine (also known as chlorination) or ozone disinfection. Additionally, certain polymers or chemicals are added to help dry and remove water from the sludge produced during the anaerobic digestion stages [22].

Generally, in wastewater treatment, chemical treatment units are used in conjunction with and complement physical treatment units. In most food and chemical industries, chemical treatment units are established after or before biological treatment units. For example, chemical neutralization processes (using acids or alkalis) precede chemical treatment units in order to prepare and adjust the pH to be suitable for the microorganisms that biologically treat pollutants in the biological treatment units, Figure (3).

Treatment Methods of Wastewater

(a) Neutralization: Regulating the pH of acidic or alkaline industrial waste to warrant its safety and neutralize the waste.
(b) Advanced Oxidation Processes (AOPs): Using a combination of ozone, hydrogen peroxide, and ultraviolet radiation to break down stubborn organic pollutants.
(c) Precipitation: For removing oils, fats, and colloidal chemicals.
(d) Preliminary Treatment: The purpose of this treatment is to protect the supply pumps and associated facilities. It may include the removal, shredding, or grinding of large suspensions, sand removal, removal of some heavy organic matter, and removal of floating materials such as oils, fats, and greases. It may also include a flow meter, balance tanks, and bar screens. Chlorination may be added. Generally, the results of the final treatment do not depend heavily on these preliminary treatments [22].

(e) Secondary Treatment Method: In this treatment, the percentage of phosphorus, nitrogen, heavy metals, non-biodegradable materials, bacteria, and viruses is reduced, but the removal rate remains limited. After this stage, a final sedimentation tank is needed to remove suspended solids, and the sludge resulting from the primary and final sedimentation tanks is collected for further treatment.
(f) Large-sized material removal: In this stage, solid materials are separated using appropriately designed mechanical means. Wastewater passes through metal filters with appropriate openings for separating large solids. The mineralized water settles in suitable basins.

In this stage, floating and foamy materials are separated from the water surface using metal filters.

Despite the vital importance of some heavy metals, they have a toxic effect due to their inability to be broken down by microorganisms and other natural processes. Furthermore, they are persistent in the environment and can be dispersed long distances from their sources by wind, storms, and rain. These metals are also characterized by their ability to bioaccumulate in the bodies of living organisms. Their concentrations increase through the food chain, entering the bodies of organisms via air, water, and soil, leading to bioaccumulation that causes permanent toxicity in living organisms. Therefore, they are dangerous to humans because they are at the top of the food chain and are the final reservoir for the accumulation of these elements in the bodies of various organisms. Numerous studies have indicated that rivers are subject to pollution. Heavy metals from various sources, such as domestic waste, mining activities, and agricultural practices like the application of fertilizers and pesticides, negatively impact the balance of the aquatic ecosystem [24, 25].

Other study indicated that the primary cause of water pollution is the direct discharge of untreated wastewater into rivers and reservoirs. These pollutants include heavy metals, pesticides, and others. Heavy metals are found in the aquatic environment either in the water itself, in suspended loads, or in bottom sediments. However, estimating their concentrations in water over short periods does not provide accurate indicators of the extent of pollution due to variations in water discharges, suspended loads, and the instability of the pollution source, as well as the irregularity of local releases of these pollutants. Therefore, the focus is on bottom sediments because they provide... A more stable indicator of these elements, as these deposits act as a trap for various elements [22–25].

CONCLUSIONS

Wastewater is treated using engineering and chemical methods, and these methods have successfully recycled water from pollutants. Treated water, especially treated wastewater, is used for various purposes, both directly and indirectly, after undergoing numerous tests and laboratory analyses to ensure its suitability for use. These uses include:

Agricultural applications such as irrigation, particularly for commercial ornamental plants, non-edible crops, and fruit trees.

Industrial uses, as well as street and road washing.

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