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Separation Heavy Metals from Waste Water

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P A P E R I N F O

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A B S T R A C T

The aim of the study of wastewater treatment is to reduce the amount of pollutants in the waterways. Certain countries use biological filtration techniques, while others resort to sedimentation or filtration. Several factors have reduced harmful emissions, including technological advancements and a shift towards less mineral production. However, with the increasing consumption of heavy metals, it is of utmost importance to vigilantly monitor the concentration of these contaminants. Mass spectrometry and atomic absorption spectroscopy are utilized to analyze the various elements in wastewater. These analytical tools are vital in this process and are highly regarded in scientific studies.

1. INTRODUCTION

Humans and other aquatic life rely on water for survival. However, water availability has decreased due to the increased human activities and the need for more resources. Large-scale sewage discharges can threaten industrial facilities [1]. Those producing heavy metals, like those found inside industrial facilities, tend to absorb heavy metals, which can then accumulate in various parts of the body [2]. These are originated from the Earth's crust. While heavy metals are often considered non-toxic, their cumulative effects can be detrimental to human health. For instance, exposure to zinc, copper, and selenium can lead to severe poisoning. Realizing the factors that impact human health is crucial to preventing heavy metals from infiltrating our water supply and posing a threat to individuals [3]. The two types of heavy metals are essential and non-negotiable. The former refers to substances living organisms that must be utilized to perform certain functions. The latter, on the other hand, includes elements such as zinc, copper, and Fe. In contrast, non-essential metals such as those that are found in Al, Pb, Zn, Cu, Cr, and Hg are not required in metabolic processes [4]. Table 1 shows a comparison of properties of the heavy metal with light metal [5,6].

TABLE 1. Properties compared heavy and light metals.

Chemical and physical properties	**Light metal**	**Heavy metal**
Density	Usually lower	Usually higher
Melting point	Mostly low	Mostly to very high
Periodic table location	Most were found in groups 1 and 2	Nearly all found in groups 3 through 16
Reactivity	More reactive	Less reactive
Complex	Colourless	Colored

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1.1 Classification of heavy metals

Heavy metals are classified into two types: non-essential and essential. The former includes elements of living organism which are required to perform certain functions, such as growth and metabolism. Essential ones, such as copper, zinc, and iron, are commonly required in trace amounts. On the other hand, non-essential elements like aluminum, manganese, and PB are not essential in metabolic processes [7,8].

1.2 Sources of heavy metals in aquatic environment

Heavy metals are transported to various bodies of water, especially freshwater, which is the primary medium for the largely rural and urban environment circles that develop. Pollution can occur in different ways due to human activities and natural sources [9].

1.2.1 Natural resources

Various geological processes, such as erosion and rock formations, release heavy elements into the aquatic environment through the ground or the air, transporting these minerals to the region [10].

1.2.2 Human resources

Industrial activity is a significant source of pollution with heavy metals in the environment. They are sources of metal pollution, including the petroleum industries, oil refineries, iron and steel factories, copper, glass, aluminum, tanning factories, fertilizers, pesticides, gasoline, and others [11].

1.3 Forms of heavy elements in the aquatic environment

There are three forms of heavy metals in water:

1- Dissolved heavy metal: this is represented by the elements present in the aqueous phase that passes through a filter paper whose openings are (45.0um) when filtering the water sample [12].

2. Particulate heavy metals

They include the elements present with suspended materials inside the components of the water, which cannot pass through filter papers whose openings are (45.0um) when filtering the water sample [13].

3. Heavy metals in bottom sediments:

Including:

- Exchangeable metals: these comprise elements that do not fall within the silica or reticular structure of sediment but are absorbed on the surfaces of benthic sediment particles [14].
- Residual metals: they are elements that fall within the silica or reticular structures of the benthic sediments [15].

1.4 Method of remove heavy metals in aquatic environment

The existence of heavy metals in wastewater increases with the growth of industry and human activities, such as the paint and electroplating industry, batteries, pesticides, mining industry, rayon industry, metal rinses, tanning industry, fluidized bed bioreactors, textile industry, metallurgy, smelting applications, petrochemicals, paper manufacturing, and electrolysis. Wastewater contaminated with heavy metals finds its way into the environment, menacing human health and the ecosystem. Heavy metals are not biodegradable. Besides, they can be carcinogenic. Thus, these minerals in inappropriate quantities in the water can lead to thoughtful health problems for living organisms. The greatest common heavy metals are lead (Pb), zinc (Zn), mercury (Hg), nickel (Ni), cadmium (cadmium, copper (Cu), chromium (Cr), and arsenic (As), but we can find other metals in wastewater such as silver (Ag), iron (Fe), manganese (Mn), molybdenum (Mo), boron (B), calcium (Ca), antimony (Sb), cobalt (Co), etc. These metals must be removed, and here we review recent developments and different methods for removing heavy metals from wastewater. The researchers also evaluate the advantages and limitations of applying these techniques. There are many methods for removing minerals in wastewater. These methods can be categorized into adsorption-, membrane, chemical, electrolysis, and photocatalysis-based treatments. Nevertheless, particular emphasis is placed on the processes of innovative removal, including adsorption on anaerobic adsorbents, biosorption, and photocatalysis. These processes have led to new directions and attracted more and more research in eliminating heavy metals from wastewater due to their high efficiency, versatility, and availability in large quantities. Applicability, wastewater characteristics, cost-effectiveness, and plant simplicity are the main factors in choosing the most appropriate method for contaminated wastewater [16-21].

1.5 Adsorption -based separation

Adsorption is the process of deposition of molecular organisms on a surface. The molecular species that are adsorbed are referred to as adsorbate, while the surface where they occur is called an adsorbent. Some of the frequently used adsorbents include silica gel, clay, and colloids. [22]. The mechanism for adsorbing heavy metals is determined by the various properties of the materials used, such as their chemical and physical properties. The initial concentration of the metal ions, operating conditions, and pH value are also considered to determine the effectiveness of this method. This method can be utilized to remove heavy metal ions from the surface of a sorbent. It has low operating costs and easy processing. [23]. Adsorption process for heavy metal ions: the metal ions of wastewater adhere to the surface of nanoporous adsorbents, which have a high surface area due to their porosity. The adsorption process could be selective for one or more metals than others. The regeneration process could be achieved using a desorbing agent as shown in Figure 1 [24].

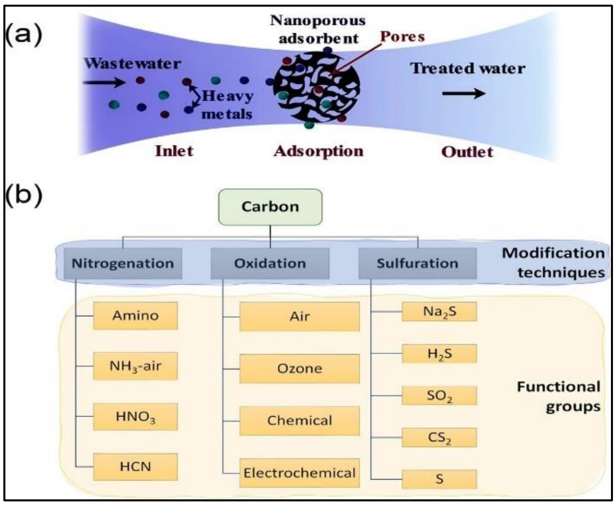

Figure 1. The regeneration process [25].

1.6 Toxic Effects of Heavy Metals

There is no widely agreed definition, so it can be defined based on density or the basis of atomic weight. Definitions based on atomic weight have been criticized because they cover elements with low-density [26]. Several health organizations are currently studying the effects of heavy metals such as Vanadium, Titanium, Gallium, Chromium, Cobalt, Iron, and Copper, which have a density of over 5. They are also interested in studying the effects of other critical minerals like Gold, Tin, Lead, and Mercury [27]. A silvery-white metal known as nickel is a constituent of the transition metals. It exhibits various characteristics, such as a malleable and ductile structure. It is also commonly used in the manufacture of batteries and electroplating. Due to its electrical conductivity, nickel is regarded as an ideal conductor. It is toxic, and it must be handled with care [28]. Cadmium is toxic and it threatens the environment. It can also cause various health conditions like kidney damage and respiratory failure. Although it is known to be present at low environmental levels, human activity increases its levels [29]. See Table 2.

TABLE 2. The elements average in ppm and location.

Elements average (ppm)z						Location
Zn	**Fe**	**Cu**	**Mn**	**Cd**	**Pb**	**Elements**
0.302	4.947	0.094	0.285	0.005	0.007	Crude(C)
3.095	3.713	0.085	0.903	0.002	0.005	Pre.Aeration(P.A)
0.139	2.140	0.115	0.215	0.004	0.005	Prim.setting(PS)
0.06	0.307	0.098	0.116	0.003	0.003	Final(F)
0.040	0.455	0.115	0.120	0.004	0.008	After chlorination (Cl_2)
0.727	2.312	0.101	0.327	0.0036	0.0053	General Average

2. METHOD

Water purification center to learn how to remove various impurities and minerals from the water. The water supply came from multiple sources, such as streams, lakes, and rivers. The first step in the purification process is to enter a sedimentation chamber with multiple funnels designed to separate the contaminants from the water. Alum, a key component in the water purification process, plays a significant role when the concentration of impurities or mud exceeds a certain level, typically 40% or 30%. It attracts minerals and breaks them apart into a gel substance [30,31], thereby facilitating their removal. However, when the percentages are low, the filters and sedimentation process alone can effectively remove contaminants, making alum unnecessary. After the initial purification steps, the water is collected in metal basins. The accuracy of this technique is its main advantage. The sedimentation process. To initiate the process, mixers are used to move the water [32], and a perforated tube is employed to remove the water from the top surface. The impurities, now separated from the water, are transferred to the collection basins, ensuring the cleanliness and safety of water for human use. Following the sedimentation process [33], the water is sent to the purification stage using filters, which can help remove unwanted elements and impurities. The water is then transferred to the filters through tubes [34,35]. Each filter features a set of legs spread throughout the basin, and its shape is a large basin below it. The filters help remove various elements and impurities from the water. After stopping work at night, the filters are washed. They are ready to work the following day once the water has been pumped from the bottom. Chlorine is then added to water in order to treat the contaminants. This process is carried out using a pressure-dispersion method [36]. The membrane is then removed through this process, and a portion of chlorine is pumped for increasing its sterilization. This process then prepares the product for human use. In long distances, chlorine's concentration decreases, and its aroma sometimes disappears from water [37]. A particular type of basin is made to deal with defective or perforated gas bottles that contain chlorine. This substance can be harmful if ingested or inhaled., and it can cause severe respiratory damage if its concentration exceeds a certain level, Figure 2. [38]

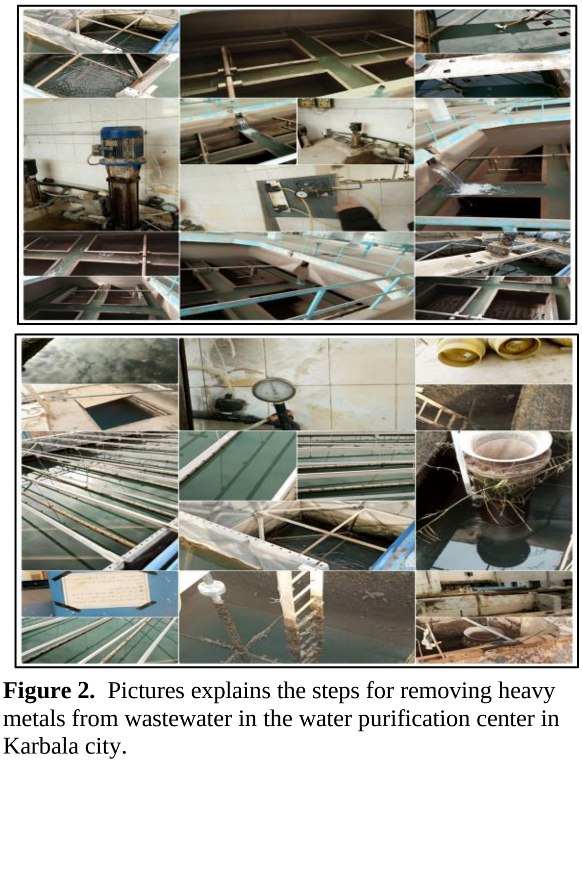

Figure 2. Pictures explains the steps for removing heavy metals from wastewater in the water purification center in Karbala city.

3. RESULTS AND DISCUSSION

The analysis of the samples revealed that the lead concentration in the water samples was over 17 mg/l. In the water that came from the tank and was treated, the concentration was around 08.0 mg/l. This suggests that proper water treatment is essential to minimize the effects of lead exposure. The process of water treatment induced a cadmium concentration fluctuation, highlighting the element's unpredictable nature. For instance, the sample water's 005.0 concentration exceeded the 04.0mg/liter limit. This suggests that the water treatment process must be continuously adjusted and monitored. The process of water treatment reduced the overall rate of change in the samples. For example, the sample water with a level of 005.0mg/l decreased in concentration to 0036.0mg/l during the operation of the Diyala River. The drop in the rate of change demonstrated the efficiency of the the process of water treatment . While the sample water had a lead concentration of 903.0 mg/L, the lowest reading during the tank's final chlorination was 116.0mg/L. Despite the slight decrease in the element's value, the wastewater still had a high concentration. The copper element's overall rate of change was 327.0 mg/l. After reaching 94.0 mg/l during treatment, its concentration increased in the samples from different regions. The changes exhibited after treatment were also higher than those of the source. A conclusion was reached after further analysis of the iron results. That was , a way existed to reduce the element's body parts' concentration. Concentrations in the chloroform and sediment basins decreased after the water treatment process started. Before the treatment started, they were at a high of 947.4 mg/l. The air Aeration and primary sedimentation basins maintained their rates of change. The water supply of the station comes from the nearby district of the Diyala river, which has about half of its body's total elements. The zinc element's value fluctuated with the samples, and before it was treated, it had a value of about 302.0 mg/l. [39- 44].

4. CONCLUSION

The sedimentation process was synthesized for the heavy metals removal from wastewater. It showed an extraordinary adsorption capacity to aqueous heavy metals ions based on the ion exchange reaction. The air Aeration and primary sedimentation basins maintained their rates of change.

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Arabic Abstract

الهدف من معالجة مياه الصرف الصحي هو تقليل كمية الملوثات في المجاري المائية. وتستخدم بعض الدول تقنيات الترشيح البيولوجي، بينما تلجأ دول أخرى إلى الترسيب أو الترشيح. وقد أدت عدة عوامل إلى خفض الانبعاثات الضارة، بما في ذلك التقدم التكنولوجي والتحول نحو إنتاج كميات أقل من المعادن. ومع ذلك، مع تزايد استهلاك المعادن الثقيلة، من الأهمية بمكان مراقبة تركيز هذه الملوثات بيقظة. يتم استخدام قياس الطيف الكتلي ومطياف الامتصاص الذري لتحليل العناصر المختلفة في مياه الصرف الصحي. تعتبر هذه الأدوات التحليلية حيوية في هذه العملية وتحظى بتقدير كبير في الدراسات العلمية.