REVIEW OF INTERNATIONAL GEOGRAPHICAL EDUCATION

ISSN: 2146-0353 ● © RIGEO ● 11(12), SPRING, 2021

www.rigeo.org

Research Article

Evaluation Of Heavy Elements in Health Institutions' Water Treatment Systems

Nibras Rashid Saeed[1]
The Iraqi Ministry of Education \ Baghdad, Rusafa II/Iraq

Anmar Dherar Kosaj[2]
College of Education for Pure Sciences, University of Anbar, Ramadi, Iraq
eps.anmard.kusaji@uoanbar.edu.iq

[2]Corresponding author: College of Education for Pure Sciences, University of Anbar, Ramadi, Iraq. Email: eps.anmard.kusaji@uoanbar.edu.iq

Abstract

The study's main goal is to assess the concentrations of heavy elements in hospital wastewater treatment systems. Some hospitals have various treatment systems whose goal is to lower the toxicity of heavy metals in waste from hospitals to urban sanitation systems. Pollution of the environment is a big worry for all countries around the world. International organizations are working to achieve environmental stability, especially as technological advancement occurs. The study collected (48) samples of sewage water for hospitals at (8) hospitals in the following locations (Najaf... Karbala... Babylon... Ramadi... Fallujah) before the start of the study. to look at the most hazardous heavy metals before and after treatment, an atomic emission spectrometer was used to measure the heavy metals, which revealed the most dangerous components. (AS..Hg...Cu. Cd. Pb), where the average value of elemental arsenic (As) after treatment was (0.0109125ppm), and the average value of elemental mercury (Hg) after treatment was (0.0109125ppm) (0.010447). ppm), average cadmium (CD) after treatment (0.0064 ppm), average copper (Cu) after treatment (0.0071 ppm), and average lead (Pb) value following the procedure was (0.010525 ppm). The relevance of hospital treatment systems and their critical role in reducing infection rates is highlighted by the findings removing heavy hazardous components from waste and reducing pollution The findings revealed that the elements were in accordance with the Iraqi Ministry of Health and Environment's determinants, with the exception of the element mercury, which was higher than the specified level in all hospitals, and thus was used in dental fillings, as well as the fact that some medicines contained percentages of elemental mercury . Where there are studies that did not address many treatment systems and show their importance and role, such as The researcher (Waad Muhammad Ali Abbas) in (2002) conducted a study on (System of Sequential Dose Basins (SBR) for the treatment of hospital water wastes The researcher (Yasser Jassem) in 2013 studied (the performance of the oxygen/anaerobic bio-membrane (SAM) sequestration agent system in hospital wastewater treatment and reuse)

Keywords
heavy elements, Liquid waste, Pollution

To cite this article: Saeed N, R, and Kosaj A, D. (2021). Evaluation of heavy elements in health institutions' water treatment systems. Review of International Geographical Education (RIGEO), 11(12), 1222-1230. Doi: 10.48047/rigeo.11.12.111

Submitted: 09-08-2021 ● **Revised:** 15-09-2021 ● **Accepted:** 15-11-2021

Introduction

Liquid waste represents a major threat to human and environmental safety due to its ability to penetrate into the watershed and contaminate groundwater and drinking water when improperly treated and disposed of. Considered illegal, knowing that unethical reuse can be harmful and even deadly in the event of an epidemic outbreak. The waste is adequately treated before disposal in public sewage systems according to the treatment rules (1998) and with the control of medical, liquid and chemical pathological waste. Effluent management includes the processes and practices prior to discharging the water into the sewage system, which prevents the release of untreated pollutants into the wastewater. Disposal of non-hazardous liquid waste [1] Heavy metals are elements greater than (6g / cm^3) of atomic density and are among the most persistent wastewater pollutants. Trace elements are sometimes referred to as metallic elements in the periodic table. Arsenic, lead, mercury, cadmium, chromium, copper, nickel, silver, and zinc are among the most common toxic heavy metals in wastewater. Releasing large concentrations of heavy metals into the water supply causes significant health and environmental problems and can contribute to increasing the cost of wastewater treatment. Heavy metals also occur in small amounts naturally and through rocks, airborne dust, forest fires and plants can enter the aquatic environment. Adequate treatment of liquid wastes is necessary before they are discharged to surfaces receiving aqueous materials to avoid the harmful effects of heavy metal toxicity in wastewater. The ultimate goal of treatment is the removal of Present or future risk to human/animal health and the environment [2] In previous studies, all the researcher (Sufyan Muhammad Saeed) (2002) conducted a study on (evaluating the efficiency of wastewater treatment plants in Three government hospitals in Mosul) [3] The researcher (Waad Muhammad Ali Abbas) in (2002) conducted a study on (the system of sequential dose basins (SBR) in the treatment of hospital wastewater) [4] - (B. Pauwels and W. Verstraete) (The treatment of hospital wastewater) (2006) [5] - The researcher (Madiha Mahmoud Al-Ani) in (2010) conducted a study on (medical waste pollutants resulting from diagnostic, analysis and health care processes for patients in the Women's and Children's Hospital - Ramadi and Hit General Hospital [6] We note from previous studies that work was done on one or two hospitals The effective role of wastewater treatment systems by collecting a number of samples before treatment and after treatment, and they are examined Heavy Elements ◙

Lead Element

Lead is a toxicologically important component and is present in the atmosphere in large quantities in the environment. The amount of lead in deep ocean waters is approximately 0.02-0.01) µg\l. But it is approximately 0.3 µg\l at the surface water. Lead is ubiquitous and can be found as metallic lead and inorganic ions and salts, like many other pollutants. Food is one of the main sources of lead exposure and the other sources are air and
drinking water.

Leadelement Toxicity

Lead toxicity is found in children and adults. However, toxicity in children has a greater impact than in adults. In fact, its tissues, both internal and external, are softer than those of adults. Long-term exposure to adults can result in decreased performance on some cognitive performance tests that measure nervous system function. Infants and young children are especially sensitive to low lead levels [7]

Cadmium Element

Cadmium is a relatively rare element that is widely distributed in the earth's crust with an average concentration of about (0.2 mg / kg). It is not found in nature in its purest form. The minerals zinc, lead, and sulfide copper are mainly combined.

Cadmium Toxicit

Tobacco smoke is one of the main causes of human exposure to cadmium. Tobacco contains

large amounts of the mineral in all its forms. Since cadmium is much higher in the lungs than in the digestive system, smoking greatly increases the overall body burden [8]

Mercury Element

Mercury (Hg) is the only element that is liquid at room temperature. The density is high (13.6 times that of water), the boiling point is relatively low (357C0) and the liquid has a wide freezing blister range (-396C0). Since conjugation with mercury does not wet the glass, the mercury is uniformly expanded so that the metal is suitable for use in thermometers. Mercury is not commonly found in the Earth's crust (0.1 to 1 ppm)

Element toxicity Mercury

can impair the function of any organ and the main target organ of mercury vapour is the brain, but peripheral nerve function, kidney function, immune function, endocrine function, muscle function, and many types of skin diseases have been described. With severe acute exposure to mercury vapour, inflammation may be associated with severe acute exposure to mercury vapour. [9]

Copper Element

Copper is a non-toxic Element. Where the copper content in the human body is about 100-150 mg), and represents an integrated functional protein movement. Being unable to synthesize copper, copper is a brown non-ferrous metal, has atomic number of 29 and is placed among the transition metals. This metal is a strong conductor of electricity and heat, and the reason for this is that many electronic devices contain copper. Copper is a very corrosion-resistant metal. It is the main reason why alloys such as bronze and brass are also mixed with other metals. Copper has very similar properties to gold and silver.

Copper Element Toxicity

Copper poisoning leads to an excessive breakdown of all protein structures, including hair and nails. Anemia: High copper/molybdenum ratio may contribute to iron deficiency anemia and may cause iron storage disease. Anxiety: Anxiety is frequently associated with elevated copper levels in the hair. This may be due to excessive production of stimulatory neurotransmitters which include catecholamines, epinephrine, norepinephrine, serotonin and dopamine. Arthritis: Copper levels in the synovial fluid of patients with rheumatoid arthritis are three or more times higher than normal. Autism: Both of these minerals (copper and iron) are brain stimulants and may lead to hyperactivity and/or autism[10]

Element the Arsenic

Arsenic is a widely distributed metal in the Earth's crust. Arsenic is rarely pure in the environment. The most common is its association with various elements such as oxygen, sulfur and chlorine to form inorganic arsenic compounds, and with carbon and hydrogen to form organic arsenic compounds. Trivalent water soluble and oxidation states Pentavalent inorganic arsenic is considered the most toxic of arsenic compounds. Atmosphere Arsenic is mainly found in inorganic form and absorbed by particles, while soluble arsenic and arsenic salts are most typically described in water. Arsenic deposits are transferred from the atmosphere to the soil

Toxicity Element Arsenic

Arsenic poisoning is a global health problem that affects millions of people. Pollution is caused by arsenic leaching from natural geological sources into aquifers, contaminating drinking water and can also occur through other industrial processes. Acute arsenic poisoning is initially associated with nausea, vomiting, abdominal pain, and severe diarrhoea. Chronic arsenic poisoning results in a multi-system disease, and arsenic is considered a human carcinogen that affects many organs[11]

Biological Remediation Processes for Heavy Metal Pollutants in Wastewater

The biological removal of heavy metals in wastewater includes the use of biological techniques for the elimination from pollutants from sewage. It is a selective technology that uses the operational flexibility of microorganisms and plants. Ex-situ and on-site microbial therapy may necessitate application. In phototherapy, plants play a role It is significant in the biological process because it breaks down, reduces, decomposes and removes these contaminants (12) in microbial or pretreatment Microbial biological societies are of prime importance. The process is a cost-effective process, with non-hazardous end products. While removing pollutants, the microbe (microbes) changes the chemistry of the mineral and move through it Either reduction, accumulation, mobilization, or immobilization. According to (13) major groups a microorganism involved in heavy metals' treatment is bacteria (such as Enterobacter, Bacillus Sap, Enterobacter, Cupriavidus metallidurans, Cyanobacteria, Enterobacter cloacae Pseudomonas aeruginosa, Streptomyces SP, Zoogloe Aramint Alcaligenes, Sphinganas, Rhodococcus. Mycobacterium and arthropods and fungi such as Aspergillus Tears, Penicillin hypogeum, Candida utilize, Hamsenula Anomaly and Rhodotorula mucilaginous Besides bacteria and fungi, some protozoa, such as Explodes Mirabilis and algae, such as Oscillator SP and Chlorella Vulgar is, and Chlamydomonas SP has been reported to possess minerals of limiting capacities . Microbial processing of toxic metals is said to occur in two ways: direct and indirect reduction. In the context of biomimetics, microbial therapy may be bio-absorption or bio-exploration processes. The biotic increase includes the production of the introduction of the germ line, which led to a high level of decomposition factor in the active support of the original microbe in the active (14)

The most important methods used in wastewater treatment

As countries strive to conserve basic water resources that are permitted and suitable for use by wastewater treatment methods, which are considered a traditional alternative to treatment systems. This gives hope to stop the inevitable loss of usable water in all ways of life, in addition to other important initiatives, namely traditional water recycling(15)

Sequencing Batch Reactor for Wastewater Treatment (SBR)

Sequential batch reactor (SBR) filling and withdrawal of activated sludge for wastewater treatment. In this system, wastewater is added to a single batch processor reactor to remove unwanted components and then discharged. Equation, aeration, and clarification can be achieved using a batch reactor. To improve System Performance, Two or more batches use reactors in a predetermined sequence of operations. SBR systems have been successfully used to treat municipal and industrial wastewater. They are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions (16) (Batch Chain Reactor) Treatment Type (Biological + Chemical + Physical

Moving Bed Biofilm Reactor (MBBR)

Focusing on building treatment plants that enable compact installations, which occupy the least physical space possible, that succeed in maintaining stable operation while minimizing the environmental impact. In this context, it is crucial to make the decision regarding what is related to design preceded by discussions involving various sectors of society, taking into account not only the technical aspects but also the administrative factors and the accompanying financial support in order to reach the target goals In recent years, there has been an increase in interest in biofilm operations for the treatment of municipal and industrial wastewater, due to the fact that these processes meet the future expectations mentioned above. There are several reasons why biofilm reactors have been preferred over other conventional suspended biomass processes. One of the main reasons is the possibility of working at high biomass concentrations, which allow the reactor to operate at a higher load. Adequacy of good removal of organic compounds, greater stability with respect to changes in effective composition and abrupt changes in load, temperature and toxicity, and ease of separation of solids downstream of the reactor. The attractive operations are illustrated Biofilms, a more compact form of these systems, take up less space. (17)

Biological Yeasts Treatment of Wastewater

Yeasts are unicellular fungi, which are usually ovoid, circular or cylindrical. It can be divided into two categories: (1) fermented yeast: a kind of yeast that can only use six-carbon sugar to ferment into alcohol and carbon dioxide mainly used in making bread, steamed bread, and wine-making industry; (2) oxidized yeast: a kind of yeast with strong oxidation ability, weak fermentation ability or no fermentation ability, such as Candida and hansenula polymorph a, mainly used in the petroleum processing industry and wastewater treatment process, which is the key target for water treatment(18) .

Biological treatment of conventional activated sludge

How Package Optimization Works BioCAS Package Wastewater Treatment Units are fully automatic with ease of operation, based on the SBR (Sludge Separated Sludge) principle. Before entering into package treatment, waste water from the facility or process is collected in an underground reinforced concrete structure. Prior to this construction, a rough mesh or pre-setting room can be built to install the insoluble parts. The purpose of this chamber is to ensure that wastewater enters the package treatment in a homogeneous manner. The waste water kept in the balancing chamber is conveyed to the package treatment tank by sewage pumps with shredding blades under PLC automatic control in package treatment. The aeration process with the blower begins simultaneously with the transfer of waste water to the tank by submersible pumps in the balance chamber and the filling process continues until the waste water is filled to a certain level. On the other hand, aeration feeds the waste water with oxygen for the time required for the bacteria in the waste water taken into the tank to reach saturation in terms of oxygen. After the aeration process, the stage of stabilization and rest begins and the microorganisms present in the water are expected to settle at the bottom of the tank for a certain period of time. During the unloading phase, the clear water remaining at a certain height from the bottom of the tank is conveyed to the unloading point with the help of submersible pumps in the tank. In this way, the processes are continued periodically and the purification process is completed at the vacuum limits in accordance with the legislation, thanks to the BioCAS package processing units. Package handling units can optionally be designed as circular, prismatic or reinforced concrete. The quality of treatment of effluents in packaging ensures compliance with the discharge limits based on the relevant environmental legislation as a standard. Additionally if desired, the effluent values can be reduced to higher quality effluent water values by increasing the properties in the BioCAS packaging processing units. Wastewater treatment units aim at high water quality with low energy consumption. Wastewater treatment units with PLC support work according to water density due to their design. Advanced treatment equipment such as sand filter, carbon filter and UV unit can be added to improve water quality after package treatment. Wastewater treatment methods For wastewater treatment, several methods are used in the current technology, and processes of economic benefit and high efficiency are selected, taking into account the required effluent quality. some of those; SBR Series Batch Reactors) It is a sequential sequential sludge system The process takes place in the next cycle BioCAS® P batch process units are manufactured from 5mm thick carbon steel in portable sizes, and the internal and external sandblasted surfaces are covered with two coats of epoxy coating to protect against corrosion. The packaging unit is operated, by placing it on a light concrete floor.. Thanks to the ease of operation of the BioCAS® wastewater treatment units, there is no need for any personnel. It is more attractive than other alternative processes with low maintenance costs. The operation of BioCAS® is based on the principle of batch activated sludge. The system, which operates for a total of 4 periods per day due to operation, completes each period such as upgrade, ventilation, evacuation and disinfection. In sewage treatment units, effluents can be easily drained as a garden drench into places such as canals and stream ponds. By using a sand filter, carbon filter or UV unit at the package processing port, the efficiency of the water generated from the package treatment can be increased. [19]

Case Study

The research aims to assess the environmental reality of hospitals in terms of damage resulting from pollution with heavy metals, such as concentrations of the most toxic elements before treatment and after treatment (lead, cadmium, copper, mercury, and arsenic). studying. Where wastewater

was measured and compared with the determinants. Permitted by the Iraqi Ministry of Health and Environment as a flame atomic emission spectrometer was used Technique used Flame Atomic Emission Spectrometer The spectrometer is used to measure the concentrations of heavy metals in heavy water samples taken from treatment systems Hospitals such as (AS. Hg. Cd. Cu. Pb) are of German origin, year (2012) The method of work Working method: flame atomic emission spectrometer spectrometer

▓ Works at a frequency of (220 volts) and (50 Hz) Forms are entered consecutively consecutively
▓ Then we enter the concentrations of standard solutions using the element (Stander) whose purpose is to create a calibration curve. The purpose of the titration curve is to display known patterns of concentrations
▓ After the device is turned on, the item to be measured is selected by input The name of an element to the calculator where the device is connected directly to it, and the device performs the rest of the element parameters (wavelength. Gas consumption and element beam exit aperture Measurement is direct without adding acids or other (20) chemicals

Results and Discuss

Table (1)
of heavy elements before and after water treatment

number	elementsHeavy	Determinants
1-	Arsenic (As) ppm	0.05mg \ l
2-	Mercury(Hg) ppm	0.005mg \ l
3-	Cadmium(Cd) ppm	0. 1mg \ l
4-	Copper (Cu) ppm	0. 1mg \ l
5-	Lead (Pb) ppm	0. 1mg \ l

Table (2)
of determinants of the Iraqi Ministry of Health and Environment for heavy metals in water

number	name of the hospital	system type
1-	Al-Sadr	YET
2-	Al- Zahraa	MBBR
3-	Al- Furat	SBR
4-	AL- Fallujah	SBR
5-	AL- Ramadi	SBR+CAS
6-	AL - Sadiq	SBR
7-	AL-Husseini	MBBR
8-	AL-Women's Hospital for Children	MBBR

From Table No. (1) we note the values of toxic elements before and after treatment and we find the highest and lowest values of heavy metals and compare them with the determinants of the Iraqi Ministry of Health and Environment for Table No. (2) for each of the following hospitals: -

1- AS (element, arsenic)
* - Al-Sadr → → (0.0038 ppm) < (0.05mg\l)
*-Al- Zahraa → → (0.0033 ppm)
*- Al- Furat → → (0.0031 ppm)

*-AL- Fallujah → → (0.0011 ppm)
*-AL- Ramadi → → (0.0027 ppm)
0.0036 ppm) (→ → AL - Sadiq* -
0.0014 ppm) (→ → AL-Husseini* -
And Children's → → (0.001 ppm) AL-Women's* -

- We note from the arsenic values above that they contain the lowest value in Al-Hussein Hospital and Women's Hospital for Children (0.001 ppm) (0.0014 ppm and the highest value in Al-Sadiq and Al-Sadr Hospital 0.0036 ppm) (0.0038 ppm) and this indicates the efficiency of the treatment system MBBR in Al Hussein Hospital and Women's Children's Hospital The lowest value for arsenic, where the value of arsenic in general is less than the limit set by the Iraqi Ministry of Health and Environment (0.05mg\l)

2- Hg (element, Mercury)
* - Al-Sadr → → (0.005133 ppm) (0.005mg\l)
*-Al- Zahraa → → (0.0009333 ppm)
*- Al- Furat → → (0.002133 ppm)
*-AL- Fallujah → → (0.0022 ppm)
*-AL - Ramadi → → (0.002866 ppm)
0.002667 ppm) (→ → AL - Sadiq* - 0.005323ppm) (→ → AL -Husseini* -
And Children's → → (0.001866 ppm) AL -Women's* -

-*-We note that the above values of mercury from the product of treatment systems for hospitals are higher than the specification of the Iraqi Ministry of Health and Environment (0.005mg/l), where the outputs of the systems in hospitals were from lowest to highest for women and children (0.001866 ppm) and Fallujah (0.0022 ppm) Al-Furat (0.002133 ppm) Al-Sadiq (0.002667 ppm)) Al-Ramadi (0.002866 ppm) Al-Sadr (0.005133ppm) Al-Hussein 0.005323ppm) Where mercury enters the manufacture of dental fillings, as well as some medicines that contain mercury

3- Cd (element, Cadmium)
* - Al-Sadr → → (0.0036 ppm)
*-Al- Zahraa → → (0.00017 ppm)
*- Al- Furat → → (0.0023 ppm)
*-AL- Fallujah → → (0.0014 ppm)
*-AL - Ramadi → → (0.0013 ppm)
0.0027 ppm) (→ → AL- Sadi* - 0.0006ppm) (→ → AL -Husseini* -
And Children's → → (0.0008 ppm) AL -Women's* -

*- We note from the cadmium values above that it contains the lowest value in Al-Hussein Hospital and Women's Hospital for Children (0.0006ppm) (0.0008 ppm) and the highest value in Al-Sadiq and Al-Sadr Hospitals is 0.0036 ppm (0.0027 ppm)) and this indicates the efficiency of the MBBR treatment system in Al-Hussein Hospital and Al-Sadr Hospital. Women and children where cadmium values are generally lower than the limit set by the Iraqi Ministry of Health and Environment (0.1mg\l)

4- Cu (element, copper)
* - Al-Sadr → → (0.0032 ppm)
*-Al- Zahraa → → (0.00029 ppm)
*- Al- Furat → → (0.0017 ppm)
*-AL- Fallujah → → (0.0009 ppm)
*-AL - Ramadi → → (0.0018 ppm)
0.0026 ppm) (→ → AL - Sadiq* -
0.00037 ppm) (→ → AL -Husseini* -
And Children's → → (0.001 ppm) AL -Women's* -

-*We note from the above copper values that it contains the lowest value in Fallujah Hospital and Al-Ramadi Hospital (0.0009 ppm) (0.0018 ppm) and the highest value in Al-Zahra and Al-Sadr Hospital (0.0032 ppm) (0.00029 ppm), and this indicates the efficiency of the treatment system in Fallujah SBR Hospital and Ramadi Hospital SBR + CAS In general, copper values are lower than what was determined by the Iraqi Ministry of Health and Environment (0.1mg/l)

5- Pb (element, lead)
* - Al-Sadr → → (0.0033 ppm)
*-Al- Zahraa → → (0.0014 ppm)
*- Al- Furat → → (0.0026 ppm)
*-AL- Fallujah → → (0.005 ppm)
*-AL - Ramadi → → (0.0016 ppm)
0.0026 ppm) (→ → AL - Sadiq* -
0.0048 ppm) (→ → AL -Husseini* -
And Children's → → (0.0025 ppm) AL -Women's* -

*- We note from the values of lead above that it contains the lowest value in Al-Fallujah Hospital and Al-Zahra Hospital (0.001 ppm) (0.0014 ppm and the highest value in Al-Husseini and Al-Sadr Hospitals is 0.0048 ppm) (0.0033 ppm), and this indicates the efficiency of the treatment system in Fallujah SBR Hospital and Al Zahra Hospital MBBR with the lowest value Lead, where the values of lead are generally lower than the limit set by the Iraqi Ministry of Health and Environment (0.1mg\l)

Conclusions

It is clear to us through the above results and after discussing them that the only element that has a high percentage is mercury, and the reason is due to the fact that hospitals have dental clinics, as well as pouring sewage medicines that contain a percentage of mercury. And the average values of the five elements that were examined are less than the determinants of the Iraqi Ministry of Health and Environment, except for the average values of mercury

average arsenic after treatment (0.0109125ppm) < (0.05mg\l)
average mercury after treatment (0.010601375 ppm) > (0.005mg\l)
average cadmium after treatment (0.0064 ppm) < (0.1mg\l)
average copper after treatment (0.00529575 ppm) < (0.1mg\l)
average lead after treatment (0.010525 ppm) < (0.1mg\l)

References

Muller Journal of Medical Sciences and Research | Vol 4 | Issue 2 | Jul - Dec 2013.
USEPA (2004). Citizen's community window on the hunters point shipyard cleanup. United States Environmental Protection Agency (USEPA). Available at: http://www.communitywindowontheshipyard.org
Igwe, JC and Abia AA (2006). A bioseparation process for removing heavy metals from waste water using biosorbents.African Journal of Biotechnology, 5(12):1167-1179
Amaral, A, Cruz, JV, Cunha, RT and Rodrigues, A (2006). Baseline levels of metals in volcanic soils of the Azores (Portugal). Journal on Soil & Sediment Contamination, 15:123–130
Cushnie, GC (1985). Electroplating Wastewater Pollution Control Technology. Noyes Publication: New Jersey: pp. 375-377
Wei, C, Wang, C and Yang, L (2008). Characterizing spatial distribution and sources heavy metals in the soils from mining-smelting activities in Shuikoushan Hunan Province, China. Journal of Environmental Sciences, 21:1230–1236
Lead, chemical element. (2012). Retrieved from Physical and Chemical Properties http://www.chemistryexplained.com/elements/L-P/Lead.html
Rahimzadeh, M.R.; Rahimzadeh, M.R.; Kazemi, S.; Moghadamnia, A.A. Cadmium toxicity and treatment: An update. Caspian J. Intern. Med. 2017, 8, 135–145
ENVIRONMENTAL TOXICOLOGY Second Edition Biological and Health Effects of Pollutants 2005 by CRC Press LLC (References/For More Information Environment Canada http://www.ec.gc.ca/mercure-mercury/ U.S. EPA http://www.epa.gov
Badiye Ashish, Copper Toxicity: A Comprehensive Study, Research Journal of Recent Sciences, 2013; 2(ISC-2012): 58-67
Chilvers, D. C., and P. J. Peterson. 1987. "Global Cycling of Arsenic." In T. C. Hutchinson and K. M. Meema, eds., Lead, Mercury, Cadmium and Arseni in the Environment. Scientific Committee on Problems of the e Environment (SCOPE) 31 . New York: John Wiley & Sons

USEPA (2004). Citizen's community window on the hunters point shipyard cleanup. United States Environmental Protection Agency (USEPA). Available at http://www.communitywindowontheshipyard.org
Dias, MA, Lacerda, ICA, Pimentel, PF, Castro, HF and Rosa, CA (2002) Removal of heavy metals by an Aspergillus
terreus strain immobilized in a polyurethane matrix. Letters in
Applied Microbiology, 34: 46-50
Sharma, S (2012). Bioremediation: Features, strategies and
applications. Asian Journal of Pharmacy and Life Sciences, 2(2): 202-212
Naghizadeh, A., Mahvi, A. H., Mesdaghinia, A. R., & Alimohammadi, M. (2011). Application of MBR technology in municipal wastewater treatment. Arabian Journal for Science and Engineering, 36(1), 3-10.
Mikkelson, K. A. (1995). AquaSBR Design Manual, Aqua-Aerobic Systems. Inc., Rockford. 16
Bassin, J. P., & Dezotti, M. (2018). Moving bed biofilm reactor (MBBR). In Advanced biological processes for wastewater treatment (pp. 37-74). Springer, Cham.18- Qadir, G. (2019). Yeast a magical microorganism in the wastewater treatment. Journal of Pharmacognosy and Phytochemistry, 8(4), 1498-1500.19- https://www.coskunaritma.com/tr-TR/biyolojk-paket-aritma/3/7
novAA® Quality is the difference novAA® 350 with hydride system2012