

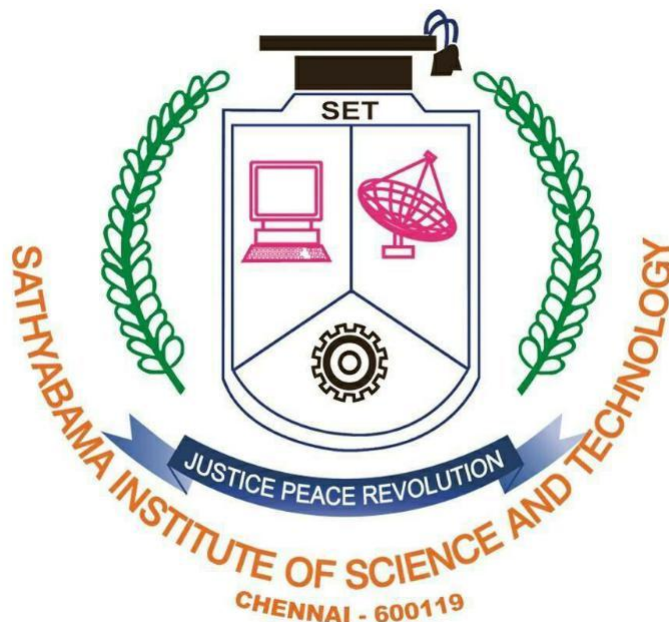
HEAVY METAL REMOVAL FROM AQUEOUS SOLUTION BY ADVANCED CARBON NANOTUBES

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Civil Engineering

by

NAVEEN KUMAR.G (38200021)

PERIANNAN.K (38200024)



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119
APRIL 2022



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **NAVEEN KUMAR.G (38200021)** and **PERIANNAN.K (38200024)** who carried out the project entitled "**HEAVY METAL REMOVAL FROM AQUEOUS SOLUTION BY ADVANCED CARBON NANOTUBES**" under my supervision from October 2021 to April 2022.

INTERNAL GUIDE
(Mrs. B. PRIYADHARSHINI)

Head of the Department
(Dr. S. PACKIALAKSHMI)

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We, NAVEEN KUMAR.G (38200021) and PERIANNAN.K (38200024) hereby declare that the Project Report entitled “**Heavy metal removal from aqueous solution by advanced carbon nanotubes**” done by us under the guidance of **Mrs. B. Priyadharshini.**, M.E at Sathyabama Institute of Science and Technology, Chennai is submitted in partial fulfillment of the requirements for the award of a Bachelor of Engineering degree in Civil Engineering.

1.

2.

SIGNATURE OF THE CANDIDATE

DATE:

PLACE:

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ABSTRACT

Recently, the contamination of drinking water due to the presence of heavy metals is being analyzed by scientists. Most heavy metals adulterate both surface water and subsurface water and transform the quality as these metals are highly toxic, persistent, and dangerous to humans and the environment. Hence, in this study, the Aqueous solution was analyzed using a UV Spectrometer and Atomic Adsorption Spectrometer (AAS) method to estimate the heavy metal concentration in the Aqueous Solution. The solution is prepared at the lab by using lead nitrate and potassium dichromate and dissolving in distilled water. After the solution is tested the values are checked with the before solution. Tests are done by the variation of time, dosage, pH, and temperature. Results are compared before and after the solution.

Keywords: Aqueous solution, Heavy Metal, UV spectrometer, Heavy atomic adsorption spectrometer, lead, chromium

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CHAPTER-1

INTRODUCTION

1.1 GENERAL

Water is without a doubt the most important and valuable resource. Water is the source of life, and it is the source of life's nourishment. Abysses hold 97 percent of the world's water. Non-saline fresh water makes up only 2.5 percent of the world's water. There are species that can survive without oxygen, analogous to anaerobes. However, no life can exist for long without water. It's a universal detergent that maintains ionic balance and gives nutrients to support all types of life. Groundwater is the most important source of water in India for household, agricultural, and industrial needs. Water that is buried underground in cracks and crevices in soil, beaches, and jewels is known as groundwater. This source has two distinct functions; originally, it's a significant source of both civic and pastoral population's water force and secondly, it sustains numerous swamp ecosystems.

Groundwater is a good source of freshwater resources, which is the biggest issue for its sustainable application in front of policymakers. Natural filtration through soil and sediments makes the groundwater free from organic contaminations. Colorful major controlling groundwater chemistry factors are indigenous geology, geochemically process, and land-use patterns. The evaporation and irrigation return inflow also shows the major ion chemistry of groundwater. Due to anthropogenic conditioning, groundwater quality and volume are deteriorating at a veritably fast rate. Major provocation for the general public, experimenters, and water directors are the groundwater inflow and its storehouse in hard gemstone regions, either its quality or volume are also affected.

A major issue is the limitation of groundwater resources and their long-term sustainability. Over pullout of groundwater is deteriorating the groundwater quality achieving advanced saltiness, Nitrate, Iron, Fluoride, and another heavy essence in groundwater. Inordinate use of pesticides and fungicides, undressed sewage treatment systems, and mixing of non-treated external and artificial backwaters with groundwater are deteriorating the groundwater quality.

Groundwater is used for residential, agricultural, and artificial purposes in the world's farthest reaches. Ponds, gutters, and groundwater are used for home and agricultural uses in India. Swab water has intruded into fresh-water aquifers in several littoral locations because to furious pumping of fresh groundwater. Artificial products produced with little consideration for environmental consequences have resulted in increased water and air pollution, soil deterioration, and large-scale global effects such as acid rain, global warming, and ozone depletion. Another crucial component is the soil quality. The mortal body's proper functioning is dependent on the heavy essence. The natural function of mortal beings will be disrupted if any of the weighty rudiments are out of balance. Both natural and man-made sources of heavy essence are added to the water system.

In water, heavy essence refers to the heavy, viscous, metallic rudiments that exist in trace amounts but are poisonous and tend to collect, hence being referred to as trace essence. Artificial wastes from mine sites, manufacturing and essence finishing establishments, home wastewater, and road runoff are the main anthropogenic sources of heavy essence. Many of these trace elements, such as Hg, Pb, Fe, Cr, Mn, Ni, and Co, are highly dangerous to humans. Their presence on the face and in underground water, which is hidden from view, is unwelcome. Pb, Cr, Fe, Co, Mn, and Cr are some of the heavy elements that have been connected to harming the underwater ecology and mortal health. For that heavy essence, the MCL limits were defined by the USEPA (Babel and Kurniawan, 2003)

1.2 HEAVY METAL

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations

Examples of heavy metals

1. Mercury (Hg)
2. Cadmium (Cd)
3. Arsenic (As)
4. Chromium (Cr)
5. Thallium (Ti)
6. Lead (Pb)
7. Zinc (Zn)
8. Nickel (Ni)
9. Copper (Cu)

1.3 EFFECT OF HEAVY METALS

TABLE 1.1 *EFFECTS OF HEAVY METALS*

Heavy metal	Toxicities	MCL (mg/L)
Arsenic	Skin manifestations, visceral cancers, vascular disease	0.050
Cadmium	Kidney damage, renal disorder, human carcinogen	0.01
Chromium	Headache, diarrhea, nausea, vomiting, carcinogenic	0.05
Copper	Liver damage, Wilson disease, insomnia	0.25
Nickel	Dermatitis, nausea, chronic asthma, coughing, human carcinogen	0.20
Zinc	Depression, lethargy, neurological signs, and increased thirst	0.80

Lead	Damage to the fetal brain, diseases of the kidneys, circulatory system, and nervous system	0.006
Mercury	Kidney problems and circulatory systems defects	0.00003

1.4 TREATMENTS FOR HEAVY METALS

Heavy metals square measure discharged into water from varied industries. they'll be noxious or malignant neoplastic diseases and might cause severe issues for humans and aquatic ecosystems. Thus, the removal of serious metals from waste matter may be a major problem. The sorption method is widely used for the removal of serious metals from waste matter owing to its low price, accessibility, and eco-friendly nature. each business adsorbents and adsorbents square measure used for the removal of serious metals from waste matter, with high removal capability. This critical review aims to compile scattered data on the various adsorbents used for serious metal removal and to produce data on the commercially obtainable and natural bio adsorbents accustomed to taking away atomic number 24, cadmium, and copper, especially

1.5 ADSORBENT AND ITS VARIATION

An adsorbent is an insoluble substance with capillaries and pores on its surface that is coated with liquid. When a fabric, similar to a sponge, can hold a specific amount of liquid in small chambers, it is said to be adsorbent.

Adsorbents play a significant role in chemical absorption, which takes place once an explicit substance is at bay on a material's surface. surface assimilation is the method of a liquid or gas accumulating on a liquid or solid surface, building associate degree atomic or molecular film. it's well totally different from the method of absorption, wherever a substance goes through diffusion into a solid or liquid to provide an answer.

Adsorbents, through the method of surface assimilation, square measure operative in the majority of systems like chemical, biological and physical. They additionally play a serious role within the trade, with several applications like in water purification, activated carbon, and artificial resins.

Adsorbents aid in the infliction of waste heat in order to supply cold water for air conditioning and other processes. The adsorbent composition is extremely beneficial in the trade for preventing corrosion in a variety of instruments and machinery, such as mufflers.

Internal corrosion of metal mufflers near combustion engines, for example, is prevented by maintaining the exterior void space of adsorbent mass mixed with crystalline zeolites and various crystal forms that have a synergistic effect on corrosion retardation.

1.6 NANOTUBES AND THEIR VARIATION

There are Major types of adsorbents in use are:

1. Activated Alumina
2. Silica Gel
3. Activated Carbon
4. Molecular Sieve Carbon
5. Molecular Sieve Zeolites
6. Polymeric Adsorbents.

IN THAT CARBON NANOTUBES AS ADSORBENT

1.7 CARBON NANOTUBES

A carbon nanotube is a tube with a diameter measured in nanometers that is formed of carbon. It has enormous cylindrical molecules made up of a HEXAGONAL

ARRANGEMENT OF HYBRIDIZED CARBON ATOMS that can be rolled up from a single sheet of graphene.

There are two types of Carbon Nanotubes

1. Single-walled carbon nanotubes
2. Multi-walled carbon nanotubes

IN THAT MULTI-WALLED CARBON NANOTUBES ARE USED

1.7.1 MULTI-WALLED CARBON NANOTUBES

MWCNT is the abbreviation for MWCNT. It is made up of multiple carbon nanotubes that have been thoroughly examined. Nanotubes of this sort have two diameters, one for the outside diameter and one for the interior diameter. Chiral Multi-walled Carbon Nanotubes are one type of multi-walled carbon nanotube.

Properties

1. The outer diameter of Multiwalled Carbon nanotubes is around 2-20 nanometres.
2. The inner diameter of Multi-walled carbon nanotubes is 1-3 nm.
3. The length of Multi-walled carbon nanotubes is around 5-6 micrometers.

Table 1.2: *Properties of MWCNT*

Product name	Multi-walled carbon nanotubes
Product code	CNT-P1
Formula	C
Mol. wt	12
Appearance	Black powder
Average particle size	10-30nm,length 1-10nm
Purity	93%

SSA [BET]	475 m ² /g
pH value	7.9
Bulk density	0.25 g/cm ³

CHAPTER – 2

LITERATURE SURVEY

2.1 GENERAL

The main purpose of the literature review is to give an idea about the research work conducted by various researchers in the world. This helps to get an idea of how to carry out our project in the right way. The following literature review elaborates on

how to analyze the groundwater and estimate the heavy metal pollution and removal of identified heavy metals using an adsorbent

2.2 LITERATURE SURVEY

Matej suranek et al., (2021) had studied - The surface assimilation of nickel (Ni(II)) by clay samples was an energy-absorbing and spontaneous method. The natural bentonites from JP and SK were best suited for the removal of nickel from synthetically ready solutions. All experiments were done below execution conditions, with the concentration of Ni(II), temperature, and time because of the variables.

Przemyslaw Bartczak et al., (2015) have studied - Humate will be used as a possible adsorbent to get rid of serious metal ions from binary compound solutions, in line with researchers at the University of Bristol. A big part of the study concerns tests of surface assimilation of nickel and lead(II) ions from model solutions. Results show sturdy correspondence to a pseudo-second-order mechanics model of sort one (r a pair of zero.999 for all initial concentrations).

Zhuo-nan Huang, et al., (2015) had seen regarding - Magnetic multi-wall carbon nanotubes were ready with wet chemical treatments and characterized by a transmission microscope (TEM) and X-ray diffraction (XRD). They were used as adsorbents for the removal of Cr(VI) in binary compound solutions. The surface assimilation was a spontaneous and energy-absorbing process; the total heat deviation was three.835 kJ·mol⁻¹.

A.H.Karim, et al, (2014) have learned about- Carbon nanotubes–mesostructured silicon oxide nanoparticles (CNT–MSN) composites were ready by a straightforward ballroom dancing methodology with numerous loading of CNT. In a pair of physisorption measurements unconcealed the event of a bimodal pore structure that magnified the pore size, pore-volume, and area. They were able to take up 524 mg g

À1 (q m) of sixty mg L $\hat{a}$, $\sim$ 1 MB at pH scale eight and 303 K and showed promising potential as new adsorbents for dye surface assimilation.

Hacer Sibel Karapinar et al, 2018- In this study, TiO₂ nanofibers were synthesized by the electro-spinning methodology and determined to be economical[a good] adsorbent for efficient removal of serious metal ions from binary compound solutions. surface assimilation stabilization time was twenty-eight minutes and surface assimilation capability was 834.56 mg g⁻¹ for Cu(II), 756.67 mg g⁺¹ for Ni(II) ions, and 685.56mg g ⁺¹ for Pb(II). The reusability of nanofiber for the take up of Ni(III), Cu(III), and Pb(II) ions was examined in 5 studies. TiO₂ is eco-friendly, low cost, high stability, and non-toxic, and might be used persistently to with efficiency take away serious metals.

Ghadah M. Al Senai, et al, 2018 -The surface assimilation of serious metals onto EH and TH was captivated with particle size, dose, resolution pH scale, contact time, and temperature. Kinetic knowledge was tested in mistreatment pseudo-first-order and pseudo-second-order kinetic models. Results counsel that the take up of serious metal by wild herbs is AN energy-absorbing and spontaneous method. The study concludes that wild herbs are promising adsorbents for adsorbate serious metals from binary compound solutions.

2.3 INFERENCE FROM THE LITERATURE REVIEW

1. The heavy metals which are toxic and non-toxic to the environment were determined.
2. Which are the metals that affect the environment on the higher composition
3. And what are the different methods used to measure the heavy metal by differing in time, concentration, ph, temperature, etc...
4. Difference in time and concentration used in the experiment
5. And knew about the structure of carbon nanotubes

6. Effects of heavy metals on the environment

CHAPTER-3

OBJECTIVE AND SCOPE OF STUDY

3.1 OBJECTIVE OF THE STUDY

The objective of the study was given below

1. Preparation of aqueous solution of heavy metal (chromium, lead)
2. Collection of multi-walled carbon nanotubes as adsorption

3. Characterization of adsorption before and after treatment
4. To reduce the concentration of heavy metal with an adsorbent.

3.2 SCOPE OF STUDY

1. 1. Several research have been conducted in recent years, focusing on highly selective adsorbents of natural origin whose use does not result in further pollution. Studies on components that make up waste material are becoming more common.
2. Coconut shells, tree bark, zeolites, lignin, mollusk shells, orange peel, minerals, natural clays, and microorganisms are among the most common metal ion adsorbents (bacteria, fungi, and yeast) It is recognised as a low-cost method for trash and pollutants due to its wide availability and low extraction cost.
3. **Peat is a complex mixture of organic chemicals, including organic acids and their salts, cellulose, lignin, and proteins, as well as mineral components (magnesium, potassium, calcium, sodium, iron, silicon, and aluminium)**
4. **The performance of desorption tests for sorbent regeneration was another important aspect of the research.**

CHAPTER – 4

METHODOLOGY AND MATERIALS

4.1 METHODOLOGY

The methodology of the study for the removal of heavy metal Chromium and Lead was given below.

1. Preparation of aqueous solution Ni (potassium dichromate), Pb (lead nitrate)]

2. Collection of MWCNTs
3. Characterization of MWCNTs
4. Batch adsorption study
5. By varying dosage stage (weight vary), Ph, temperature, contact time
6. Percentage of adsorption recovery
7. Characterization of MWCNTs after treatment

4.2 MATERIALS

4.2.1 AQUEOUS SOLUTION OF LEAD

1. Lead nitrate $[\text{Pb}(\text{NO}_3)_2]$ to Lead Metal
2. Molecular weight of lead nitrate is 331.2
3.

$\text{Pb}(\text{NO}_3)_2$ - Lead(Pb) – $1 \times 207.2 = 207.2$
 Nitrogen (N) – $2 \times 14.0067 = 28.0134$
 Oxygen (O) – $6 \times 15.9994 = 95.9964$
4. 207.2 g of lead is obtained from 331.2 g of lead nitrate
5. Therefore, 1g of lead will be obtained from $331.2/207.2 = 1.5984$ g
6. So, 1.5984 g of lead is obtained and it should be dissolved in 1 liter of distilled water

4.2.2 AQUEOUS SOLUTION OF POTASSIUM DICHROMATE

1. Potassium dichromate $[\text{K}_2\text{Cr}_2\text{O}_7]$ to chromium metal
2. Molecular weight of lead nitrate is 294.1846

$\text{K}_2\text{Cr}_2\text{O}_7$ - Potassium (K) $2 \times 39.0983 = 78.1966$
 Chromium (Cr) – $2 \times 51.9961 = 103.9922$
 Oxygen (O) – $7 \times 15.9994 = 111.9958$
3. 103.9922 g of chromium is obtained from 294.1846 g of potassium dichromate

4. Therefore, 1g of chromium will be obtained from $294.1846/103.9922 = 2.876$ g
5. So, 2.876 g of chromium is obtained and it should be dissolved in 1 liter of distilled water

4.2.3 MULTI-WALLED CARBON NANOTUBES

MWCNTs (multi-walled carbon nanotubes) are elongated cylindrical nanoobjects made from sp² carbon. Their diameter is 3–30 nm, and they will grow to be several centimetres long, therefore their ratio will be between ten and ten million.

It's referred to as MWCNT. It's made up of a lot of tried and true carbon nanotubes. This type of nanotube has two diameters, one of which is known as the outer diameter and the other as the inner diameter. Chiral Multi-walled Carbon Nanotubes are a good example of Multi-walled Carbon Nanotubes.



4.3 BATCH EXPERIMENTAL STUDY

Adsorption is a process in which a chemical accumulates in molecular forms at increasing concentrations on a surface. When we look at H, Nitrogen, and Oxygen, we can see that they all sorb on atomic number 6. Meanwhile, we must keep in mind that sorption is not the same as absorption. The mechanisms involved in the two processes are fundamentally different.

For the Adsorption method, 2 elements area unit needed,

- **Adsorbate:** Substance that's deposited on the surface of another substance. for instance, H₂, N₂, and O₂ gases.
- **Adsorbent:** Surface of a substance on that adsorbate adsorbs. Examples, Charcoal, Silica gel, and aluminium oxide.

4.3.1 ADSORPTION EXPERIMENT



TREATED LEAD AQUEOUS SOLUTION

4.3.2 ATOMIC ABSORPTION SPECTROMETER

Atomic absorption spectroscopic analysis (AAS) is a qualitative analysis technique that atomizes the contents of a sample and measures the absorbance of a wavelength specific to that particular component within the aerosolized state to determine the concentration of explicit|a specific|a selected component during the sample. Free atom absorption lines are extremely narrow, having absorption ranges of only a few picometers (1 picometer = zero.001 nanometers). Furthermore, these

absorption lines do not usually overlap with those of diverse components, resulting in technique-specific absorption lines.

AAS is carried out with the use of an atomic absorption mass spectrometer, which comprises of a sample preparation sprayer, a radiation lamp, and a detector. Two atomic absorption spectrometers are available, depending on the lamp type: AAS for line supply (LS) and time supply (CS).

LS Metallic element AAS employs a lamp that will live many different components, whereas AAS utilises one bulb for one component of interest. While metallic element AAS may sound more enticing, they require a more expensive high-resolution monochromator for wavelength selection.

AAS is used in chemistry, biology, prescription medications, material analysis, and water quality analysis to determine the presence and concentration of a particular atom of interest, such as a cyanogenic metal atom like lead. AAS is used to examine over seventy components, the majority of which are metals.



The sample is tested using Atomic Absorption Spectroscopy

Materials	used
Element	Pb
Lamp	2.5 mA
-H Vol	172 V

Slit	0.7 nm
Equation	Linear equation
Reading Mode	Continue mode
Wave	283 nm
Single-mode	AA Read
Time	2.0 sec
Mode	Flame

Table 4.1: Materials used in AAS

CHAPTER-5

RESULT AND DISSCUSION

5.1 EXPERIMENTAL ANALYSIS

DOSAGE OF LEAD

TABLE 5.1 *DOSAGE VARIATION OF LEAD*

CONCENTRATION	ADSORPTION	EFFECT OF INITIAL CONCENTRATION
---------------	------------	---------------------------------

		After treatment	Total adsorption	percentage of adsorption
20 PPM	1.883	1.518	0.365	19.383
40 PPM	1.922	1.521	0.401	20.863
60 PPM	1.934	1.522	0.412	21.302
80 PPM	1.935	1.518	0.417	21.550
100 PPM	1.939	1.513	0.426	21.970

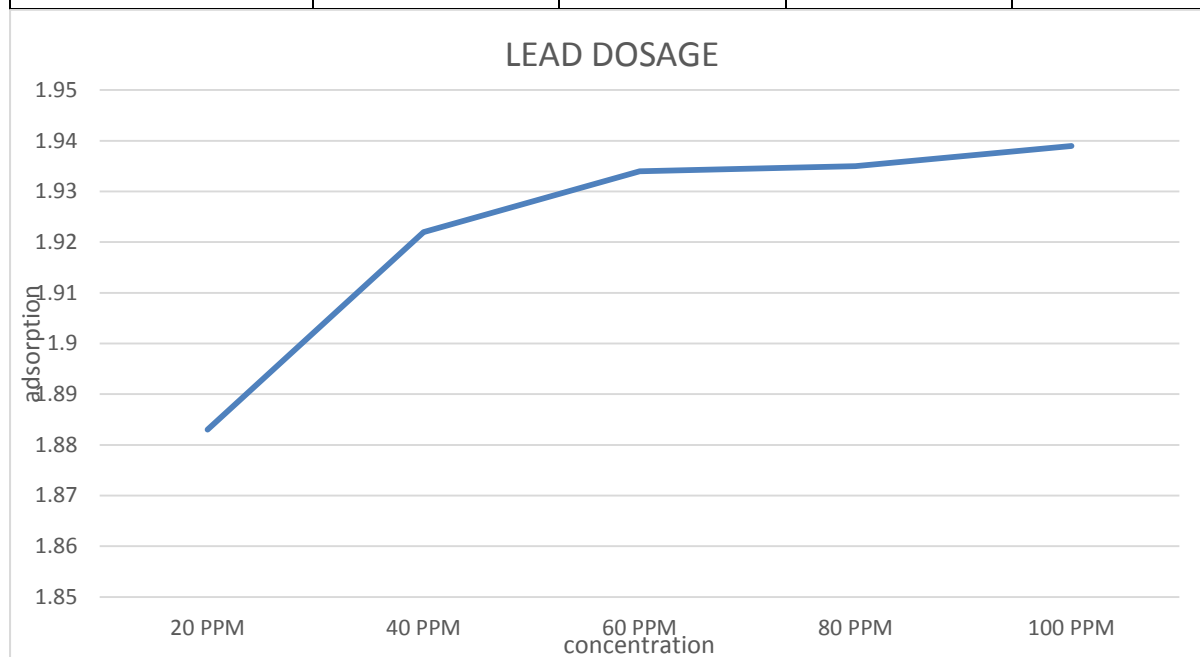


Fig 5.1: Calibration chart for lead by differences in dosage

TIME OF LEAD

TABLE 5.2 TIME VARIATION OF LEAD

CONCENTRATION	ADSORPTION	EFFECT OF INITIAL CONCENTRATION		
---------------	------------	---------------------------------	--	--

		After treatment	Total adsorption	percentage of adsorption
100 PPM (30min)	1.939	1.514	0.425	21.918
100 PPM (60min)	1.939	1.523	0.416	21.454
100 PPM (90min)	1.939	1.521	0.418	21.557
100 PPM (120min)	1.939	1.532	0.407	20.990
100 PPM (180min)	1.939	1.513	0.426	21.970

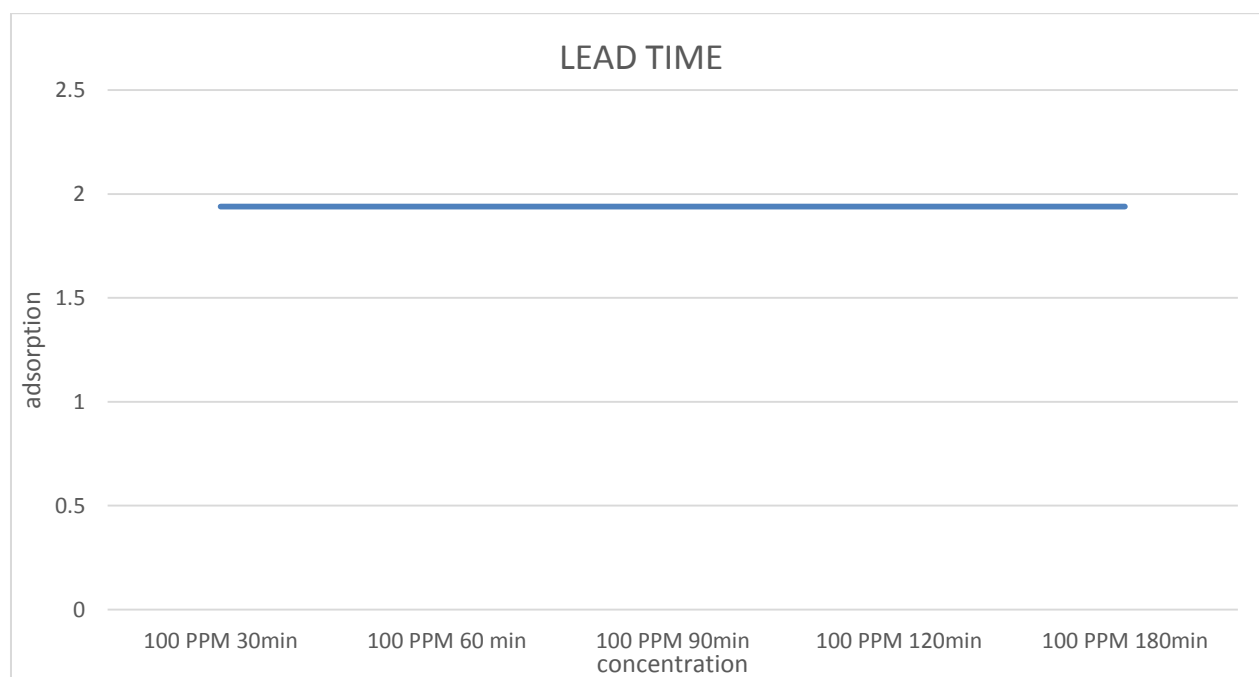


Fig 5.2: Calibration chart for lead by differing in time

DOSAGE OF CHROMIUM

TABLE 5.3 *DOSAGE VARIATION OF CHROMIUM*

CONCENTRATION	ADSORPTION	EFFECT OF INITIAL CONCENTRATION		
---------------	------------	---------------------------------	--	--

		After treatment	Total adsorption	percentage of adsorption
20 PPM	1.599	1.366	0.233	14.572
40 PPM	1.985	2.073	-0.088	4.433
60 PPM	2.300	2.047	0.253	11.000
80 PPM	2.138	1.417	0.721	33.723
100 PPM	2.036	1.958	0.078	3.831

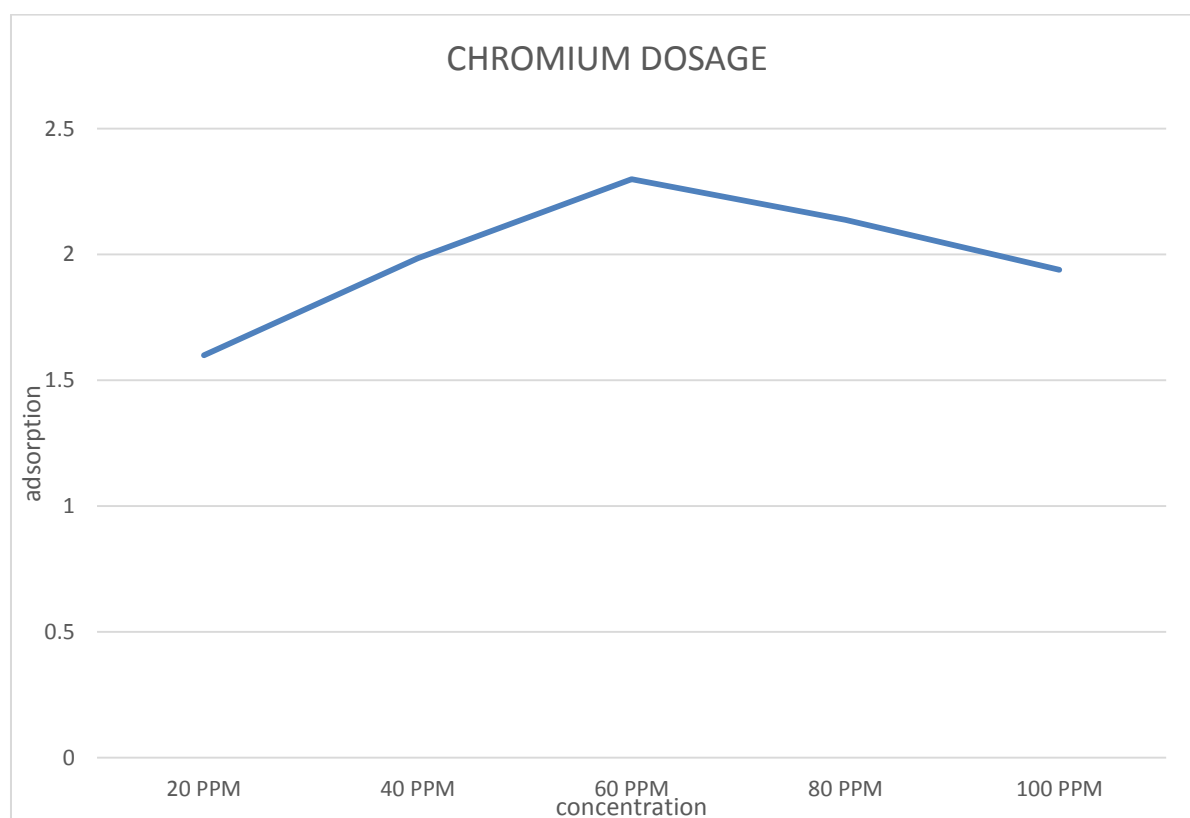


Fig 5.3: Calibration chart for chromium by differences in dosage

TIME OF CHROMIUM

TABLE 5.4 *TIME VARIATION OF CHROMIUM*

CONCENTRATION	ADSORPTION	EFFECT OF INITIAL CONCENTRATION		
---------------	------------	---------------------------------	--	--

		After treatment	Total adsorption	percentage of adsorption
100 PPM (30min)	2.036	2.042	-0.006	0.294
100 PPM (60min)	2.036	2.063	-0.027	1.326
100 PPM (90min)	2.036	2.034	0.002	0.098
100 PPM (120min)	2.036	2.069	-0.033	1.620
100 PPM (180min)	2.036	1.958	0.078	3.831

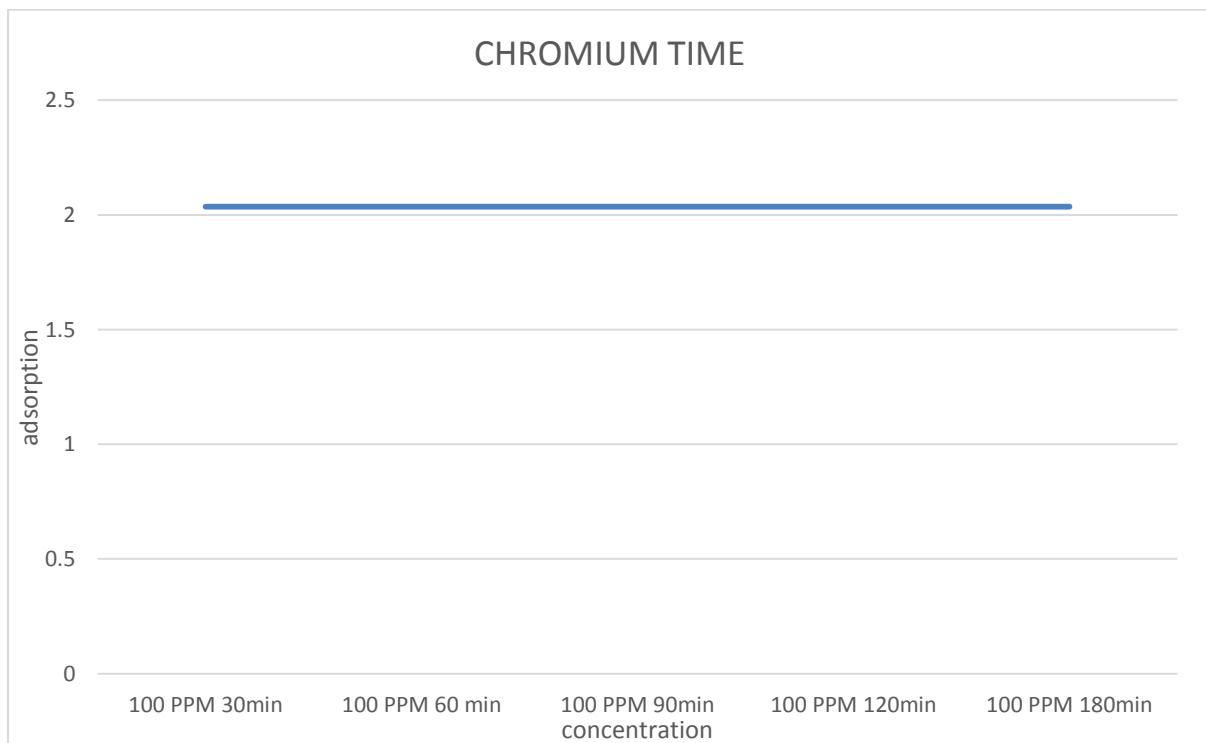


Fig 5.4: Calibration chart for chromium by differing in time

DOSAGE VARIATION OF LEAD IN AAS

TABLE 5.5 *DOSAGE VARIATION OF LEAD IN AAS*

S.NO	The initial concentration of lead (mg/L)	The final concentration of lead was tested using AAS (mg/L)
1	20 PPM (180 min)	7.6
2	40 PPM (180 min)	7.2
3	60 PPM (180 min)	6.3
4	80 PPM (180 min)	32
5	100 PPM (180 min)	16.40

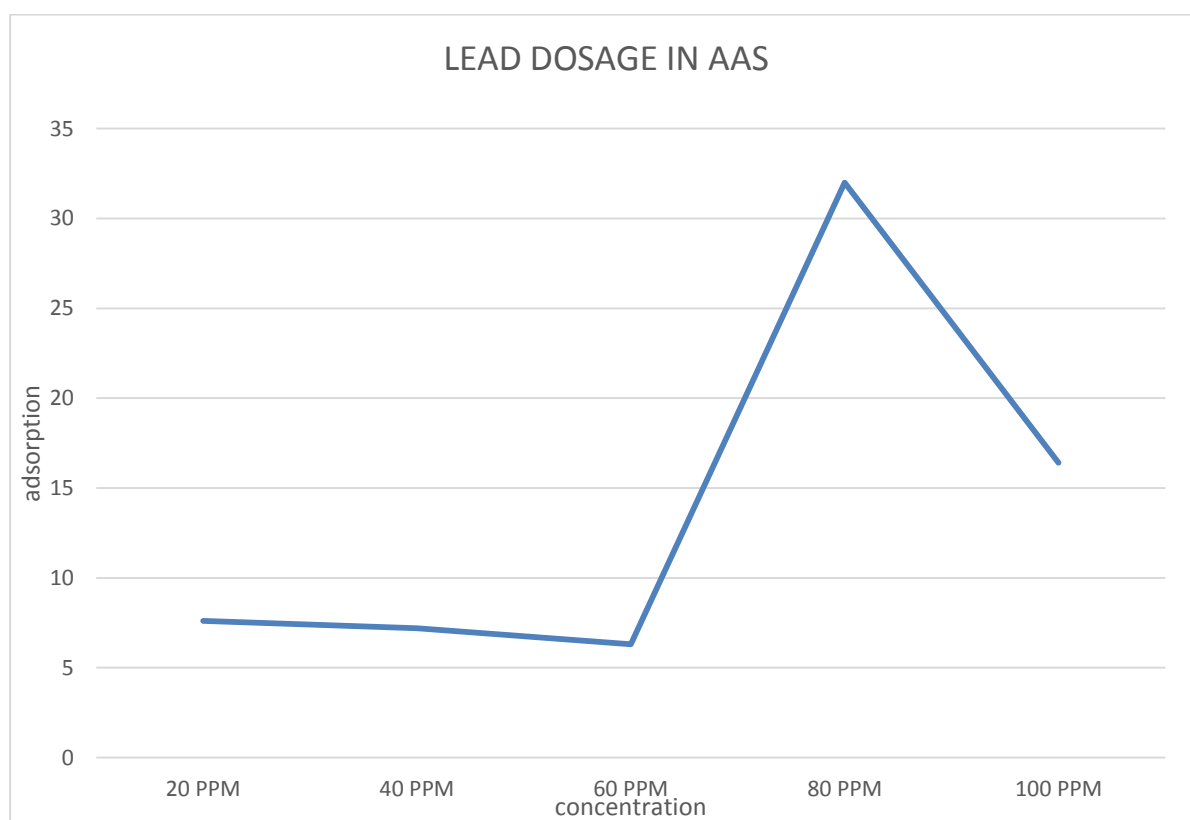
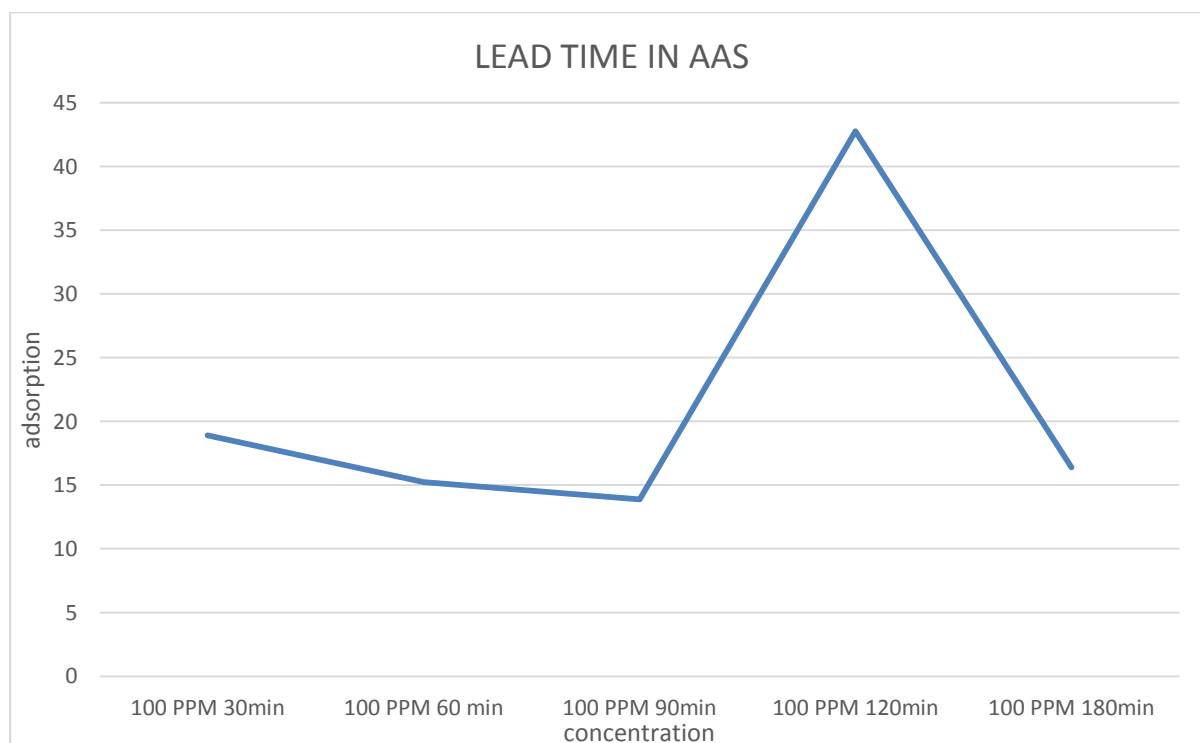


Fig 5.5: Calibration chart for lead by differing in dosage

TIME VARIATION OF LEAD IN AAS

TABLE 5.6: *TIME VARIATION OF LEAD IN AAS*

S.NO	The initial concentration of lead (mg/L)	The final concentration of lead was tested using AAS (mg/L)
1	100 PPM (30min)	18.91
2	100 PPM (60 min)	15.25
3	100 PPM (90 min)	13.89
4	100 PPM (120 min)	42.78
5	100 PPM (180 min)	16.40



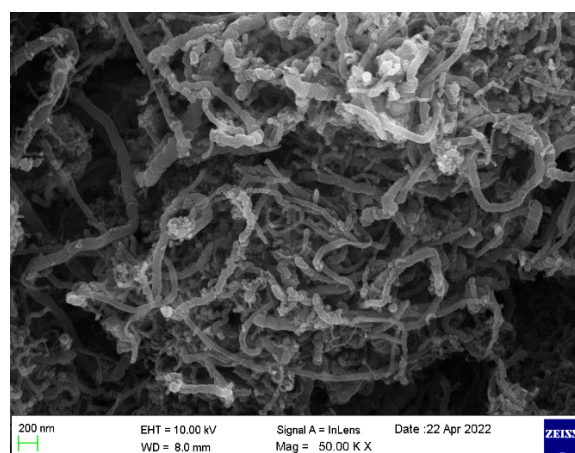
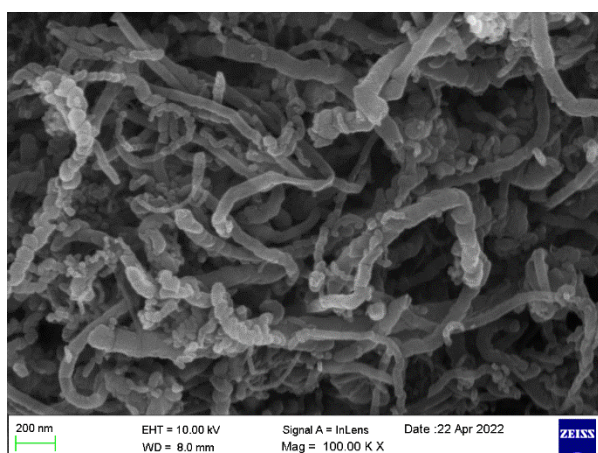
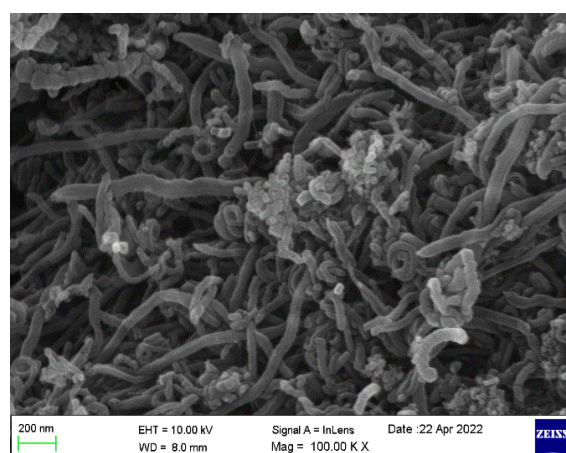
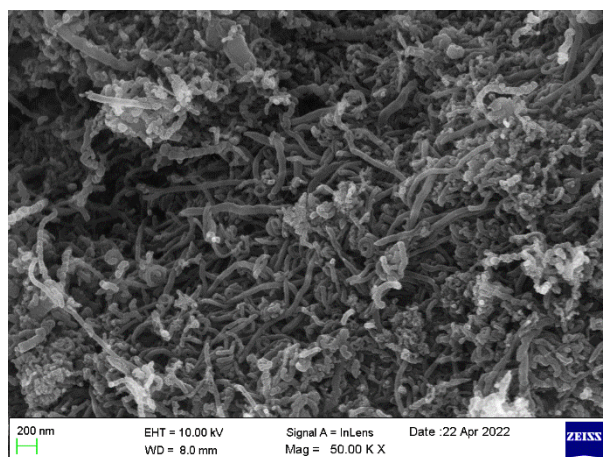
5.1.1 SEM ANALYSIS AND FTIR

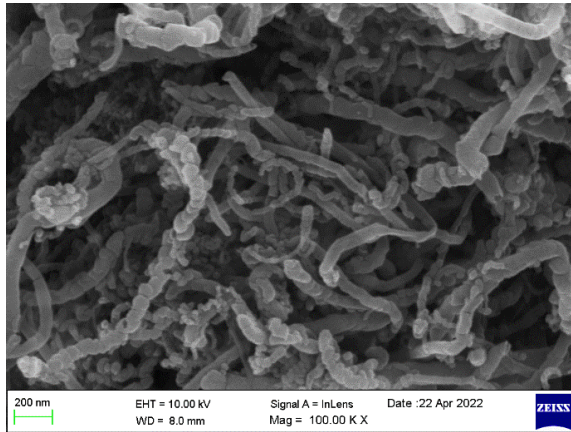
SEM ANALYSIS (SCANNING ELECTRON MICROSCOPE)

SEM analysis is a strong investigative tool that produces complex, high magnification images of a sample's surface topography using a focussed stream of electrons. SEM analyses were done for before and after treatment

BEFORE TREATMENT

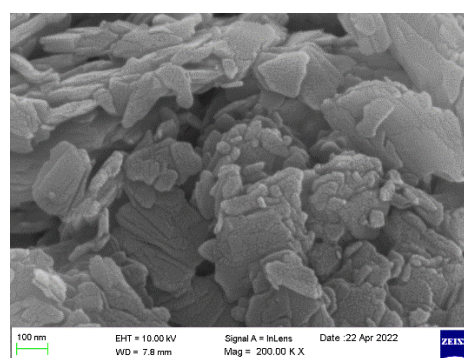
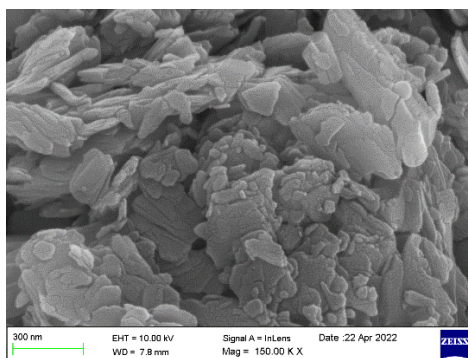
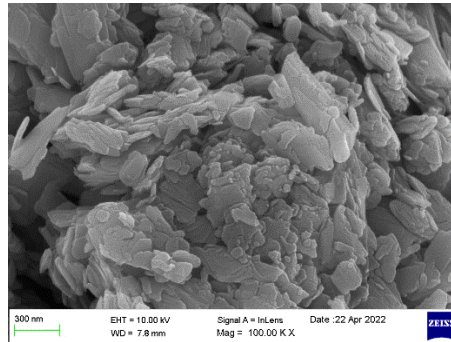
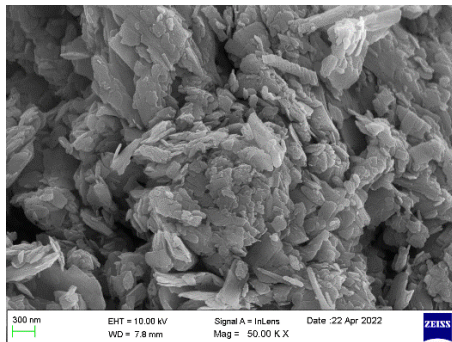
The sample is tested with no added chemicals and the result will be checked the results are given below

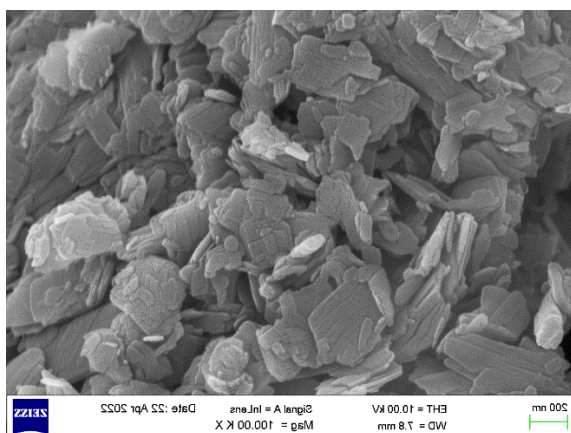




AFTER TREATMENT

The sample is tested with chemicals and the result will be checked the results are given below

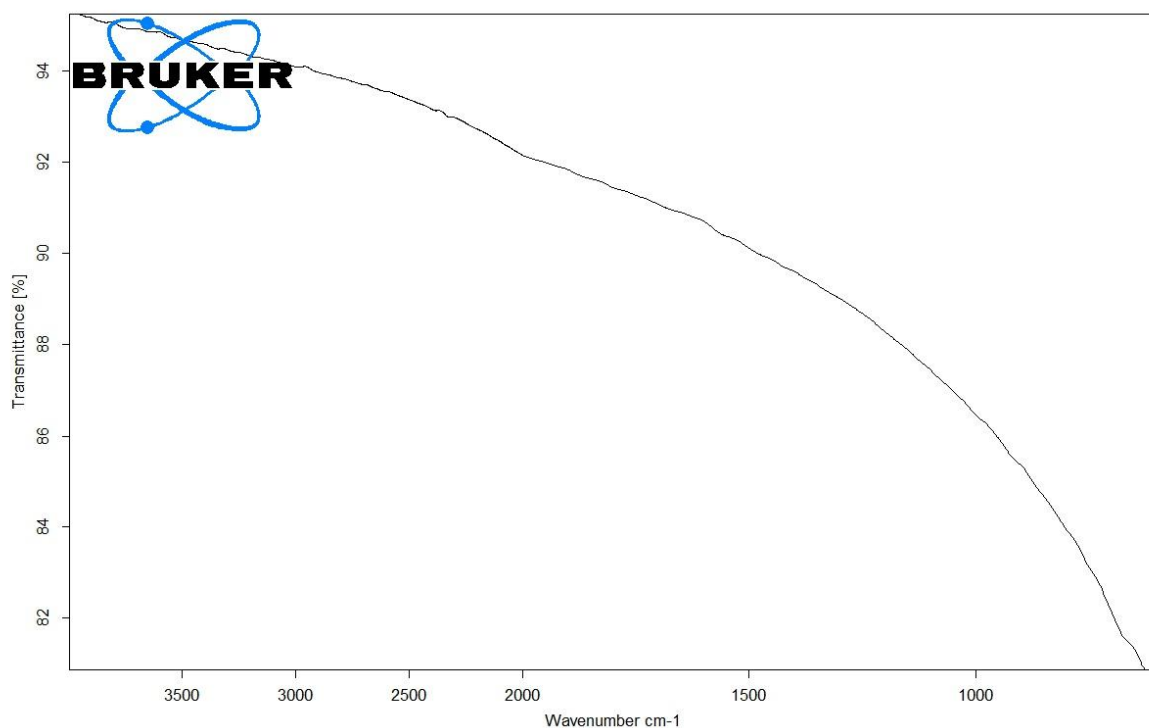




FTIR(FOURIER TRANSFORM INFRARED)

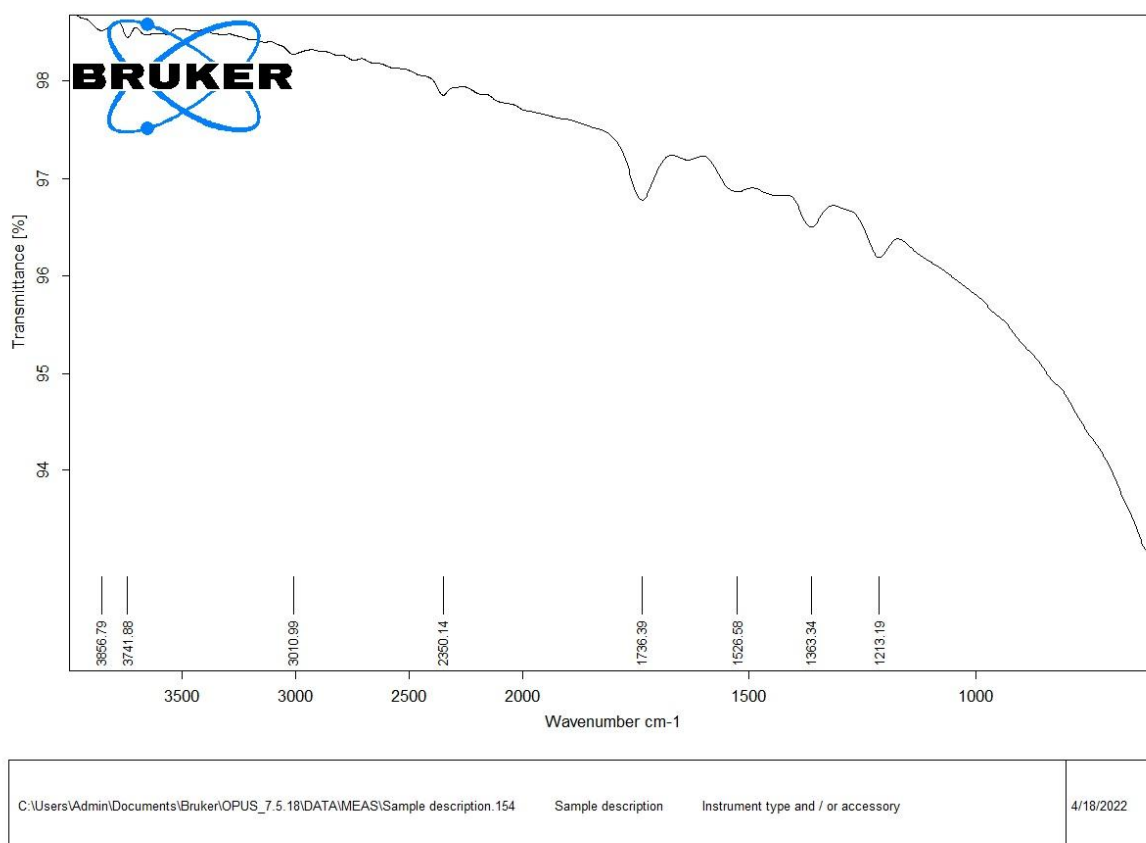
FTIR stands for Fourier rework infrared, a popular infrared spectrographic analysis method. When an object responds to IR radiation, some of it is absorbed by the object, while others pass through (are transmitted)

BEFORE TREATMENT



C:\Users\Admin\Documents\Bruker\OPUS_7.5.18\DATA\MEAS\Sample description.156	Sample description	Instrument type and / or accessory	4/18/2022
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AFTER TREATMENT



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5.1.2 EFFECT OF VARYING INITIAL CONCENTRATION

The effect of initial Hexavalent metal concentration on BWAC surface assimilation efficacy under optimal hydrogen ion concentration and talk time conditions. The surface assimilation potency for Hexavalent metal increased from 92.87 to 98.71 percent when the starting concentration was increased from 25 to 150 mg/L. However, the solution achieved equilibrium at 100 mg/L, and no significant changes in surface assimilation occurred at this time. Because the initial metal particle concentration increased from twenty-five to one hundred fifty mg/L, the surface assimilation capability for Hexavalent metal will increase from nine.87 to 59.23 mg/g. The effect of initial Hexavalent metal concentration on BWAC surface assimilation efficacy under optimal hydrogen ion concentration and talk time conditions. The surface assimilation potency for Hexavalent metal increased from 92.87 to 98.71 percent when the starting concentration was increased from 25 to 150 mg/L. However, the solution achieved equilibrium at 100 mg/L, and no significant changes in surface assimilation occurred at this

time. Because the initial metal particle concentration increased from 25 to 150 mg/L, the surface assimilation capability for Hexavalent metal increased from 9.87 to 59.23 mg/g, and a further increase in initial metal particle concentration resulted in a competition between metal ions for available binding sites on the BWAC surface, resulting in increased surface assimilation. Alternative researchers have also reported on similar surface assimilation strategies. The experimental surface assimilation isotherms are frequently obtained from the mass balance equation on the adsorbate in a very system with answer volume, which is acquired from the mass balance equation on the adsorbate in a very system with answer volume..

5.1.3 EFFECT OF VARYING TIME

The adsorptions of metal ions by C were examined at various time intervals (3–120 min) and a concentration of one hundred mg/L. Atomic number 24 absorption is rapid for the first 3–20 minutes, then slows down and eventually reaches saturation. The initial rapid reaction could also be due to the large number of unoccupied sites on the market at the start; as a result, there's an exaggerated concentration gradient between adsorbate in resolution and adsorbate within the adsorbent. When using a surface reaction approach for sorption, the initial sorption is usually swift. Then, because the on-market sorption website is being cut piece by bit, slower sorption would follow. This is because there is a large number of vacant surface sites available for sorption in the beginning, and after some time has passed, the remaining free surface sites are difficult to fill due to repulsive forces between the substance molecules in the solid and bulk phases. At twenty minutes, the highest percentage of sorption (98.019 percent in one hundred mg/L of solution) occurs; after that, the percentage of sorption remains constant.

5.1.4 EFFECT OF VARYING DOSAGE

The effect of adsorbent dosage on metal surface assimilation on the BWAC is depicted. It can be seen that as the dose of BWAC is increased from zero.1 to 0.25 g, the percentage of surface assimilation increases from 97.105 to 98.45 percent, and remains practically constant for adsorbent amounts greater than

0.25 g. This could be due to the increased availability of surface assimilation sites on the adsorbent, making Cr(VI) penetration to the surface assimilation sites simpler. Because the amount of metal particle remains constant, increasing the amount of sorbent over the amount required to fully adsorb the available Cr(VI) had no effect on the increase in p.c surface assimilation. Because the dose will increase, the surface assimilation capability for Hexavalent metal will decrease from 24.28 to 8.2..

5.2 ADSORPTION ISOTHERM

Isotherm investigations are required to properly interpret the surface assimilation method. For surface assimilation isotherms, numerous models are used to describe experimental knowledge. The Langmuir and Freundlich isotherms, on the other hand, are the most relevant models for this research. Surface assimilation occurs at many places and produces a monolayer, according to the Langmuir isogram. In other words, once adsorbate is connected to a website, there will be no further surface assimilation. The Langmuir isogram equation's linear form is given as $Ce/qe = Ce/qm + 1/qmbL$

The equilibrium concentration of Hexavalent metallic element inside the adsorbable component is (mg/g), and the equilibrium concentration within the liquid part is C_e (mg/L). The slope of the linear plot of C_e/q_e vs C_e is typically used to determine Langmuir constants, the area unit associated with surface assimilation capability (q_m) and energy of surface assimilation (bL); a line with slope $1/q_{max}$ and intercept of $1/q_{max}bL$ is obtained. The Langmuir equation's basic properties are frequently described in terms of a dimensionless issue, RL , which is written as

$$RL = \frac{1}{1 + bLC_0}$$

Where is the highest initial concentration of Hexavalent metallic element particles (mg/L)? The relevance of the ideals of the separation issue issue is as usual. The Freundlich isogram provides a link between equilibrium liquid and solid part capabilities, which is aided by the multilayer surface assimilation features of the adsorbent's heterogeneous surfaces. The rationale behind this isogram is that

surface assimilation sites are dispersed exponentially in terms of surface assimilation warmth. Freundlich isograms can be linear or non-linear.

$$\log q_e = \log K_f + \frac{1}{n} \log C_e$$

Where C_e is the equilibrium concentration (mg/l), K_f and n are the Freundlich constants, $1/n$ is the heterogeneity issue linked with the capability and intensity of surface assimilation, and C_e is the adsorbable quantity at equilibrium (mg/g). The slope and intercept of a plot of $\log q_e$ against $\log C_e$ are frequently used to calculate K_f and $1/n$. However, the current study attempted to investigate the preceding isogram parameters at 300 K, and thus the R^2 correlation coefficients were calculated by fitting the experimental equilibrium knowledge for the Hexavalent metallic element particle BWAC system mistreatment each Langmuir and Freundlich isotherms. The results demonstrate that the surface assimilation of hexavalent metallic elements on BWAC is consistent with the Freundlich model. Because the Freundlich model is a good fit for experimental surface assimilation data, it implies physical surface assimilation as well as a heterogeneous distribution of active sites on the BWAC surface. Freundlich isotherm correlation coefficients were found to be zero.775. The surface assimilation is linear if the worth is adequate unity. If the value of constant n is less than unity, the surface assimilation approach is undesirable; if the value is more than unity, surface assimilation is advantageous. The value at equilibrium in the gift study was higher than unity, indicating favourable surface assimilation. Furthermore, the values of the dimensionless issue, RL , were between zero and one, indicating that BWAC and Hexavalent metallic element particle surface assimilation is beneficial.

CHAPTER-6

CONCLUSION

During this process, there are numerous strategies for removing metal ions from contaminated water. Chemical precipitation, natural processes, adsorption, membrane filtration, reverse diffusion, solvent extraction, and chemistry treatment are all included in this category. The removal of certain metal ions (lead, chromium, and cadmium) from water exploitation CNTs was highlighted in this paper. Various types of CNTs, as well as raw, acidmodified, and functionalized alternative materials, are utilised to remove heavy metals from water. Although raw CNTs showed reasonable sorption potential for a few metal ions, modified CNTs had the highest sorption capability for a wide range of significant metals. Physical sorption, static interaction, surface complexation, and chemical interaction between the surface purposeful teams and therefore the metal ions are among the different sorption mechanisms. The effect of method parameters such as pH, CNTs dose, time, ionic strength, temperature, and surface charge on the sorption of significant metal ions on the surface of CNTs was discussed. The feasibility of using CNTs for regeneration by metal ion activity was also addressed. This is a critical factor in determining the future use of carbon nanotubes in industrial treatment plants. Any analysis effort, however, must specialise in possible large-scale CNT manufacturing and exploring CNT cyanogenetic consequences. The use of carbon nanotubes in industrial water treatment plants is predicted to be a game-changer in the future.



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Conference Chair

Dr. Helen Santhi M
Conference Chair

Dr. S. Elavenil
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