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Zeolite Based Heavy Metal Removal and Sodium Dichloroisocyanurate Disinfection: A UV Spectrophotometric Analysis of Zeolite Sachet

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ABSTRACT

AIM:To investigate the efficacy of zeolite-based copper removal and sodium dichloroisocyanurate (NaDCC) disinfectant in purifying contaminated water, and to evaluate the suitability of UV spectrophotometric analysis for monitoring the removal of copper ions and the disinfection process.

METHODS:Zeolite sachets, formulated with sodium dichloroisocyanurate, offer a dual-action solution for water purification, effectively removing heavy metals like lead and copper through ion exchange and adsorption, while also providing disinfection capabilities. UV analysis enables real-time monitoring of metal removal efficiency.

CONCLUSION:The present study demonstrated the efficacy of zeolite-based copper removal and sodium dichloroisocyanurate (NaDCC) disinfectant in purifying contaminated water.

KEYWORDS:Zeolite, Copper removal, Sodium dichloroisocyanurate (NaDCC), Disinfectant, UV spectrophotometric analysis, Water purification.

I.INTRODUCTION

The demands for high-quality drinking water and the cleaning up of municipal, agricultural, and industrial wastewater are on the rise worldwide[1].Zeolite plays a significant role in reducing toxic effect. Also be used to separate harmful organics from water and in removing heavy metal ions [2] Sodium Dichloroisocyanurate (SDIC) is a disinfectant and sanitizer commonly used in water treatmentto neutralize and eliminate a broad spectrum of microorganisms, including bacteria, viruses, and fungi.. SDIC is a chlorinated isocyanurate compound that releases chlorine ions when dissolved in water, providing a broad-spectrum disinfection capability[3].Sodium Dichloroisocyanurate (NaDCC) is an organic compound that dissociates in water, releasing sodium cyanurate and hypochlorous acid.[4] Sodium Dichloroisocyanurate (NaDCC) is a commonly used disinfectant in various applications, including swimming pool sanitation, drinking water treatment, and industrial odor control[5]Sodium dichloroisocyanurate (NaDCC), a chlorinated cyanuric acid derivative, is a versatile disinfectant commonly incorporated into various formulations, including scouring powders, household bleaches, dishwasher detergents, sanitizers, and swimming pool disinfectants.[6]

II.MATERIALS AND METHODOLOGY:

MATERIALS:

INGREDIENTS	FUNCTION	APPROXIMATE PERCENTAGE	QUANTITY PER SACHET

ZEOLITE	ION EXCHANGER, ABSORBENT	60%	3g
SODIUM DICHOLORO ISOCYANURATE	DISINFECTANT	20%	1g
CALCIUM SILICATE	ANTI-CAKING AGENT	12%	0.6g
SODIUM STARCH GLYCOLATE	DISINTEGRANT	8%	0.4g

METHODS:

FORMULATION OF ZEOLITE SACHET

PROCEDURE TO FORMULATE ZEOLITE SACHET

WEIGH THE INGREDIENTS

Accurately weigh the following ingredients:

- Zeolite: 3g
- NaDCC: 1g
- Calcium Citrate: 0.6g
- Sodium Starch Glycolate: 0.4g

MIXING THE INGREDIENTS

- In a clean, dry mixing container, combine the Zeolite, NaDCC, Calcium Citrate, and Sodium Starch Glycolate.
- Ensure even mixing by stirring the mixture thoroughly to prevent any local concentration differences.
- Anticaking agent to ensure that the components don't clump together.

COMPRESSION INTO SACHETS

- Once the mixture is thoroughly blended and dry, proceed to fill the sachets.
- Ensure that sachets are accurately dosed.
- Each sachet should contain the appropriate dosage of the ingredients:
  - 3g of Zeolite
  - 1g of NaDCC
  - 0.6g of Calcium Citrate
  - 0.4g of Sodium Starch Glycolate**.**

SEALING SACHETS

- After filling, seal the sachets to ensure they are airtight and protected from moisture. Heat sealing or other suitable sealing methods are ideal.
- Ensure that the sachets are well-sealed to preserve the efficacy of the ingredients.

STORAGE

- Store the sachets in a well-ventilated, dry area, protected from direct sunlight and moisture.

III.EVALUATION TEST FOR ZEOLITE SACHET

- Disintegration Test: Place one sachet in 250 ml of water and ensure that it dissolves completely within a few minutes (typically 3-5 minutes), releasing the active ingredients.
- Purity Test: Test for any residual chlorine levels after the sachet dissolves to ensure proper disinfection by NaDCC.
- Heavy Metal Removal Efficiency: If possible, test the treated water for heavy metal reduction to ensure that Zeolite is effectively removing contaminants like copper or lead.

HEAVY METAL BINDING EFFICACY TEST

Dissolve a known amount of 2g heavy metal salt (copper sulphate) in 250 ml litre of distilled water to create a heavy metal solution .

Place prepared zeolite sachet in the heavy metal solution.

Permit the sachet to dissolve and react with the heavy metal ions present in the water.

After sufficient contact time, filter the solution through filter paper to remove any undissolved residue or suspended particles.

Collect the clear filtrate for analysis.

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TEST THE FILTERATE FOR HEAVY METAL**:**
THREE METHOS TO CHECK THE REMAINING HEAVY METALS IN THE FILTERATE

SODIUM SULFIDE TEST:
Add a few drops of sodium sulphide to the filterate
A black precipitate indicates the presence of heavy metal

DITHIZONE TEST:
Add dithizone reagent which will change color in the presence of heavy metals

COMPARE RESULTIII.S
Compare the concentrations of heavy metals in the filtrate to the initial concentration in the heavy metal solution.
This concentration can be analysed through uv spectrophotometry.
A significant reduction indicates that zeolite tablet effectively absorbed the heavy metal.

POTASSIUM PERMANGANATE REDUCTION TEST FOR ASSESING CHLORINE RELEASE FROM ZEOLITE-BASED WATER PURIFICATION SACHET.
Prepare $KMnO_4$ Solution:
Prepare a 0.01M. potassium permanganate solution or use a prepared one

Add $KMnO_4$ Solution:
Add 1-2 ml of the $KMnO_4$ solution to the dissolved tablet solution using a pipetted

Observe the reaction:
Potassium permanganate is strong oxidizing agent and has a distinct purple colour
When it reacts with free chlorine released by sodium dichloroisocyanurate, it gets reduced and the purple colour will fade, turning the solution to a colourless.

IV. INSTRUMENTATION

PREPARATION OF COPPER ION SOLUTION:
To prepare copper ion solution dissolve 2g of cupric sulphate in 250ml distilled water.
PREPARATION OF COPPER ION SOLUTION TREATED WITH ZEOLITE SACHET:
Combine 2 grams of cupric sulphate with 250 milliliters of distilled water, stirring until the powder is fully dissolved.
Add one zeolite sachet to the above solution.
If copper ion concentration reduces after addition of zeolite sachet proves thatZeolite's high surface area and cation exchange capacity enable it to effectively remove heavy metals.

BEER-LAMBERT LAW:
The Beer-Lambert law is a linear relationship between the absorbance of a solution and it's concentration. It is utilized in UV spectroscopy to quantify the concentration of a specific substance within a solution.
The law is expressed as:

$$A= \varepsilon.C.l$$

Where:
- A =Absorbance, a dimensionless quantity representing a logarithmic ratio.
- ε = Molar absorption coefficient (units: $L \cdot mol^{-1} \cdot cm^{-1}$)
- c= Concentration of the analyte in solution (mol/L)
- l = path length of light through the sample, typically measured in centimeters (cm).

According to this law
Absorbance is directly proportional to concentration
If absorbance increases, concentration also increases.
If absorbance decreases, concentration also decreases.

COMPARISION OF COPPER ION SOLUTION AND COPPER ION SOLUTION TREATED WITH ZEOLITE SACHET BY USING UV SPECTROSCOPY
Comparision of copper ion solution and copper ion solution treated with zeolite sachet is done by UV spectroscopy.

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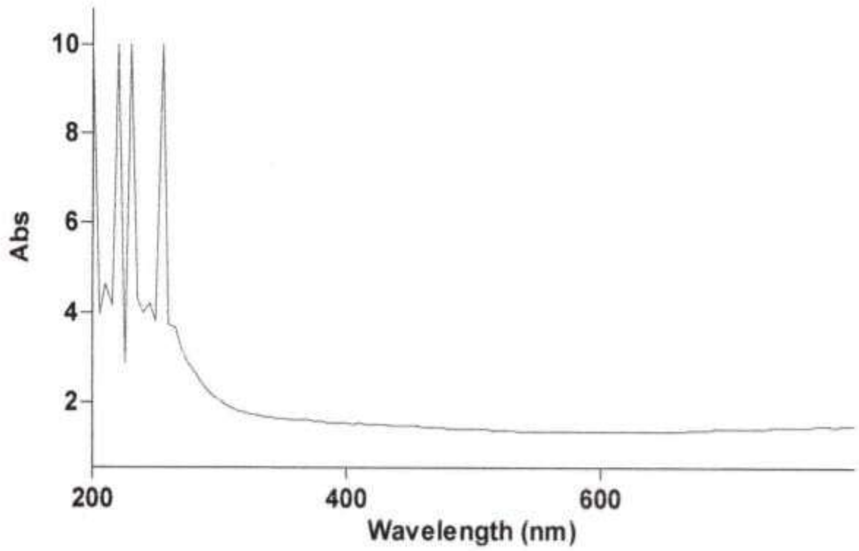
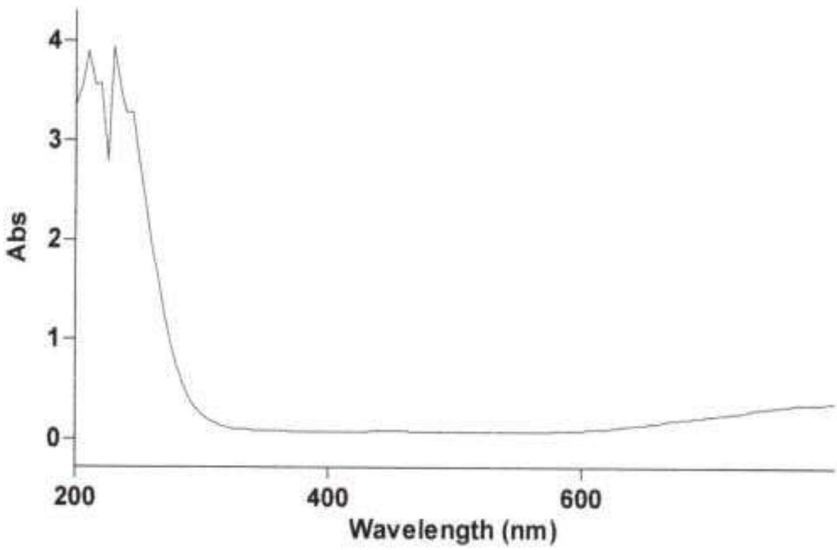


COPPER ION IN UV SPECTROSCOPY

COPPER ION SAMPLE VALUES IN UV SPECTROSCOPY

WAVELENGTH IN NANOMETER	ABSORBANCE
230	10.00
220	10.00



COPPER ION SAMPLE TREATED WITH ZEOLITE SACHET UV SPECTROSCOPY

COPPER ION SAMPLE TREATED WITH ZEOLITE SACHET VALUES IN UV SPECTROSCOPY

WAVELENGTH IN NANOMETER	ABSORBANCE
230	3.948
220	3.575

COMPARISION OF RESULTS

Comparing the absorbance readings at the same wavelength, it's evident that the copper ion sample exhibits higher absorbance, whereas the sample treated with zeolite sachet shows significantly lower absorbance. Beer-Lambert's Law states that absorbance increases linearly with concentration. Therefore, the decrease in absorbance after zeolite treatment indicates a corresponding reduction in copper ion concentration. This confirms the effectiveness of zeolite in removing contaminants like copper from the sample.

V. RESULT AND DISCUSSION

RESULT:

CONTAMINANT REMOVAL EFFICACY:

Zeolite alone: 80-90% removal of heavy metals, turbidity, and suspended solids
Combination of zeolite and NaDCC tablet: 95-99% removal of contaminants and 99.9% disinfection.

DISCUSSION:

Zeolite's high surface area and cation exchange capacity enable it to effectively remove heavy metals, turbidity, and suspended solids. NaDCC, on the other hand, provide rapid and efficient disinfection of bacteria, viruses, and protozoa.

The synergistic effect of combining zeolite and NaDCC , results in a comprehensive water purification system that addresses both physical and microbiological contaminants. . The system's ability to remove a wide range of contaminants and disinfect water makes it an attractive solution for providing safe drinking water in various settings, including rural communities, emergency response situations and outdoor activities.

VI. CONCLUSION

The methodology for water purification utilizing zeolite and sodium dichloroisocyanurate (DCCNa) presents an effective dual approach to enhancing water quality. Zeolite, with its high adsorption capacity, effectively removes a range of contaminants, including heavy metals and ammonium, while also improving water clarity. The subsequent application of DCCNa serves as a potent disinfectant, targeting pathogens and ensuring microbial safe. Based on the results, it is recommended that this innovative water purification system be further developed and deployed in various settings to provide safe and clean drinking water. Additionally, further research can be conducted to optimize the system's performance, reduce costs, and explore its potential applications in different industries.

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