**INTERNSHIP REPORT**

**REMOVAL OF FLUORINE FROM BIOCHAR THROUGH ADSORPTION PROCESS**



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**INTRODUCTION**

The removal of fluorine from contaminated water sources is a critical environmental challenge. Biochar, a carbon-rich material derived from biomass , has shown potential for contaminant adsorption. This report details the methods and findings from an internship focused on the removal of fluorine using biochar from SGB woodbiochar and Miscanthus, including biochar impregnated with aluminium.

**OBJECTIVE**

The objective of this study is to evaluate and compare the effectiveness of SGB and Miscanthus biochar, both plain and aluminium-impregnated, in removing fluorine from aqueous solutions through adsorption processes. This involves:

1. **Characterizing Biochar**: Determining the physical and chemical properties of the biochars, including surface area, porosity, surface morphology, and functional groups.

2. **Optimizing Adsorption Conditions**: Identifying the optimal conditions for fluorine adsorption, such as adsorbent dosage, initial fluorine concentration, pH, and contact time.

3. **Assessing Adsorption Capacity**: Measuring and comparing the maximum adsorption capacities of the different biochar types for fluorine removal.

4. **Enhancing Performance**: Determining the impact of aluminium impregnation on the adsorption capacity and efficiency of SGB and Miscanthus biochar.

5. **Providing Insights for Practical Applications**: Offering recommendations for the potential use of these biochars in water treatment applications, focusing on their feasibility, efficiency, and regeneration potential.

**EXPERIMENTAL SETUP**

**Preparation of Stock Solution**

To begin the experiment, a stock solution of fluorine was prepared with a concentration of 1000 ppm (parts per million). This high-concentration solution was necessary to ensure the availability of sufficient fluorine ions for accurate adsorption studies.

Preparation of 6 ppm Solution from a 1000 ppm Stock Solution

In this report, we describe the process of preparing a diluted solution of 6 ppm from a 1000 ppm stock solution. This involves calculating the necessary volume of the stock solution and mixing it with distilled water to achieve the desired concentration and final volume.

**Volume Calculation:**

To prepare a 6 ppm solution from a 1000 ppm stock solution, we use the dilution formula:

M1.V1 = M2.V2

500\*6=1000\*V

V=3ml

Where:

- M1 is the final concentration (6 ppm)

- V1 is the final volume of the solution

- M2 is the concentration of the stock solution (1000 ppm)

- V2 is the volume of the stock solution needed

Therefore, 3 ml of the 1000 ppm stock solution is required to prepare 500 ml of a 6 ppm solution.

**Preparation:**

1. Measure 3 ml of the 1000 ppm stock solution using a pipette.

2. Transfer the 3 ml of stock solution into a 500 ml volumetric flask.

3. Add distilled water to the volumetric flask until the total volume reaches 500 ml.

4. Mix the solution thoroughly to ensure uniform concentration.

The resulting solution has a concentration of 6 ppm and a total volume of 500 ml. This process ensures accurate dilution and preparation of the desired solution for further use in experiments or analyses.

**MATERIAL AND METHODS**

**MATERIAL USED**

1. **Biochar Sources:**

- SGB wood biochar

- Miscanthus biochar

- Miscanthus biochar impregenated with aluminium

- SGB wood biochar impregenated with aluminium

**2. Chemicals:**

- Potassium hydroxide (KOH)

- Aluminium nitrate [Al(NO₃)₃]

- Distilled water

**PREPARATION OF ACTIVATED BIOCHAR**

**Initial Activation with KOH**

- **Sample Preparation**: 1 g of each biochar (SGB and Miscanthus) was weighed and placed into separate conical flasks containing 100 ml of distilled water.

- **KOH Addition**: 4 g of KOH was added to each flask.

- **Mixing**: The mixture was stirred for 1 hour to ensure thorough impregnation.

- **Filtration**: The mixture was then filtered using a vacuum filter, ensuring minimal air exposure.using 42 micron meter of filter paper

- **Washing**: The biochar was continuously washed with distilled water to remove any residual KOH.

- **Drying and Cooling**: The washed biochar was dried and cooled, yielding the KOH-activated biochar (SGB-KOH and Miscanthus-KOH).

**IMPREGENATION WITH ALUMINUM NITRATE**

- **Sample Preparation**: 0.5 g of the KOH-activated biochar was mixed with 1.90 g of Al(NO₃)₃ in 50 ml of distilled water.

- **Mixing**: The mixture was stirred for 1 hour.

- **Filtration and Washing**: The mixture was filtered using a vacuum filter and washed thoroughly with distilled water.

- **Drying and Cooling**: The biochar was dried for about 4 hours and then cooled, resulting in aluminium-impregnated biochar (SGB-Al and Miscanthus-Al).

**CHARACTERIZATION OF BIOCHAR**

**Surface Area Analysis**: BET surface area analysis was conducted to measure the surface area and porosity.

**Scanning Electron Microscopy (SEM):** SEM was used to observe the surface morphology.

**Fourier Transform Infrared Spectroscopy (FTIR):** FTIR analysis identified functional groups on the biochar surface.

**X-ray Diffraction (XRD):** To identify crystalline phases.

**BET Surface Area Analysis**: To determine the surface area and porosity.

**FLUORINE ADSORPTION TEST**

**Analytical Methods**

Fluorine Measurement: Fluorine concentration in the solution was measured using an ion-selective electrode (ISE).

Batch adsorption experiments were conducted to evaluate the fluorine removal capacity of the biochar samples:

- A known concentration of about 6ppm of fluorine solution was prepared.

- Biochar samples were added to the solution at different dosages.

- The mixture was stirred for a specific contact time.

- Samples were filtered, and the residual fluorine concentration was measured using an ion-selective electrode.

To evaluate the fluorine removal efficiency, the prepared biochar samples were subjected to fluorine adsorption tests. The adsorption capacity of each sample was measured, and the results are as follows:

- SGB biochar (without aluminium): **1.2 mg/g**

- Miscanthus biochar (without aluminium): **1.4 mg/g**

- SGB biochar with aluminium: **1.7 mg/g**

- Miscanthus biochar with aluminium: **1.52 mg/g**

**RESULTS AND DISCUSSION**

The adsorption capacities of the different biochar samples indicate the following:

Adsorption Performance

**SGB Wood Biochar**

- Non-activated: Showed moderate fluorine removal efficiency.

- The base SGB biochar exhibited an adsorption capacity of 1.2 mg/g.

**SGB Wood Biochar with Aluminium**

- Activated: Activation further improved the adsorption capacity, with chemically activated aluminium-impregnated biochar showing the highest efficiency.

- When impregnated with aluminium nitrate, the adsorption capacity increased to **1.7 mg/g,** indicating a significant enhancement due to the aluminium treatment.

**Miscanthus Biochar**

- Non-activated: Similar to SGB wood biochar, it showed moderate fluorine removal.

- The base Miscanthus biochar showed a higher adsorption capacity of 1.4 mg/g compared to SGB biochar

**Miscanthus Biochar with Aluminium**

- Activated: Activated aluminium-impregnated biochar demonstrated superior fluorine removal, with chemical activation providing the best results.

- Aluminium impregnation increased the adsorption capacity to **1.52 mg/g**, demonstrating a moderate improvement.

**CONCLUSION**

The study successfully demonstrated that both SGB and Miscanthus biochar could be effectively activated using KOH and further enhanced by aluminium impregnation. Among the tested samples, the SGB biochar impregnated with aluminium nitrate exhibited the highest adsorption capacity for fluorine removal (1.7 mg/g). This enhancement can be attributed to the increased surface area and the presence of aluminium, which likely facilitated better interaction with fluorine ions.

**RECOMMENDATIONS**

Based on the results, the following recommendations are made for future studies:

1. Optimization of Activation Conditions: Explore different concentrations of KOH and Al(NO₃)₃ to further optimize the activation and impregnation processes.

2. Extended Testing: Conduct adsorption tests with other contaminants to evaluate the broad-spectrum efficacy of the activated biochar.

3. Characterization Studies: Perform detailed characterization studies (e.g., BET surface area analysis, SEM, FTIR) to understand the structural and chemical changes in the biochar post-activation and impregnation.

**REFRENCES**

- Relevant research papers and articles on biochar, fluorine removal, and activation methods.

- Analytical methods and standards for measuring fluorine concentrations in water.