ECCS 2025 Conference
The 3rd International Electronic Conference on Catalysis Sciences
23–25 April 2025 | Online
MDPI

# Development of a Solid Phase Extraction Method for Cadmium and Nickel Using Stearic Acid Modified Activated Carbon

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## INTRODUCTION

### Heavy metal

Heavy metals are widely used in various industrial applications.

Major uses of heavy metal
- Rechargeable batteries
- Automobiles
- Large machinery

Heavy metals have adverse effects through wastewater and emissions from factories.

Effects of heavy metal pollution
- Environmental pollution
- Health problems
- Ecosystem imbalance

### Graphite Furnace Atomic Absorption Spectrophotometer（GFAAS）

High sensitivity for measurement
Easy operation
Low cost of equipment

Sensitive to physical and chemical interference
Narrow quantitative range

} Preconcentration of analytes prior to determination

### Preconcentration

Purpose: To concentrate the analyte for measurement

Solid-phase extraction (SPE): A sample solution is passed through a solid phase, allowing separate the target material to be separated from impurities.

### Purpose of this study

**Preconcentration of trace cadmium and nickel using stearic acid modified activated carbon (SA-CAA)**

## METHOD

### Adsorption preparation

Acid treatment

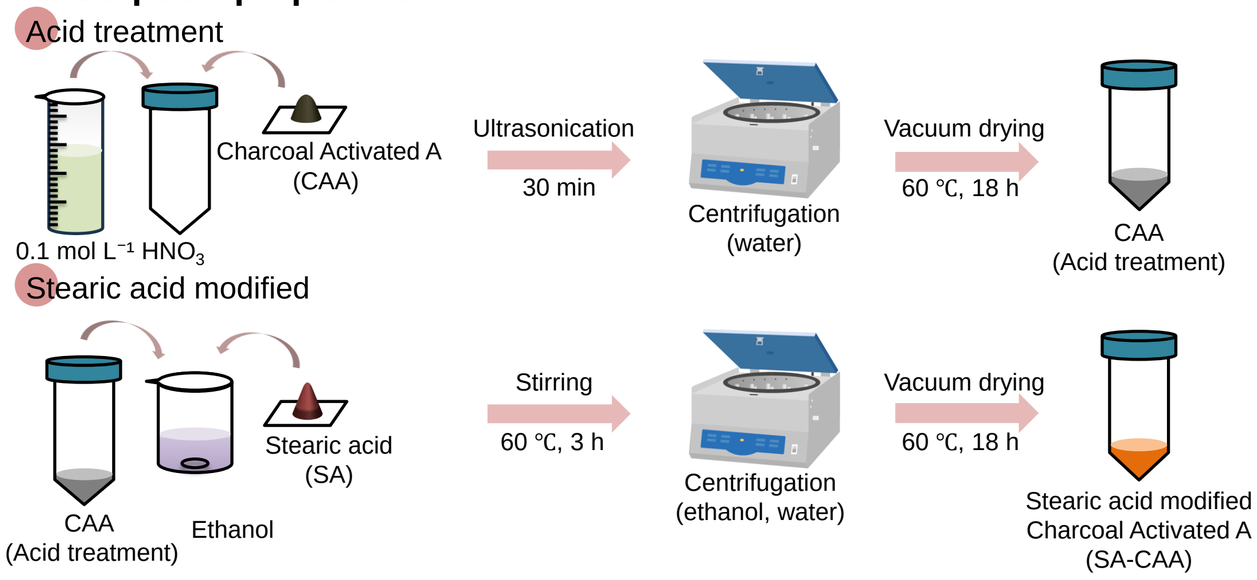


Fig. 1. Preparation of SA-CAA.

### Experimental

Solid phase extraction

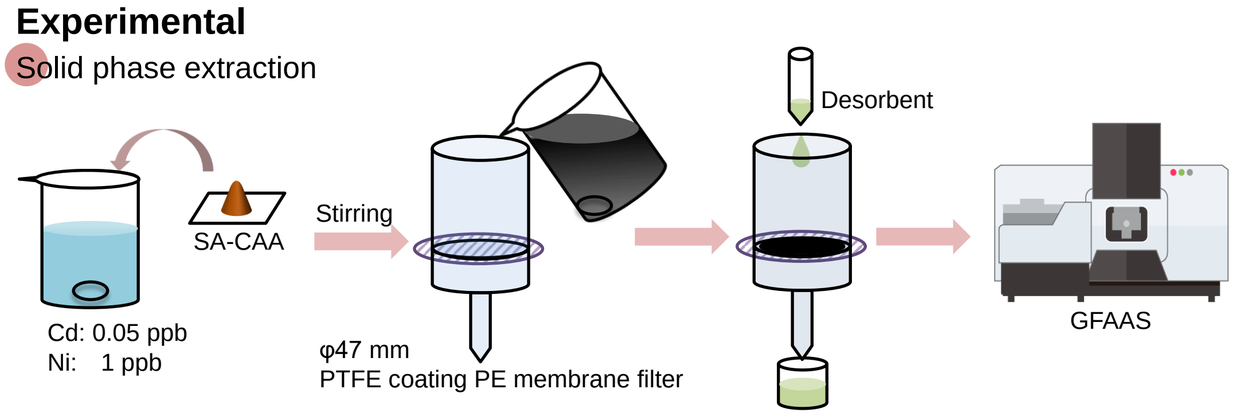


Fig. 2. Solid phase extraction method.

## RESULTS

### Characterization

BET

Table 1. BET surface area, total pore volume, and average pore diameter of CAA and SA-CAA.

| | $V_m$ ($cm^3$ (STP) $g^{-1}$) | $a_sBET$ ($m^2$ $g^{-1}$) | $V_p$ ($cm^3$ $g^{-1}$) | $d_p$ (nm) |
|---|---|---|---|---|
| **CAA** | 262.9 | 1140 | 0.96 | 3.3 |
| **SA-CAA** | 268.9 | 1170 | 0.97 | 3.3 |

$V_m$: Monolayer adsorption volume, $a_s$BET: BET Specific surface area, $V_p$: Full pore volume, $d_p$: Average maximum diameter.

SEM

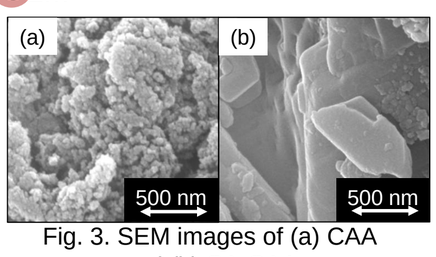


Fig. 3. SEM images of (a) CAA and (b) SA-CAA.

## RESULTS

Adsorbent type

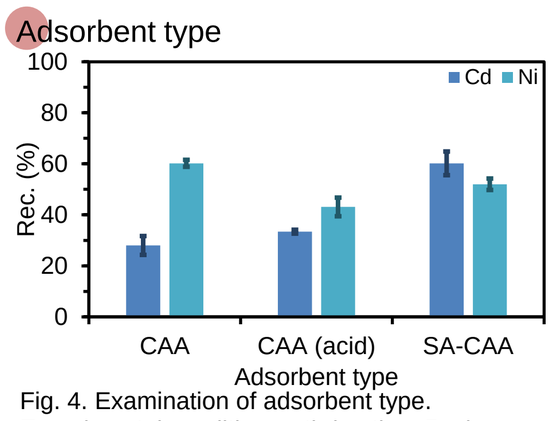


Fig. 4. Examination of adsorbent type. Experimental conditions：stirring time 5 min, adsorbent amount 50 mg, initial pH 3, desorbent 0.1 mol $L^{-1}$ $HNO_3$ 3 mL, sample volume 200 mL

SA amount

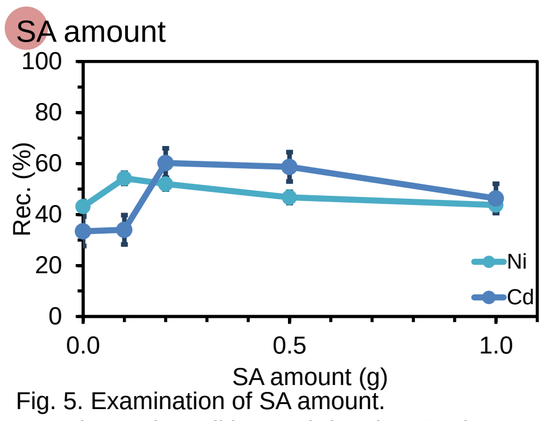


Fig. 5. Examination of SA amount. Experimental conditions: stirring time 5 min, adsorbent amount 50 mg, initial pH 3, desorbent 0.1 mol $L^{-1}$ $HNO_3$ 3 mL, sample volume 200 mL

Stirring time

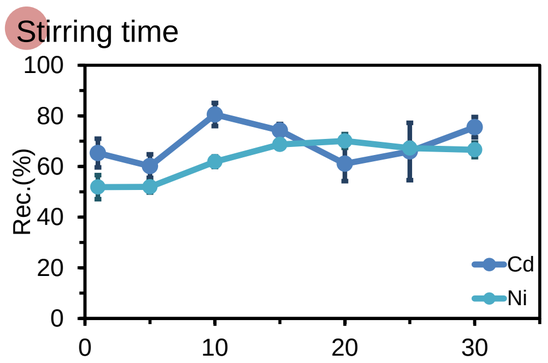


Fig. 6. Examination of stirring time. Experimental conditions: adsorbent amount 50 mg, initial pH 3, desorbent 0.1 mol $L^{-1}$ $HNO_3$ 3 mL, sample volume 200 mL

Adsorbent amount

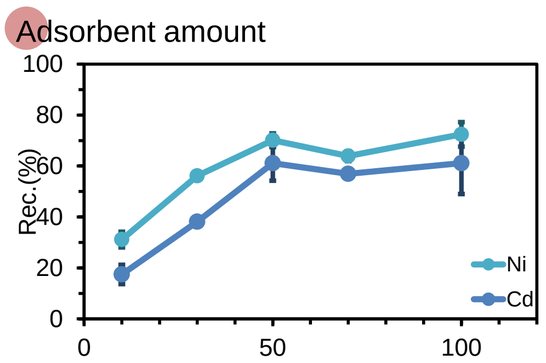


Fig. 7. Examination of adsorbent amount. Experimental conditions: stirring time 20 min, initial pH 3, desorbent 0.1 mol $L^{-1}$ $HNO_3$ 3 mL, sample volume 200 mL

pH

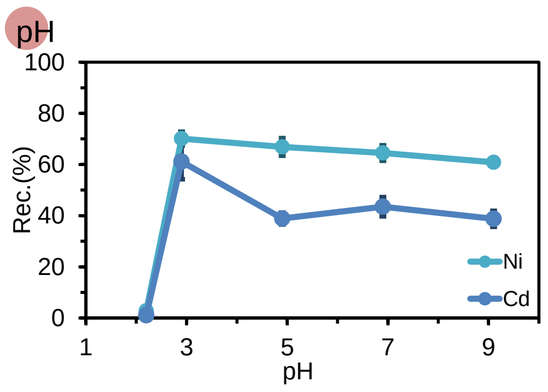


Fig. 8. Examination of initial pH. Experimental conditions: stirring time 20 min, adsorbent amount 50 mg, desorbent 0.1 mol $L^{-1}$ $HNO_3$ 3 mL, sample volume 200 mL

Sample volume

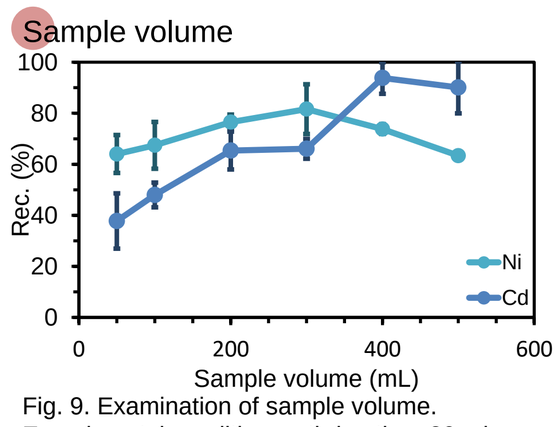


Fig. 9. Examination of sample volume. Experimental conditions: stirring time 20 min, adsorbent amount 50 mg, initial pH 3, desorbent 0.1 mol $L^{-1}$ $HNO_3$ 4 mL

Table 2. Optimum conditions.

| | |
|---|---|
| SA amount (CAA 1 g) | 0.2 g |
| Stirring time | 20 min |
| Adsorbent amount | 50 mg |
| Initial pH | 3 |
| Desorbent | 0.1 M $HNO_3$ 4 mL |
| Sample volume | 300 mL |

Table 3. Analytical performance.

| | Cd | Ni |
|---|---|---|
| **Linear range** (ppb) | 0.01～0.1 | 0.1～1 |
| **Correlation coefficient** ($R^2$) | 0.99 | 0.99 |
| **Limit of detection** ($3S^{(a)}/N^{(b)}$, ppt) | 3 | 205 |
| **Limit of quantitation** (10S/N, ppt) | 21 | 684 |
| **RSD[(c)] (%)** (Cd:0.05 ppb, Ni:1 ppb, n=9 ) | 12.6 | 14.3 |

(a) signal, (b) noise, (c) relative standard deviation.

## CONCLUSION

- ✓ The use of stearic acid-modified activated carbon as the adsorbent showed selectivity for Cd and Ni, with improved recovery compared to unmodified activated carbon.
- ✓ The detection limits were 3 ppt for Cd and 205 ppt for Ni in this method.

## FUTURE WORK / REFERENCES

- ✓ The effects of matrix elements (e.g., Mg, Ca, Na, K) on this method will be investigated, and its application to real samples will be studied.