Synergetic effect of mixture of sodium hydroxide and sodium acetate to get electrochemically treated graphite pencil electrodes for trace detection of 4-chloro-1-naphthol in real water samples

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ABSTRACT

A simple and novel procedure for sensing 4-chloro-1-naphthol (4-CNP) in real water samples was innovated using a pretreated graphite pencil electrode (PGPE).

Cyclic scanning between certain potential range of graphite pencil electrode (GPE) in mixture of NaOH and sodium acetate (NHNA) solution resulted in activation of electrode surface.

The oxidation peak current against 4-CNP concentration at PGPE-NHNA displayed linearity between 0.01 µM to 1.0 µM with equation I(µA) = 540.07 C 4-CNP(µM) + 33.028 and regression constant (R^2) of 0.9986. The PGPE-NHNA afforded very low detection limit of 0.00157 µM or 1.57 nM (S/N=3) for 4-CNP quantification.

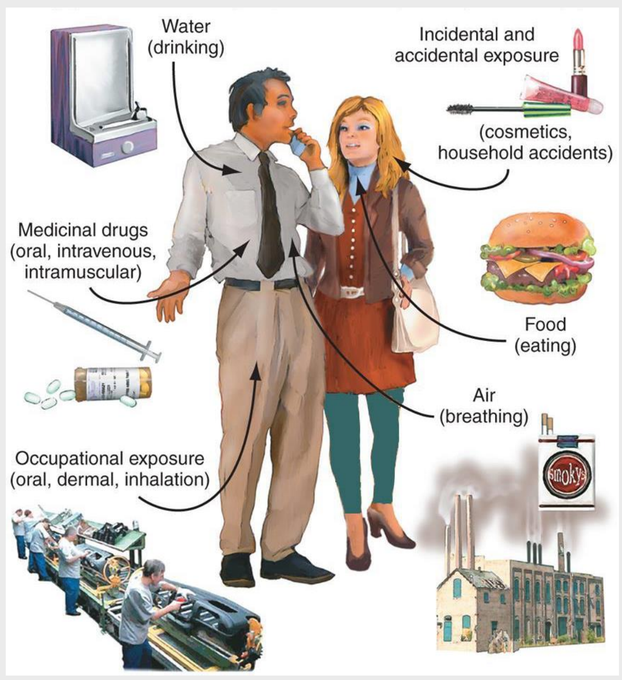
Built up single use can be employed for trace amount detection of 4-CNP in tap water, drinking water and sea water samples

Keywords

4-chloro-1-naphthol, Pretreated graphite pencil electrode, Synergistic effect, Square wave voltammetry, Real water samples

INTRODUCTION

Polyaromatic hydrocarbons (PAHs) are widely existent and burning of fossil fuels is one of the major source of PAHs in environment [1, 2].

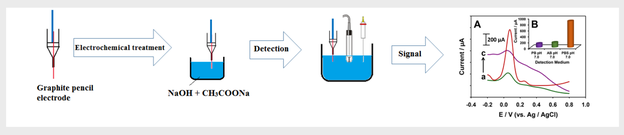


PAHs can effect pulmonic, gastral, nephritic, and dermatological structures, although in severe cases effect hematogenic and immune systems, even they can cause cancer [3 – 6].

Exposure to 4-CNP can cause skin, eyes, respiratory irritation and corrosion. In severe cases gastrointestinal irritation with nausea, vomiting and diarrhea can be observed, it can effect respiratory organs, kidney and liver [7, 8].

The study showed that pretreated graphite pencil electrode (PGPE) had an electrocatalytic effect on the 4-CNP oxidation when it is prepared in a solution containing sodium acetate and NaOH as supporting electrolytes.

METHODOLOGY



Pretreatment of GPE

For electrochemical treatment of GPE surface, potential was cycled between 1.3 V – 1.9 V with scan rate of 100 mVs-1 for 50 segments in mixture of NaOH and CH_3COONa.

Sample preparation

Water samples were initially filtered and then 3.0 ml of each water sample was diluted to 5 ml with 0.1 M PBS, pH 7.0.

RESULTS

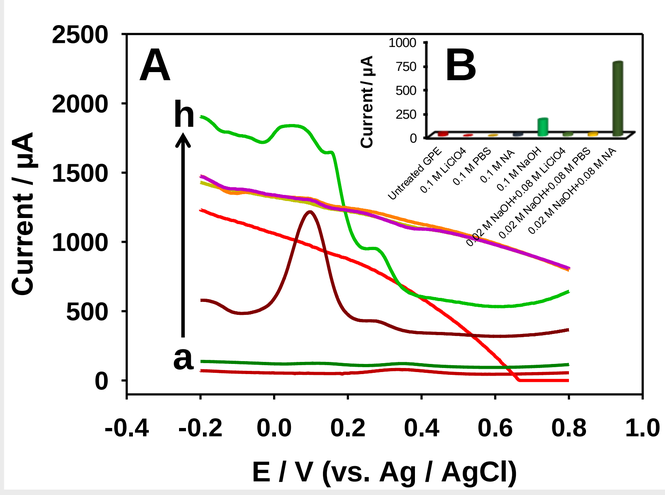


Fig 1. SWVs of 5 µM 4-CNP in 0.1 M PBS, pH 7.0.

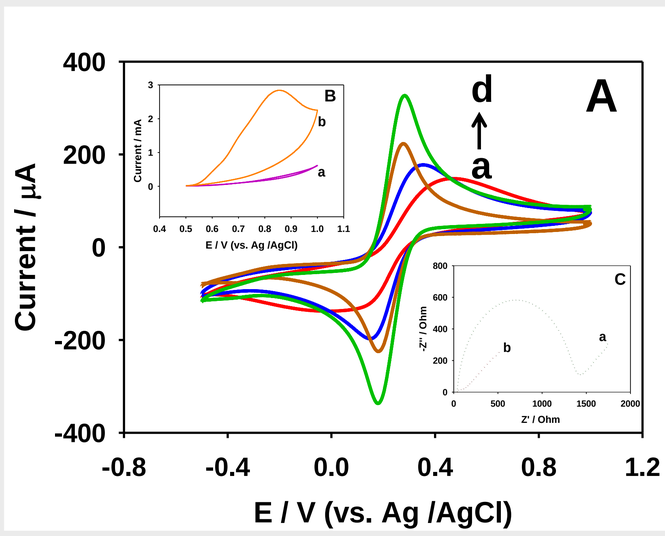


Fig. 2. characterization of PGPE-NHNA

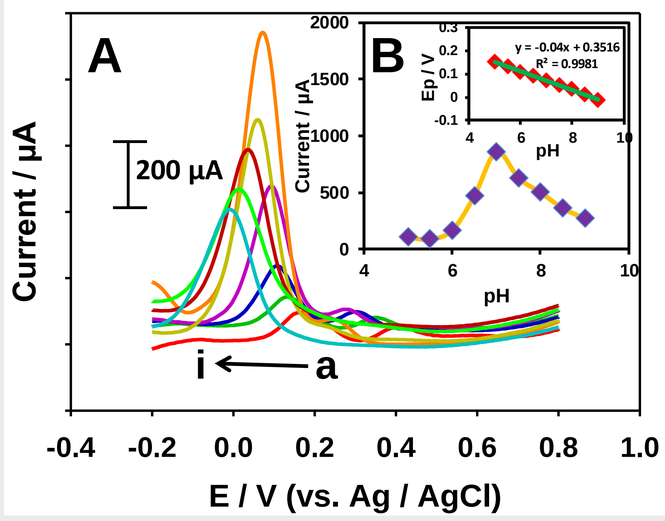


Fig. 3. Effect of pH on peak current and peak potential

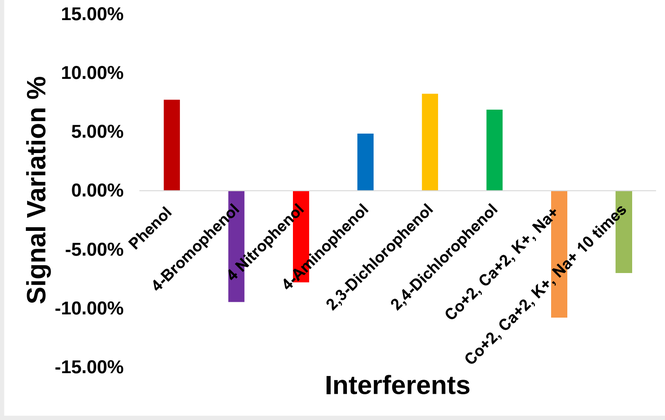


Fig. 4. Effect on oxidation current of 0.5 µM 4-CNP in the presence of 0.5 µM of different interferents.

DISCUSSION

The peak current for 4-CNP was increase 25 times after treatment with NaOH + NA mixture as compared to untreated GPE.

Calculation of capacitance for both electrodes was done by using equation
$C = Q / \Delta E \cdot m$
The capacitance calculated for untreated and treated GPE was 148.014 F/g and 8317.386 F/g respectively.

By using the equation
$Ip = 2.69 \times 10^5 C n^{3/2} A D^{1/2} \gamma^{1/2}$
Electroactive areas obtained 0.535 mm^2 and 0.94 mm^2 for untreated and pretreated GPEs respectively.

Increase in hydrophilic character and synergistic effect of mixture of supporting electrolytes corresponds to the entrance of oxygen on the surface of GPE in the form of hydroxyl, carbonyl and carboxylic groups.

A linear relation was obtained between 0.01 µM and 1.0 µM (n=3) of 4-CNP in the calibration plot of peak current vs concentration.

S. No.	Water samples	Added (µM)	Detected (µM)	% Recovery
1	Sea water	0.500	0.503	100.544
2	Tap water	0.500	0.501	100.1112
3	Drinking water (Bottle)	0.500	0.500	102.050
4	Drinking water (filter plant)	0.500	0.506	101.211

Table 1. Concentration of 4-CNP measured by PGPE-NHNA in water samples.

CONCLUSION

Sensitivity and selectivity of PGPE-NHNA predominantly rely on the method of preparation and the features of the target analyte.

First time solution mixture of NaOH and sodium acetate was utilized for pretreatment of GPE to get PGPE-NHNA.

Cyclic potential and concentration of treatment mixture showed prominent effect on voltammetric response of treated surface of electrode.

The proposed method showed very low detection limit and can be effectively employed for detection and quantification of 4-CNP in real water samples.

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