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ABSTRACT

An electrochemical method for determination of the platinum group metals (PGEs), as PtCl₂, PtCl₄, cisplatin, oxaliplatin, carboplatin, RhCl₃ and PdCl₂, was suggested and developed in this study. With the respect of their behavior in the environment, we chose two types of buffers, acetate and borate, with different pH to investigate electrochemical behavior of PGEs. In conclusion, this method provides rapid, qualitative, and screening analysis for determination of PGEs in the environment with increased contamination of these pollutants.

INTRODUCTION

Car catalysts, jewelry and other branches of industry, such as petroleum, electric, gas, and chemical industries participate significantly on the contamination of the environment with PGEs as well as hospitals [1, 2]. The aim of this study was to optimize the FIA-ED with a glassy carbon electrode to characterize electrochemically PGEs. The optimized method was further used for determination of the above-mentioned platinum, palladium and rhodium compounds in the samples of water.

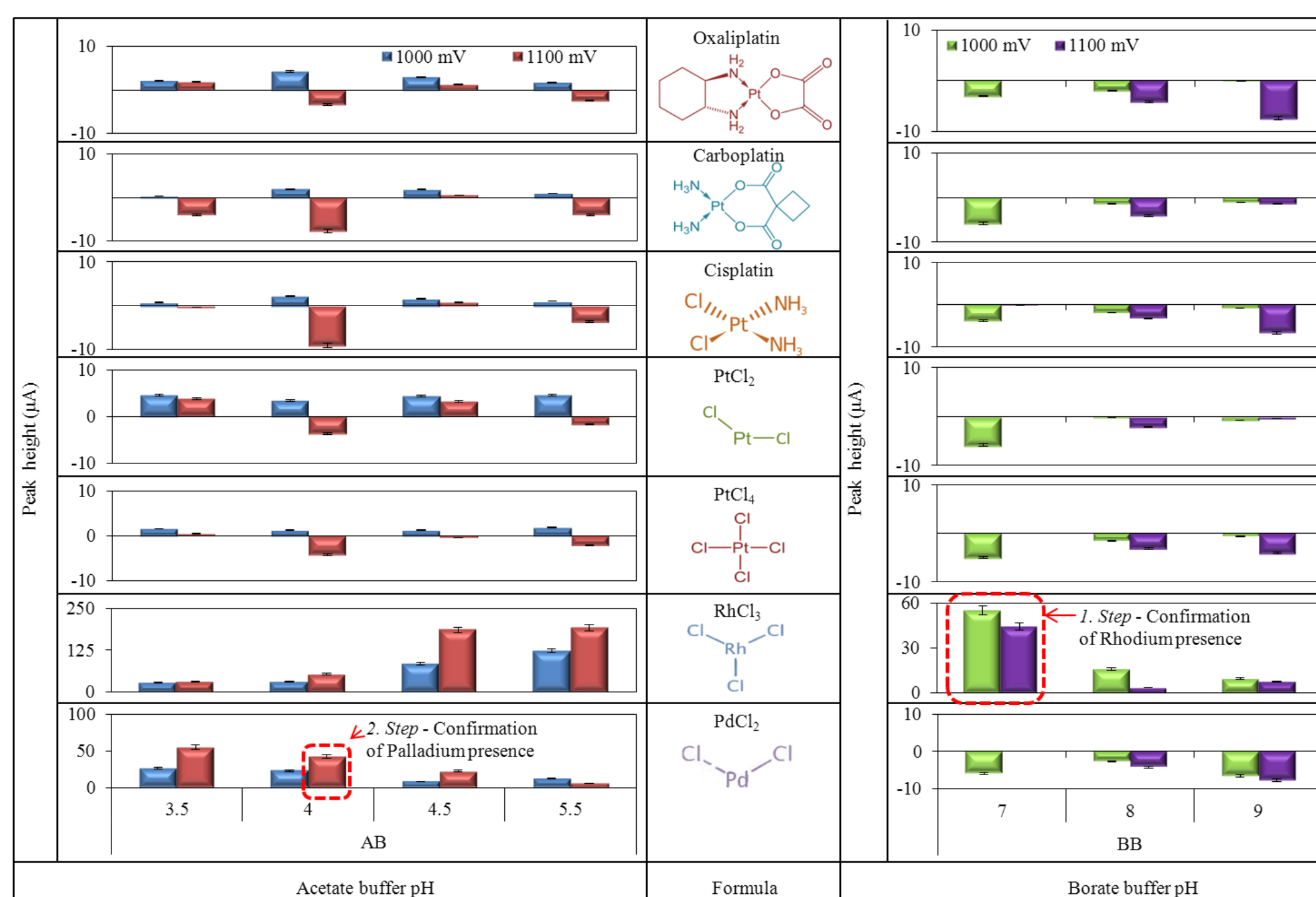


Fig. 1: Expression of ideal potentials for each buffer of individual PGEs

METHODS

FIA-ED system

The instrument for flow injection analysis with electrochemical detection (FIA-ED) consisted of a solvent delivery pump (Model 582 ESA Inc., Chelmsford, MA, USA) and an electrochemical detector. The electrochemical detector includes one low-volume flow-through analytical cell (Model 5040, ESA, USA), which consists of a glassy carbon electrode as a working electrode, a hydrogen-palladium electrode as a reference electrode and an auxiliary electrode, and Coulochem III as a control potentiostat module. As mobile phases were acetate buffer with pH 3.5; 4.0; 4.5, 5.5, and borate buffer with pH 7; 8 and 9 respectively used. Detection was carried out at different potentials (100–1200 mV) applied to obtain HDVs of individual PGEs.

Mixed samples preparation

Mixed samples were prepared as a mixtures of Rh : Pd, Pd : Rh, Rh : Pt, Pt : Rh, Pd : Pt, and Pt : Pd in the following ratios 1 : 1; 1 : 10; 1 : 50, and 1 : 100, where number 1 represents the concentration of 10 µg.mL⁻¹ (it means 10 corresponds to 100 µg.mL⁻¹, 50 to 500 µg.mL⁻¹, and 100 to 1000 µg.mL⁻¹). Height of signals was used to quantify the amount of PGEs in the mixed samples according to the calibration curve.

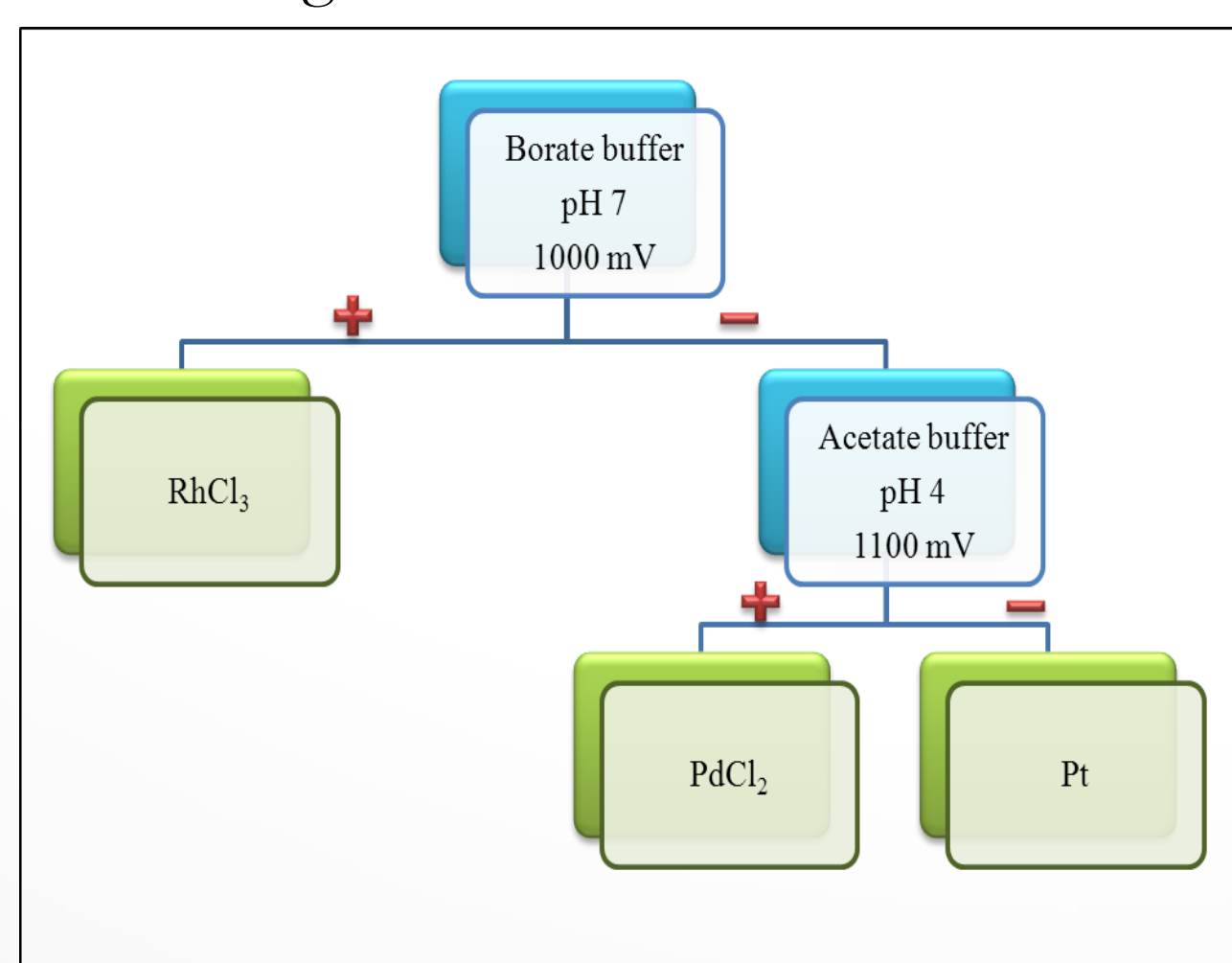


Fig. 3: Determinative scheme

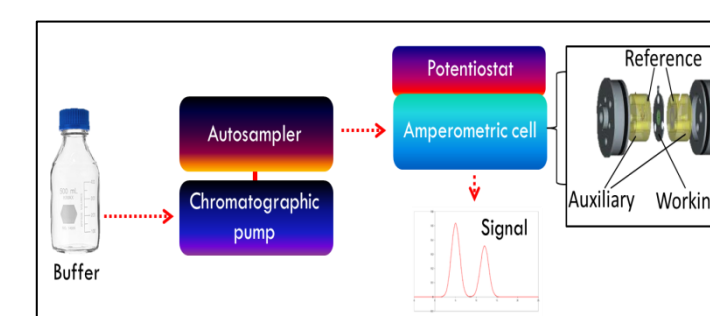


Fig. 2: FIA-ED system

RESULTS AND DISCUSSION

In Fig. 1 can be seen the ideal potentials for each PGEs in various pH buffers. As the ideal determination conditions was evaluated pH 7 borate buffer with positive signal of RhCl₃. Second step shows at PdCl₂ presence after using of acetate buffer with pH 4. Other negative signals show at possible presence of platinum. FIA-ED (Fig. 2) is well suitable for rapid platinum determination. Determinative scheme (Fig. 3) was further used for analysis of real water samples spiked with different concentrations of PGEs (Tab. 1). Accuracy was close to real concentrations (Dev ≤ 10 %).

In conclusion our method may serve for rapid and cheap PGEs determination in high risk area waters.

Analytes	Ratio	Concentration used [µg.mL ⁻¹]	Concentration measured [µg.mL ⁻¹]	Deviation [%]
Rh : Pd	1 : 1	10 : 10	9	- 10
Rh : Pd	1 : 10	10 : 100	10	0
Rh : Pd	1 : 50	10 : 500	9	- 10
Rh : Pd	1 : 100	10 : 1000	9	- 10
Pd : Rh	1 : 1	10 : 10	9	- 10
Pd : Rh	1 : 10	10 : 100	100	0
Pd : Rh	1 : 50	10 : 500	487	- 3.6
Pd : Rh	1 : 100	10 : 1000	940	- 6
Rh : Pt	1 : 1	10 : 10	10	- 0
Rh : Pt	1 : 10	10 : 100	9	- 10
Rh : Pt	1 : 50	10 : 500	10	0
Rh : Pt	1 : 100	10 : 1000	10	0
Pt : Rh	1 : 1	10 : 10	10	0
Pt : Rh	1 : 10	10 : 100	99	- 1
Pt : Rh	1 : 50	10 : 500	483	- 3.4
Pt : Rh	1 : 100	10 : 1000	963	- 3.7
Pd : Pt	1 : 1	10 : 10	10	0
Pd : Pt	1 : 10	10 : 100	11	+ 10
Pd : Pt	1 : 50	10 : 500	10	0
Pd : Pt	1 : 100	10 : 1000	9	- 10
Pt : Pd	1 : 1	10 : 10	11	+ 10
Pt : Pd	1 : 10	10 : 100	98	- 2
Pt : Pd	1 : 50	10 : 500	478	- 4.4
Pt : Pd	1 : 100	10 : 1000	979	- 2.1

Tab. 1: Table of mixed samples analysis

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