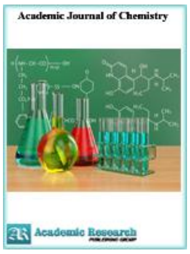

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Examination of Ionophore Properties of the 4- (6-Methoxy-1, 3-Dimetilizokinol-7-Yloxy) Phthalonitrile Compound for the Determination of Some Monovalent Cations

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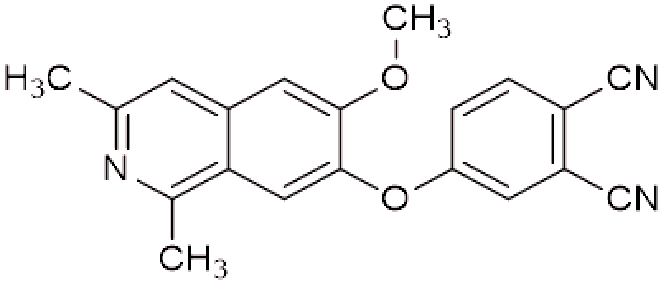
Abstract: The goal of this work is the construction of ion sensitive electrodes with the use of 4- (6-methoxy-1, 3-dimetilizokinol-7-yloxy) phthalonitrile. The lifetime, response time, optimum working range and other response characteristics of these electrodes were also be investigated. The selectivity of the electrode towards the ion of the interest (Na^+, K^+, NH_4^+) was computed.

Keywords: Analysis of cations; Ionophore; Potentiometric sensor.

1. Introduction

A large number of examples can be cited where ion chromatography(IC) finds application worldwide; such as determination of common inorganic cations in environmental compartments. The technique is now applicable to the determination of a wide range of solutes in diverse sample matrices and food analysis, although environmental studies continue further to be the largest application area of IC [1, 2]. However, low detection limits and high measurement sensitivity to ions combined with a small sample volume are needed in a number of applications of ion chromatography. Much attention has been paid to optimizing these factors and various analytical methods have been developed [3-8]. Potentiometric ion selective electrodes (ISEs) are currently the most widely used chemical sensors in medical, environmental, and industrial analysis, as they offer many advantages such as fast response, simple analytical procedure, and relatively low cost. In this study, use of the 4- (6-methoxy-1, 3-dimetilizokinol-7-yloxy) phthalonitrile (Figure 1) compound in ion selective electrode composition for determination of monovalent cations is validated. . Besides, investigation of probable usage as ionophore was searched. Therefore, totally solid state polymer membrane contact electrodes have been prepared. Membrane compositions, response time and potentiometric behaviors like selectivity against monovalent cations (Na^+, K^+, NH_4^+) and other response characteristics of the prepared electrodes have been investigated. Nevertheless, potentiometric behaviors of entirely solid contact PVC composite membrane electrodes have been tested for 10^{-1} – 10^{-5} mol L^{-1} concentration changes of monovalent cations for stability.

Figure-1. Structure of 4- (6-methoxy-1, 3-dimetilizokinol-7-yloxy) phthalonitrile



2. Materials and Methods

The construction of all solid-state contact PVC membrane cation–selective electrodes without an inner reference solution was carried out, as described by Isildak and colleague [4-7]. The sensing membrane consisted of 31.0 weight % polyvinylchloride (PVC), 2.0 wt.% 4- (6-methoxy-1, 3-dimetilizokinol-7-yloxy) phthalonitrile as active ligands, 66 wt.% dioctylsebacate (DOS) as plasticizers after evaporation of THF at room temperature open to air for 4 h. To reduce the membrane resistivity and cationic selectivity, in the case of neutral carrier electro-active materials, the membrane contained 1.0 wt. % potassium tetrakis (p-chlorophenyl) borate (KTpClPB). The epoxy resin mixture used to bind the graphite in preparing the internal conducting support of the electrode was made from epoxy and hardener in tetrahydrofuran solvent in the proportions of 1 : 0.5. The powdered graphite was mixed with epoxy resin in the proportions of 1 : 1. Electrical connection was made to copper rod inserted into a hole in the epoxy-graphite conductive support. When not in use for a long time the all solid-state contact tubular PVC-matrix electrodes were stored dry after washing with deionized water.

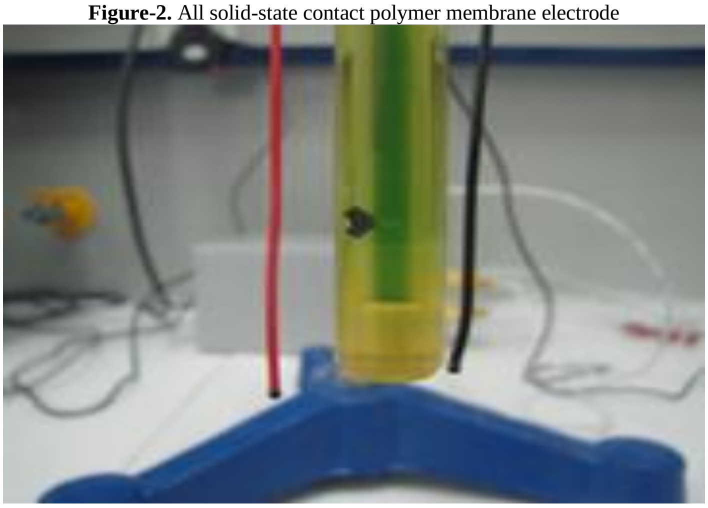
3. Results

Potentiometric sensor has been developed through immobilizing a membrane matrix on all-solid-state contact. It was for sample monitoring without any reagent consumption and at a very short analysis time [8-10].

The all-solid-state contact mixture electrode of graphite-epoxy resin was prepared in suitable ratio where the sensing membrane adhered to the surface of all-solid-state contact electrode without an internal reference solution. As a result life-time of the electrode increased without any loss in its potentiometric response property and thus electrode became more stable. All-solid-state membrane electrodes are cost effective because they are very easily prepared in miniaturized construction.

To start with copper-sensitive censor membrane was prepared by coating composite cocktail on the surface of contact transducer in solid state. Copper-sensitive censor was not constituted internal reference electrode or solution. Then the potentiometric performance of copper-sensitive chemical censor (selectivity constant, liner working interval, detection limit, response time, repeatability, lifetime, and time dependent potential decay) was determined through a computer controlled measurement system in static conditions. Figure 1 shows the all solid-state contact polymer system.

Figure-2. All solid-state contact polymer membrane electrode



Potentiometric measurement cells used in this study are displayed schematically as follows:

Conducting wire | Solid-state contact | cation-sensitive membrane | Test solution ‖ External reference electrode

The potentiometric behavior of all solid state PVC membrane electrode is shown in Figure 2. Table 1 shows linear coefficients and linearity of determination (r^2) for any of the ions studied in the concentration ranges.

Figure-3. The potentiometric behavior to exhibits of the all solid-state membrane electrode against 1x10^{-1}-5x10^{-5} mol L^{-1} cations concentration change.

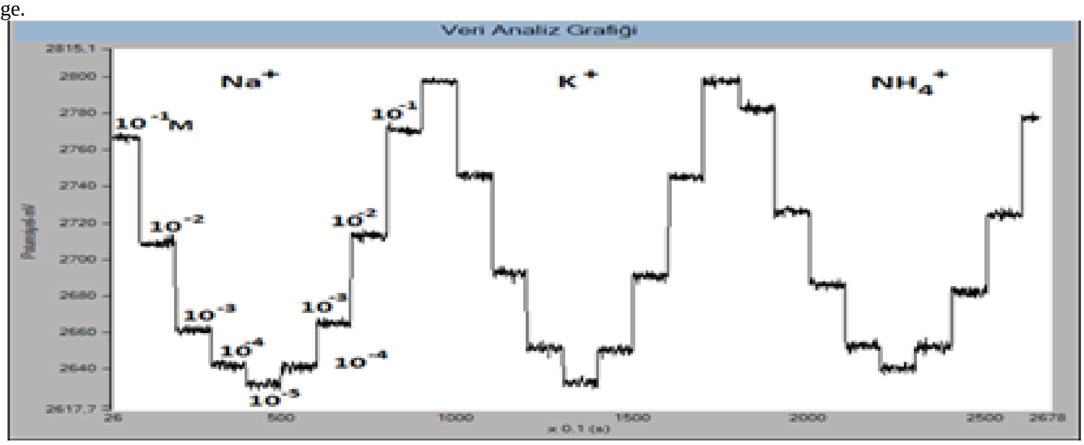
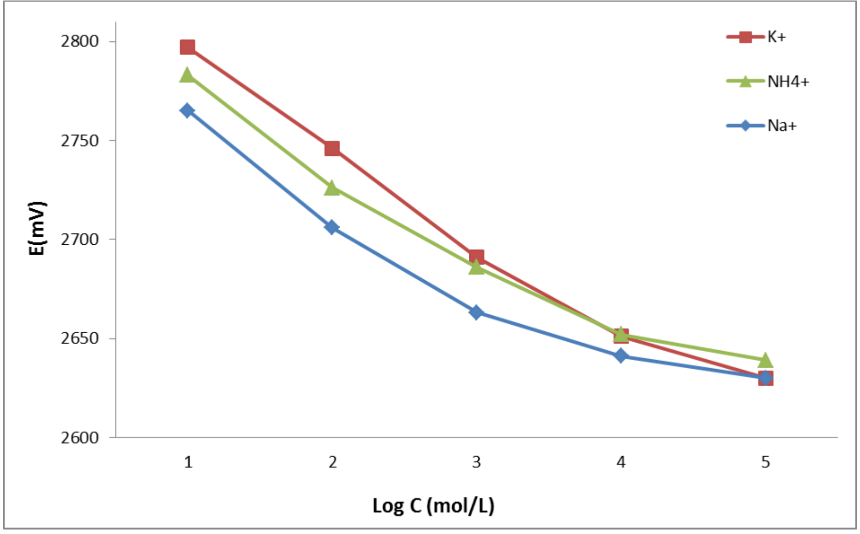


Table 1. The linear coefficients and linearity of all solid state PVC membrane electrode

Cations	linearity	r^2
K^+	y= -42.9x + 2831.7	0.9757
NH_4^+	y = -36.2x + 2805.8	0.9533
Na^+	y = -33.5x + 2781.5	0.9194

Calibration graphs were constructed by plotting peak height against concentration of the cations under the optimum conditions (Figure 3). Linear plots were obtained in the concentration ranges of $1x10^{-1}$ – $1x10^{-5}$ mol L^{-1} of cations.

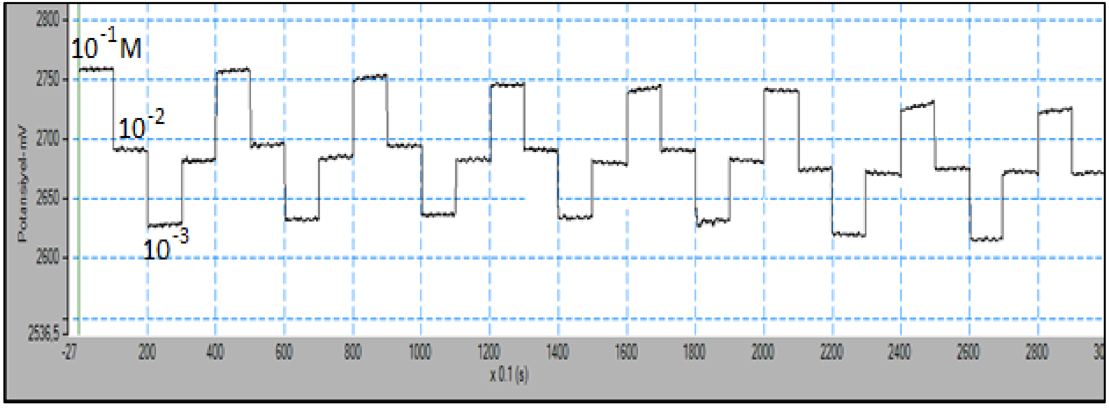
Figure-4. Linearity to exhibits of the all solid-state membrane electrode against $1x10^{-1}$-$1x10^{-5}$ mol L^{-1} cations concentration change.



The response time (t_{95}%) is known as the time period for the presented potential of electrode to reach equilibrium with the sensible part of the membrane. The ion concentration was rapidly increased from 10^{-5} to 10^{-1} mol L^{-1} and the t_{95}% values were measured. The response time was between 5-9 s.

The all-solid-state PVC membrane cation-sensitive electrode showed that the results can easily be reproduced. Figure 4 depicts the reusability of the sensor in 10^{-2}, 10^{-3}, and 10^{-4} mol L^{-1} sodium concentrations.

Figure-5. The reusability of the all solid-state contact PVC membrane electrode



5. Conclusion

It shows the potential change of the electrode can exhibit ionophore feature of 4- (6-methoxy-1, 3-dimetilizokinol-7-yloxy) phthalonitrile compound. The all solid state PVC membrane electrode could easily be prepared and economic. Its response time is considerable. Additionally, composite membrane sensor can be miniaturized and used in mobile.

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