BEHAVIOR OF A POLYmeric LIQuID MEMBRANE ION-SELECTIVE ELECTRODE FOR CHLORIDE ION

M. DE LOS A. ARADA PÉREZ, M. YAZDANI-PEDRAM

1 Department of Analytical Chemistry, Eastern University of Cuba, Santiago de Cuba. Avenida Patricio Lumumba s/n, 90500, Rpto Jimenez, Santiago de Cuba, Cuba.
2 Department of Organic and Physical Chemistry, Faculty of Chemical and Pharmaceutical Sciences, University of Chile, S. Livingstone 1007, Independencia, Santiago, Chile.

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ABSTRACT

Chloride selective polymeric liquid membrane electrode has been developed by using Bis-(2-ethylhexyl) Sebacate (DOS) as plasticizer and 2-[5-(4-nitrophenyl) furyl]-4,5-diphenyl imidazole (FFDFIN) as ionophore. Some parameters of evaluation of the electrode are presented in this work. The constructed electrode showed fast potentiometric response to chloride ion in the concentration range from 10^{-4} to 10^{-2}mol.dm^{-3} with Nernstian slope of -63.43 ± 0.85 mV/decade, response time of 25 seconds and life time of 15 days.

Keywords: Chloride ion selective PVC membrane, Ion-selective electrode (ISE), 2-[5-(4-nitrophenyl)furyl]-4,5-diphenyl imidazole.

1. INTRODUCTION

The number of investigations concerning ion selective electrodes, by using various ionophores [1-4] for determination of different ions has been increasing [4-8]. These membrane electrodes are sensitive to a large number of ions. However, the number of works reported on the potentiometric determination of the chloride ion has been scarce.

The determination of the chloride ion, by potentiometric method of analysis [9-13], allows detecting and quantifying the concentration of chloride ion in a precise and exact manner. Ion selective electrodes (ISE) are very appropriate for this purpose because they are easy to build, the results are obtained quickly, they show good selectivity for inorganic ions, they are relatively of low cost and can be taken and used in the places of interest.

In this paper, we report on the use of 2-[5-(4-nitrophenyl)furyl]-4,5-diphenyl imidazole, a highly selective carrier, for detection of chloride ion using (DOS) as plasticizer in PVC polymeric liquid membrane.

2. EXPERIMENTAL

2.1 Materials and equipments

All the reagents used in this study were of analytical grade. Poly(vinylchloride) (PVC) from Fluka was used as polymeric matrix. The plasticizer used was Bis (2-ethylhexyl) Sebacate (DOS) from Sigma-Aldrich and was employed as solvent mediator of the PVC liquid membrane. Tetrahydrofuran (THF) was analytical grade from Merck. All the reagents used in this study were of analytical grade.

2.2 Preparation of the electrode

The construction of the electrode body and deposition of the sensing membrane was carried out as shown in Figure 1.

As shown in Figure 1, the electrodes were constructed by using a 10 cm long poly(methyl methacrylate) tube (A) with a 5 mm internal diameter where a small piece of PVC tubing (2) was introduced inside to serve as support for a thin copper disk (3) which was in contact with a shielded cable (4). The prepared membranes were obtained by mixing 7 Wt.% of 2-[5-(4-nitrophenyl)furyl]-4,5-diphenyl imidazole as ionophore, 60 Wt.% of Bis (2-ethylhexyl) Sebacate (DOS) as plasticizer and 33 Wt.% of PVC as the polymeric matrix by depositing the THF solution of the mixture of PVC.

The PVC membrane was deposited on a solid conducting epoxy resin acting as support. The conducting epoxy resin (5) was prepared by mixing a commercial two component epoxy adhesive form Ciba-Geigy with graphite powder from Merck. The epoxy-graphite mixture was then deposited as a thin film, approximately 0.5 mm, from a THF solution on the conducting epoxy-graphite surface and was left to dry at room temperature for at least 24 h. The electrodes were conditioned in 1 x10^{-2}mol.dm^{-3} of their primary ions for 24 h before use.

Figure 1. Construction of the all-solid-state type electrode

2.3 Determination of the electromotive force (EMF)

The electromotive force (EMF) determinations were carried out by using an open cell at room temperature.

The calibration curves were used to calculate such parameters as slope (S), practical detection limit (PDL) and lower limit of linear response (LLLR). This was done following the Nernst law through data adjustment by linear regression method. The calibration parameters were obtained by applying the method of additions [14], determining the activity of the principal ion by using the Debye-Hückel equation (equation 1).
\[ -\log f = \frac{0.51 Z^2 I^{1/2}}{1 + I^{1/2}} \]  

(1)

Where,  
\( f \) is the activity coefficient of the ion to be determined,  
\( Z \) is its charge and  
\( I \) is the ionic force of the solution.

The characteristics of a membrane sensor are its response for the primary ion in the presence of the other ions. This is measured in terms of potentiometric selectivity coefficients (\( K_{AB}^{Pot} \)), which has been determined by using the method of mixed solutions [14] through the equation 2.

\[ K_{AB}^{Pot} = \frac{a_A}{a_B} \frac{Z_A}{Z_B} \]  

(2)

Where  
\( a_A \) are the activities and  
\( Z_A \) and  
\( Z_B \) are the charges of the primary ion, \( A \), and the interfering ion, \( B \) respectively.

3. RESULTS AND DISCUSSION

Figure 2 shows that 2-(5-(4-nitrofenyl)furyl)-4,5-difenyl imidazole in PVC membrane is highly selective to chloride ion.

The characteristic parameters of the ISE are shown in Table 1.

![Figure 2: Calibration curve for chloride ion-selective electrode.](image)

Table 1. Characteristic parameters for the constructed ISE.

<table>
<thead>
<tr>
<th>Parameters of the calibration</th>
<th>S(mV/dec)</th>
<th>LIRL mol.dm⁻³</th>
<th>Correlation coefficient</th>
<th>pH</th>
<th>(1x 10⁻³ mol.dm⁻³ of NaCl)</th>
<th>Lifetime (days)</th>
<th>SD (S)</th>
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<td>7.25 x 10⁻²</td>
<td>-63.43 ± 0.8562</td>
<td>7.25 x 10⁻⁶</td>
<td>0.9989</td>
<td>2.6</td>
<td>15</td>
<td>0.87973</td>
<td></td>
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Table 2. Potentiometric selectivity coefficients of some interfering ions.

<table>
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<tr>
<th>Ion</th>
<th>( K_{AB}^{Pot} )</th>
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<tr>
<td>NO₃⁻</td>
<td>5.424x10²</td>
</tr>
<tr>
<td>BrO₃⁻</td>
<td>7.525x10²</td>
</tr>
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<td>IO₃⁻</td>
<td>8.75x10²</td>
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</table>

All studied ions constitute interferences to the determination of chloride with the constructed electrode.

4. CONCLUSION

In this work a polymeric liquid membrane ion-selective electrode (ISE) for determination of chloride ion was constructed and characterized. The ion-selective electrode was prepared using 2-(5-(4-nitrofenyl)furyl)-4,5-difenyl imidazole (FFDFIN) as ionophore (7 wt.-%), DOS as plasticizer (60wt.-%) and PVC as matrix (33 wt.-%). The ISE showed linear response in the concentration range of the 10⁻³ to 10⁻² mol.dm⁻³ and with a slope of -63.43 ± 0.8562 mV/decade and a lifetime of 15 days.

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REFERENCES