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A Review On Analytical Applications And Simple Method For The Preparation Of Calcium Ion Selective Electrode

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Abstract: By doping calcium glyxolate complex with PVC and plasticizer and subsequently annealing the electrode, an unique calcium ion-selective device was constructed A consistent Nernstian response of 29.97 mV/decade was measured for the electrode. To put it another way, the electrode behaved brilliantly in this investigation, which used it for four months. The linear range was (10-5 to 10)-1 M, with detection limit of 10-5 M and a reaction time between (20 and 60 seconds). Temperature had no effect on electrode efficiency, and the pH range that was found to be adequate for electrode responsiveness was (5-9) at higher concentrations of calcium ions, the electrode's selectivity was higher than the electrode's potentiometric coefficients of selectivity. When precipitation or long-lasting complex structures of calcium ions develop, there is a great deal of interference. Anions or calcium ions could be detected using these interferences. When utilized in conjunction with spectrophotometric methods for calcium determination, this calcium ISE yielded positive and promising findings in the assessment of calcium in drinking water and human blood serum.

Keywords: Calcium Ion-Selective Electrode (Ca-ISE) , Glyoxal bis (2-Hydroxyanil) (GBHA), Poly Vinylchloride (PVC) , Tetrahydro Furan(THF) , Plasticizer , Ca-BiSTMBPP ion-exchanger.

1. INTRODUCTION

Plants are unable to survive in the absence of calcium. As an essential structural component of the cell wall and membrane, it serves to maintain the equilibrium between inorganic and organic anions, as an important intracellular messenger, and in the harvesting and processing of nitrates for use in protein metabolism.

Electrochemical analysis systems have increasingly relied on potentiometric sensors such as ISE, or ion-selective electrodes, which have gained in popularity. The ISE analysis technique, which is based on the correlation between electrode potential and ion activity, can be utilized to perform ion detecting. The advantages of this technology include great selectivity and sensitivity, as well as speedy analysis and inexpensive cost, to name a few. An ion-selective electrode is dependent on the presence of an ion-selective membrane. Poly (vinyl chloride) (PVC) is a polymer that is extensively used as the polymeric base for ion-selective membranes. There are a variety of technologies currently in use for the detection of samarium, including ICP-AES, cathode-ray excitation spectroscopy, and laser excitation atomic fluorescence spectroscopy, among others, to identify the element. However, as a result of the huge growth in business and technology around the world, analytical chemists are increasingly realizing the value of ion-selective electrodes (ISEs) as a fast, accurate, and low-cost method of analysis.

It was Ross who created the world's first calcium ion-selective electrode, which was used in clinical applications in 1967. The electrode was assembled using a liquid ion-exchanger and a neutral carrier as the building blocks. The inclusion of an ion exchanger or neutral carrier into a PVC matrix was the most significant advancement in the creation of calcium ISES. These PVC matrices membrane ISEs were constructed in a straightforward manner, were significantly less expensive in terms of sensor materials, and had longer life spans, which resulted in a greater number and wider range of applications, particularly in clinical analysis. In recent years, novel calcium ISEs have been developed that are composed of calcium complexes with zincon in PVC rather than ion-exchangers or neutral carriers. In the determination of calcium ions using various methodologies, the electrode found a wide range of applications in the field. Following the success of using calcium complex with zincon doped in PVC to prepare an electro active membrane for calcium determination, the current work is focused on the homemade preparation of a new calcium ions elective electrode from the complex with Glyoxalin bis (2 - hydrocyanic, GBHA) doped in PVC with a specific plasticizer and solvent to determine calcium concentration.

Because the potentiometric approach is nondestructive, the samples that have been examined can be utilized again in the future. Direct potentiometric analysis has grown increasingly essential as an analytical tool in recent years. It is a technique that uses electrodes to measure potential differences, which in turn provide chemical information about the species in solution. Potentiometric sensors, often known as infrared sensors, have been the topic of ongoing research efforts for many years.

The basic concept of the current study is to use an ester compound as an electro active material, Dibutyl phthalate (DBP) as a plasticizer, sodium tetraphenylborate (NaTBP) as an anion excluder, and PVC as a membrane matrix to create a new calcium ion selective electrode for use in electrochemical sensors.

II. LITERATURE SURVEY

The most up-to-date approaches to the subject are discussed in this section. It was decided to cover the following topics:

Because of the development of novel ion-selective electrodes, several sensory elements have been developed for clinical and environmental testing that is based on the charge and size of the target ion. These techniques have been extensively explored because of their importance in biological processes, their ease of handling, nondestructive analysis, and the high cost of sample preparation, as well as their application to coloured samples and turbid solutions, among other considerations. Calcium is the mineral found in the greatest quantity in the human body. It plays an important role in bone growth, neuromuscular function, blood clotting, and membrane permeability, among other things. As a result of its participation in the transpiration of the plant, it aids in the growth of the plant.

Bedlechowicz et al; 2002 ETH1001 was used as an ionophore in the development of a calcium ion selective electrode. In 2004, Kumar and Mittal produced a new calcium ion selective electrode that was based on a PVC membrane that had been modified with a new ionophore, dibenzo-18-crown-6, to increase its selectivity (DB18C6).

To summarize, surface modified zeolite has been used as an electro active phase in the production of Ca^{2+}-ion selective electrodes using all of the previously described facts. We found that the electrode was highly selective and repeatable for the Ca^{2+} ion in this study, and we report our findings in this paper.

III. EXPERIMENTAL ANALYSIS

"Polyvinyl chloride (PVC), dioctyl phthalate (DOP) and sodium tetraphenylborate (NATBP), tetrahydrofuran (THF) were purchased from E. Merck. All additional reagents such as calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$) and sodium chloride (NaCl) were of analytical grade. Distilled water was used to prepare the 1M $CaCl_2$ stock solutions. Working solutions were made by dilution of the stock solution. A digital potentiometer (EQUIP – TRONICS EQ 602) with Ag /AgCl electrode as a reference electrode were used for this work".

Preparation of heterogeneous precipitate for ion selective electrode

Cinnamic acid, 10 grammes, was injected into an RB flask. Cinnamic acid was treated by adding 35 mL of methanol and 4 mL of conc.H2SO4 to the mixture. Using an air condenser, it was treated to a 3-hour reflux cycle. Crushed ice was added to a beaker with the solution after it had been cold. The resultant precipitate was filtered and washed with sodium carbonate solution and cold water. After it had cooled, the precipitate was dried and ground into a fine powder. It was recrystallized from methanol.

Preparation of membrane ion selective electrode

Varying amounts of heterogeneous precipitate were taken to prepare the ion selective membranes. In 3 mL of THF, 0.1, 0.2, and 0.3 g of precipitate were dissolved along with 0.1 g of PVC, DOP, and NaTPB, and the clear solution was gently evaporated. Then it was mixed with araldite and spread uniformly over What-man filter paper No.42 to obtain 0.9 mm thicknesses of the electro-active membrane. Drying time was 48 hours at room temperature.

At the 10 cm end of hollow glass tubes with a 2 cm diameter, “resin was used to fix a circular piece of membrane from each membrane. The tubes were filled with 1 M solution of calcium chloride. Reference copper metal wire of diameter 0.5 mm and length 12 cm was introduced through the other end of tube in such a way, that it remained dipped in the 1 M solution of calcium chloride. The electrodes were conditioned for 48 hours to establish equilibrium in 1 M $CaCl_2$ solution”

IV. RESULTS AND DISCUSSION

The electrode was initially conditioned in 1 M $CaCl_2$ solution to establish stable equilibrium. In order to assess the performance of the electrode, different characteristics including response time, selectivity, the influence of pH, influence of medium and the membrane composition on the response of the electrode were explored.

“It is well known that the sensitivity and selectivity of the ion-selective sensors not only depend on the nature of ionophore, but also greatly on the membrane composition and the features of plasticizers and anion excluder utilised 14-15. Thus, the influence of the membrane composition, the nature and amount of amount of methyl cinnamate and amount of plasticizers and amount of exclude on the potential response of the Ca(II) sensor were investigated”.

Analytical applications

The Ca(II) “sensor was utilized as an indicator electrode in the potentiometric titration of Ca(II) with EDTA. The EDTA solution was titrated with 25 mL of a 1 M Ca(II) solution. Adding titrant volume increases potential before the end point, while the potential response after the end point is nearly constant”.

To examine the “applicability of the sensor to real samples, an attempt was made to measure calcium ion in genuine samples like milk, water samples. A maximum recovery of 97% was recorded for calcium ions in sample analysis, indicating quantitative recovery”.

IV. CONCLUSION

Over the course of its useful life of three months, the sensor showed good repeatability. This electrode is superior to the previous electrodes with regard to the slope, pH range, response time and selectivity over a number of cations and anions. As an indicator electrode in potentiometric titration of Ca^{2+} ions with EDTA, the suggested sensor's strong selectivity allowed it to be effectively employed as a method for determining the calcium content of various milk and water samples.

6. References

[1]. Shamsipur.M , Soleymanpour.A , Akhond.M, Sharghi,.H and Massah, A.R”Uranyl selective PVC membrane electrodes based on some recently synthesized benzo-substituted macrocyclic diamides,” Talanta,2002, 58,2, 237–246,

[2]. ZhangZ.R and Yu,R.Q “The synthesis and membrane transport characteristics of macrocyclic polyether ligands composed of 1,10-phenanthroline as carriers for primary amine species,” Talanta, 1994.41, 2, . 327–333, .

[3]. Singh,A.K Saxena.P Mehtab.S and Gupta.B “Strontium(II)- selective electrode based on a macrocyclic

tetraamide,” Talanta,2006 . 69, 2, . 521–526,

[4]. Singh,A.K Saxena,P and Panwar, A”Manganese(II)-selective PVC membrane electrode based on a pentaazamacrocyclic manganese complex,” Sensors and Actuators B,2005 . 110, 2 .377-381.

[5]. Ganjali, M.R, Razavi,T , Dinarvand,R , Riahi,.Sand Norouzi.P “New diltiazem potentiometric membrane sensor stands on theoretical calculations as a useful device for diltiazem hydrochloride analysis in pharmaceutical formulation and urine,” International Journal of Electrochemical Science,2008, . 3, . 1543–1558,

[6]. GanjaliM.R, Memari.Z Faridbod.F and Norouzi.P “Samarium microsensor: an asymetric potentiometric membrane sensor,” International Journal of Electrochemical Science, 2008 . 3, .1169-1179.

[7]. Beheshti S.S,and AminiM.K, “A simple and selective flow injection potentiometric method for determination of iodide based on a coated glassy carbon electrode sensor,” International Journal of Electrochemical Science,2007. 2,778–787,

[8]. Zhang.H , Zhang.Z, Li.J and Sh. Cai, “Effects of Mg2+ on supported bilayer lipid membrane on a glassy carbon electrode during membrane formation,” International Journal of Electrochemical Science,2007 ,2,. 788–796,

[9]. Paker.P, McGraw-Hill Concise Encyclopaedia of Science and Technology,1994 McGraw-Hill, New York, NY, USA,

[10]. D’Souza,.S.F,”Microbial biosensors,” Biosensors and Bioelectronics, 2001,16, 6, 337–353,

[11]. Caceres E, Garcia M L and Selgas M D, Meat Sci., 2006, 73, 368-377.

[12]. Ganjali M R, Norouzi P, Faridbod F, Rezapour M and Pourjavid M R, J Iran Chem Soc., 2007, 4(1), 1–29.

[13]. Rzewuska A, Wojciechowski M, Bulska E, Hall E A H, Maksymiuk K and Michalska A, Anal Chem., 2008, 80(1), 321–327.

[14]. Cha G S, Liu D, Meyerhoff M E, Cantor H C, Midgley A R, Goldberg H D and Brown R B, Anal Chem., 1991, 63,1666–1672.

[15]. Ammann D, Morf W E, Anker P, Pretsch E, Meier P and Simon W, Ion-Selective Electrode Rev., 1983, 3, 3–92.

[16]. Morakot N, Ngeontae W, Aeungmaitrepirom W and Tuntulani T, Bull Korean Chem., Soc., 2008, 29(1), 221–224.

[17]. Faridbod F, Ganjali M R, Dinarvand R and Norouzi P, Combinatorial Chemistry & High Throughput Screening, 2007, 10, 527-546.

[18]. Faridbod F, Ganjali M R and Norouzi P, Sensors, 2008, 8, 1645-1703.

[19]. Harris D C, “Quantitative Chemical Analysis Edition, Newyork, 1998, 375.

[20]. Faridbod F, Ganjali M R, Dinarvand R and Norouzi P, African J Biotechnol., 2007, 6(25), 2960-2987.

[21]. Javanbakht M, Ganjali M R, Norouzi P, Abdouss M and Riahi S, Anal Lett., 2008, 41, 619.

[22]. Mentus S, Elektrohemija (Electrochemistry), Fakultet za Fizicku Hemiju, Beograd, 1999.

[23]. El-Ragheh N A, Kosasy A M, Abbas S S and El-Khateeb S Z, Anal Cham Acta, 2000, 418, 93.

[24]. Shamsipur M, Yousefi M and Ganjali M R, Anal Chem., 2000, 72(11), 2391-2394.

[25]. Sheen S R and Shih J S, Analyst, 1992, 117, 1691-1695.

[26]. Ashok Kumar and Mittal S K, Sensors Actuators B: Chem., 2004, 99, 340–343.