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Potentiometric Determination of Potassium Using an Indigenously Fabricated Coated Wire Ion Selective Electrode

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Abstract

A potentiometric sensor system based on coated wire has been developed indigenously for selectivity towards potassium ion. The electrode has been prepared by coating a silver wire conductor with PVC based film. The preferred system with an antibiotic ***Valinomycin*** in membrane shows a linear response towards potassium ions over a concentration range of 1x 10^{-1} M to 1x 10^{-5}M of KCl solution. A saturated calomel electrode was used as a reference electrode with LiCl$_3$Ac as an internal filling solution. To avoid interferences, KCl was not used. The electrode was also tried for the determination of potassium ion in KCl tablets NEO-K, supplied by ***Zaffa,*** Pvt. Ltd. Pakistan. Reported value of potassium in tablets was 260mg/tablet and result found with coated wire electrode was 265 mg / tablet.

Key words: *Ion selective electrode, potassium, valinomycin.*

Introduction

Since the construction of the first coated wire ion selective electrode by Catrall *et al*.[1-2], numerous electrodes based on similar construction principle have been reported [3-14]. Various types of ion selective electrodes developed because of their applications in clinical and industrial measurements. Coated wire electrodes are studied more than other forms of ion selective electrodes and can be constructed with small tip [15]. They are prepared by incorporation of a slightly soluble salt in a polymeric matrix and by coating the wire support with a mixture containing the active substance, a softener and polyvinylchloride (PVC). The electrode can be thought of as an electrode of second kind in which the precipitate has been replaced with a polymeric coating. Essentially the electrode responds to whatever chemical species can penetrate into the coating.

Srivastava and coworkers [16] have developed a coated wire electrode based on Ag – Cyclam complex that is highly selective for Ag^+ ion. Coated wire ISE based on magnesium ion [17] and a precipitate based ISE for manganese ion have also been reported [18].

In 1974 Cattrall and coworkers have made a coated platinum wire version of the valinomycin based potassium selective electrode. Here we are reporting an indigenous fabrication of a coated wire electrode based on valinomycin, using silver wire and it is low cost and highly selective for potassium ions.

Experimental

Chemicals

All the chemicals (*viz*. isopropanol, HCl, KCl, dibutyl phthalate) were of analytical grade and used as such. Polyvinyl alcohol (GH-23), high molecular weight polyvinyl chloride and Valinomycin (antibiotic) were purchased from Fluka. Cyclohexanone was used after redistillation.

All solutions were prepared in doubly distilled deionized water.

Construction of Coated Wire Electrode for K^+ ion.

A silver wire of 18 standard wire gauge (SWG) and about 4-5cm in length was cleaned with isopropanol to remove any organic residue. Then it was washed with deionized water and anodized for one minute at 0.8 mA current in 0.1M HCl. Two stock solutions were prepared in following way:

(i) Stock solution of polyvinyl alcohol (PVA) in aqueous (0.005M) KCl was prepared by adding 0.01864g of KCl and 5g of PVA (GH-23) in a 50ml volumetric flask and made up to the mark with deionized water.
(ii) Stock solution of polyvinyl chloride (PVC) containing dibulyl phthalate (DBP) and Valinomycin in redistilled cyclohexanone was prepared by adding them in following ratio:

0.06g of PVC + 0.14g DBP + 0.001g valinomycin in 1ml of cyclohexanone.

Onto the base silver - silver chloride reference element, a reference medium membrane of PVA [Stock Solution (i)] was dip cast.

Afterward the electrode was immediately dipped in stock solution (ii) to form the first layer of an outer membrane. After ½ hour interval, five more coats of the outer membrane formulation [stock solution (ii)] were dip cost.

The electrode was then allowed to dry in air for 24 hours and then used as potassium ion selective electrode.

Apparatus and emf measurements

A Digital pH meter Model 2002 made by ***Good*** company, Taiwan, readable to ±0.1 mV with a saturated calomel electrode as a reference electrode was used for an electrode potential measurement. To avoid interference, lithium trichloro acetate ($LiCl_3Ac$) was used as an internal filling solution of reference electrode instead of KCl. The potassium ISE was used as an indicator electrode. All measurements were carried out at 25°C.

Calibration of Electrode

The electrode was calibrated using different concentrations of KCl ranging from $1x10^{-1}$M to $1x10^{-5}$M. The electrode response is linear with coefficient of determination 0.99. Calibration curve is given in Fig. 1.

Determination of Potassium from Potassium Chloride Tablets

Eight commercially available potassium chloride tablets (commercial name: NEO-K (*ZAFA)* Pakistan) were ground to a fine powder. A quantity equivalent to one tablet (260mg) was weighed, dissolved in water, transferred to a 100 ml volumetric flask and diluted to the mark with water. Again the dilution was made with water. Then the determination of potassium concentration was made in triplicate using coated wire ion selective electrode as indicating electrode and calomel as reference electrode. Amount of potassium in tablet was calculated using calibration curve. Table 1 shows the results.

Results and Discussion

As valinomycin is highly selective for potassium ion therefore the coated wire electrode can safely be used for the analysis of potassium in various matrices. A general method for making coated wire electrodes is given by Cattrall and Freiser [1] for making “dip” type electrodes. The “dip” procedure applies specifically to the wires; however, it can readily be adapted to other configurations, such as plates and discs. The aim is to obtain good adhesion to the metal surface and to obtain a film devoid of holes [15].

Fig. 1 shows that the indigenously fabricated potassium wire electrode gives good linear response to the range of $1x10^{-1}$M to $1x10^{-5}$M potassium chloride solution. It was successfully applied for the determination of potassium in KCl tablets (commercial name: NEO-K (*ZAFA,* Pakistan) Reported value for potassium was 260 mg / tablet. Result obtained with coated wire electrode was 265 mg / tablet (Table1).

Table 1. Result of Tablet

Tablet	Reported Amount	Amount Found
Neo – K (Zaffa, Pakistan)	260 mg	265 mg

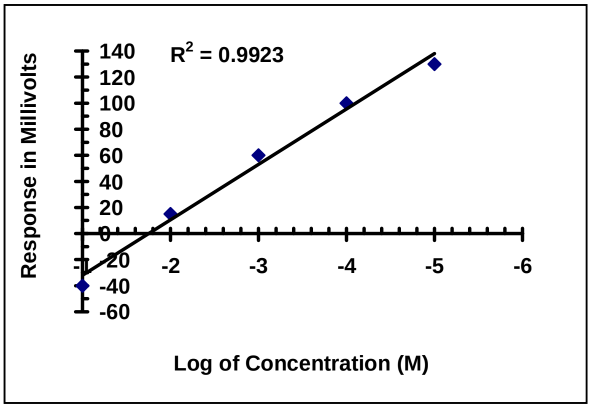

Figure 1. Calibration Curve of potassium coated wire electrode

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