

Use of Polyvinyl Chloride Membrane Contain Organic and Inorganic Anions

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ABSTRACT-

In the environment, the presence of anions can also lead to ecological disasters. It was well known that high concentrations of pollutant anions, like phosphate and nitrate, at the surface waters lead to eutrophication. The reprocessing of nuclear fuel generates long lived radioelement's such as iodide, pertechnetate or selenate which can be discharged into the seas and oceans. Perchlorate is widely used in pyrotechnics and as oxidant in rocket engines, in electroplating, leather industry, aluminium refining rubber production. Its high solubility in water and in fat makes it able to accumulate in tissues. The competition between perchlorate and iodide can lead to growth disorders as a consequence of lower thyroid activity. [6]

The highly toxic chromate and dichromate salts widely used in industry can be released in soils and waters and induce health problems because of their mutagenicity and genotoxicity. It is known that long –term exposure on chromate dust or vapours increase the risk of lung cancer [7]. However, if the connection of chromium [VI] ions with other cancers is not proven, their ability to accumulate in living organisms must not be omitted. The increase of their concentration in the environment prompted the environment protection agency (EPA) to set at 0.01 ppm the admissible level of total chromium in drinking water.

Key Words: Environment, genotoxicity, electrochemical.

INTRODUCTION-

Anions have been much less studied than cations. What is so different in anions that make their coordination chemistry so difficult to study ?

First, anions have various geometries [8] in contrast to cations. The spherical geometry which is typical for a great number of inorganic cations, is characteristic only

of halides, while oxoanions have trigonal or tetrahedral geometries and other anions can adopt linear or octahedral shapes.

Anions are in general larger than metal cations [9-11]. The smallest halide (F) has a radius of 133pm, which is comparable to that of K⁺, One of the largest metal cations. The condensations of some anions, depending on the concentration [12]. The protonation of some anions changes their charge, size and other physical properties, A good example is provided by chromates [13], which exist under four different forms aqueous solution, depending on the acidity level and the concentration: the three forms CrO_4^{2-} , HCrO_4^- and $\text{Cr}_2\text{O}_7^{2-}$ and the neutral chromic acid H_2CrO_4 .

Anions can be sorted out according to their decreasing lipophilicity on the basis of the hydration Gibbs free energies or the molar Gibbs free energy of transfer from H_2O to CH_2Cl_2



An experimental attempt to classify anions according to their lipophilicity was made by Hofmeister in 1888 on the basis of the ability of anions to salt out egg white protein from water [14, 15]. It resulted the following order, called the Hofmeister series,



Which shows a good correlation with the first one.

The important role of anions in process involved in living organisms and in ecosystems as well as in industrial technologies creates the need of fast and selective anion detection methods allowing real-time monitoring of anion concentration changes. Design of anion receptors for such applications is a great challenge for chemists, considering anion properties such as various geometries, small electric charges vs. anion sizes, pH dependence, multiple oxidation states of the central atom in ox anions and high solvation. The May be the reason why anion coordination chemistry has emerged only recently as compared to that of cations which is well- developed.

In many anion receptors, which have been synthesized, non- covalent interactions are responsible for host- guest recognition. They include electrostatic interactions, hydrogen bonding, and hydrophobicity, coordination to a metal ion or combination of these interactions.

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OBJECTIVES OF THE STUDY

1. To Study the structure of Anions.
2. To Study the toxic nature of chromate and dichromate ion.
3. Role of Perchlorate and other Anions in electro plating and Rubber Industry.
4. Assessment of silica gel in various anionic species.
5. Implementation of electrochemical sensors in an organization.

RESEARCH METHODOLOGY

1. Ion selective electrodes, calomel electrode gas electrode etc.
2. Various Anionic species such as fluoride ion and perchlorate ion ClO_4 etc.
3. Journals.

The electrochemical sensors that provide the supporting infrastructure to enable the direct processes to operate under the required controls and continually improve.

This application usually requires the immobilization of receptors on a polymeric matrix or silica gel.

Here three methods are involved

1. Nernst equation method
2. Calomel electrode method
3. Ion selective electrodes method

RESULTS & FINDINGS-

During the last ten years a lot of research has examined use of expanded porphyrins, their metal complexes, phthalocyanines and other related compounds in chemical sensors. Sensors with various actions have been elaborated. It is well known that various nitrogen containing macrocyclic compounds can be successfully applied as membrane active components of ion selective electrodes (a new class of ionophores), chemically sensitive layers of piezoresonators, opticochemical sensors and others. The application of expanded porphyrins as electroactive components of the membranes of ion selective electrodes is very promising. The porphyrin ring system is very stable and exhibits an aromatic character. Almost all metals form stable intramolecular complexes with porphyrins. Membranes doped with expanded porphyrins have shown a potentiometric response to anions different from classical Hofmeister selectivity series. Now electrode properties of a big number of expanded porphyrins have been extensively studied in order to understand the behaviour of electrodes based on expanded porphyrins. Many authors have reported the influence of the nature of the central metal atoms on selective properties of the expanded porphyrin membranes. Many researchers argue that it is possible to create electrodes selective to one kind of ions by using porphyrins with different metals in the center of their structure. Another way of varying the properties of expanded porphyrin membranes is by addition of different substituents.

The free base iron (III) derivative of 5, 10, 15, 20-tetraphenylporphyrin has been used as an ion-carrier in construction of ion-selective sensors for some common anions like nitrate, thiocyanate, iodide, salicylate, acetate, etc. The potential responses of these electrodes are shown in figure 1. As can be seen, the membrane sensor displays selectivity for CH_3COO^- ions over other anions as result of the selective interaction between the central metal ion and acetate ions. The preferential response towards CH_3COO^- is believed to be associated with the coordination of acetate with the central metal of the carrier resulting in an increase in size and axial coordination. It is well understood that the sensitivity and selectivity of the ion-selective electrode depend not only on the nature of the ion-carrier used, but also significantly on the membrane composition and the

properties of solvent mediators and additive used [7-12]. The potentiometric response curve of this acetate selective electrode exhibits stable potentiometric responses for acetate anions after conditioning for 2-3 days in 1.0×10^{-2} M NaCl solution. The effect of the membrane composition, nature of solvent mediator and additive on the response characteristics of the acetate sensor are given in table-1. Since the nature of the plasticizers influences the dielectric property of the membrane phase and mobility of the ionophores in the PVC matrix, its selection is one of the most important takes in designing a sensitive and selective anion selective electrode. The responses of the acetate sensor based on expanded porphyrin using three plasticizers having different polarities have different polarities have been investigate.

The plasticizers examined were DBP, DOS, BA and their nature significantly affected the sensor performance regarding slope, linear concentration range and detection limit (Figure-2). Among them DBP offered the best response to acetate anion with a slope of -55.0 mV/decade over a wide concentration range 2.5×10^{-5} to 1.0×10^{-1} M. the limit of detection was found to be 4.27×10^{-6} M. among the three different plasticizers used, the use of DBP (E1) resulted in the best response characteristics whereas the use of BA and DOS resulted in super-Nernstian slopes of the electrode response. Table 1 shows that the optimum amount of ionophore expanded porphyrin is 1.7%. It is well known that the cationic additives improve the EMF response of the anion-selective electrode [13]. The presence of HTAB in the membrane composition increases the sensor. The electrode E1 with an optimum ratio of HTAB/expanded porphyrin of about 0.35% revealed a Nernstian response to the concentration of acetate. By addition of more HTAB to the membrane composition, the selectivity of the electrode for the high lipophilic anions such as perchlorate and salicylate will increase by co-extraction of ion-pair formation between perchlorate or salicylate anions and hexacetyltrimethyl-ammonium cation. Table 1 shows that the PVC membrane electrode with PVC: DBP : expanded porphyrin: HTAB percent ratio of 31.4:66.3:1.7:0.6 results in the near-Nernstian behaviour of the membrane electrode over a very wide concentration range.

The influence of pH of the test solution (1.0×10^{-2} M of acetate anions) on the potentiometric response of the membrane electrode was examined in this case.

The dynamic response study carried out with electrode E1 of sodium acetate solutions from lower (1.0×10^{-5} M) to higher (1.0×10^{-5} M) concentration demonstrated that stable potentiometric signals were obtained in the short time period of 25 s. Lifetime studies were based on monitoring the changes in the slope of the electrode with time. After 9 months, slight decrease in slope (from -55.0 ± 2 to -52.2 ± 3) mV/decade) of the

sensor was observed. Since the response stability was confirmed as longer than 9 months in terms of electrode lifetime, the present type of acetate anion-selective electrode has excellent and steady response characteristics as required at a practical level.

In this system, the relative responses to the primary ion over other ions presents in the solution (known as potentiometric selectivity) were determined by the fixed potential method. The results of selectivity coefficient data with different compositions are given in Table 2. It is obvious that the selectivity coefficients are in the order of 10^{-4} for divalent anions and 10^{-3} for monovalent anions, which seems to indicate that these anions have negligible disturbance on the functioning.

REFERENCES-

1. P. Schulthess, D. Ammann, W. Simon, C. Caderas, R. Stepanek and B. Kraudler, *Helv. Chim. Acta*, 67 (1984) 1026.
2. E.D. Steinle, T. Bakker, U.E. Sprichiger and E. Pretsch, *Anal. Sci.*, 14 (1998) 9.
3. D. Gao, *J. Anal. Chem.*, 351 (1995) 484.
4. E.D. Steinle, U. Schaller and M.E. Meyerhoff, *Anal. Sci.*, 14 (1998) 79.
5. D. Gao, J. Gu, R. Q. Yu and G.D., *Analyst*, 120 (1995) 499.
6. I.H.A. Badr, M.E. Meyerhoff and S.S.M. Hassan, *Anal. Chim. Acta*, 321 (1996) 11.
7. T. Poursaberi, M. Hosseini, M. Taghizadeh, H. Pirelahi, M. Shamsipur and M.R. Ganjali, *Microchem. J.*, 72 (2002) 77.
8. M.R. Ganjali, T. Poursaberi, M. Hosseini, M. Salavati-Niasari, M. Yousefi and M. Shamsipur, *Anal. Sci.*, 18 (2002) 289.
9. T. Poursaberi, M. Salavati-Niasari, S. Khodabakhsh, L. Hajiagha-Babaei, M. Shamsipur, M. Yousefi, S. Rouhani and M.R. Ganjali, *Anal. Lett.*, 34 (2001) 2621.
10. M.R. Ganjali, T. Poursaberi, F. Basiripour, M. Salavati-Niasari, M. Yousefi and M. Shamsipur, *Fresenius J. Anal. Chem.*, 370 (2001) 1091.
11. M. Shamsipur, M. Yousefi, M. Hosseini, M.R. Ganjali, H. Sharghi and H. Naemi, *Anal. Chem.*, 73 (2001) 2869.
12. M. Shamsipur, M. Yousefi, M.R. Ganjali, T. Poursaberi and M. Faal Rastgar, *Sens. Actuators B*, 82 (2002) 105.
13. M.K. Amini, S. Shahrokhian and S. Tangestanimaj, *Anal. Chem.*, 71 (1999) 2502.
14. U. Schaller, E. Bakker, U.E. Sprichiger and Pretsch, *Anal. Chem.*, 66, (1994) 391.
15. Y. Umezawa, K. Umezawa, and H. Sato, *Pure. Appl. Chem.*, 67 (1995) 507.

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