CHAPTER-1

INTRODUCTION

1.1 General

Analytical chemistry plays a significant and increasing role in almost all aspects of our 'material' life. It has developed from classical, largely chemically oriented disciplines to physico-chemical and instrumental problem-oriented methodologies. Owing to the wide variety of analytical methods sofar available, it is now possible to deal with smaller concentration ranges and to analyze thoroughly more complex material mixtures using high-power separation methods. Trace analysis seems essential for a number of political, legal and medical decisions, which are mostly related to the maintenance of the quality of air, water resources and different types of food materials. In this regard, analysis as applied to environmental protection can be mentioned for air pollution control and water analysis.

According to the previous sequence, the proposed program for the present thesis is to focus on the use and wide application of ion-chromatography and nuclear measurements in a number of analytical investigations dealing with trace elemental determinations of some heavy metals and naturally occurring radionuclides that have different environmental impacts. The present investigations aim to enhance the separation power and to improve resolution efficiency of the studied elements. The results are further used in the determination of essential elements in drinking water that play important role in the level of naturally occurring radionuclides in water samples from different resources. In this work, we are mostly concerned with both radium-226 and radium-228 radionuclides, which are among the most hazardous radionuclides released to the environment. Radium-226 is considered in particular as it is among the most toxic long-lived alpha emitters present in environmental resources.

1.2 Ion chromatography

1.2.1 Historical aspects

"Chromatography" is the general term for several physico-chemical separation techniques, all of which have in common the distribution of a component between a mobile phase and a stationary phase. "Chromatography" was first tried by Tswett [1], who in 1903 used a column of precipitated calcium carbonate to separate the pigments of green leaves. He extracted the dried leaves with petroleum ether and poured the extract onto the top of used column. The pigments were gradually washed down the column, and separated into different coloured zones. Since then, the name "chromatography" has been extended to the separation of several dissolved constituents whether coloured or not, by partition between an absorbent and a flowing solvent, followed by suitable detection and identification of dissolved substances as they emerge from the used column.

In 1935, Adams and Holmes [2], at the National Chemical Laboratories, England, made the first organic ion-exchange resin as condensation products of formaldehyde with phenol or with phenolsulfonic acid giving stable products in aqueous solutions. Other ion exchangers were also made by treating bituminous coal with fuming sulfuric acid, that were used for partial separation of yttrium, lanthanum and neodymium by Russell and Pearce [3], and of copper, cadmium, and nickel by Kozak and Walton [4].

In 1939, Samuelson [5], first investigated systematically the use of ion exchange phenomena in chemical analysis. He reported on the separation of interfering cations and anions, by absorbing iron cations on a resinous cation exchanger and replacing it in solution by hydrogen ions, which are not interfering in subsequent analysis. He also showed that one could measure the total electrolyte concentration of a solution by passing it through a cation exchange resin in its hydrogen form, thus converting dissolved salts to their corresponding acids, and then titrating these acids.

In 1941, Martin and Synge [6], proposed the concept of theoretical plates, which was adopted from the assumption that the chromatographic columns are similar in operation to distillation and extraction fractionating columns. They considered the column as consisting of a number of theoretical plates, within each of which equilibrium between two phases generally occurs. This theory has been further expanded by Mayer and Tompkins in 1947, so as to render possible the prediction of the number of "theoretical plates" needed to obtain a required purity of separated products [7].

Ion chromatography (IC) was introduced in 1975 by Small, et al. [8], as a new analytical method. Within a short period of time, ion chromatography developed from a new detection scheme for a few selected inorganic anions and cations to a versatile analytical technique for different ionic species. For sensitive detection of ions via their electrical conductance, the effluent from the separating column is passed through a " suppressor " column to reduce the background conductance of the eluent used, while at the same time to increase the electrical conductance of the analyte ions. In 1979, Fritze et al. [9], described an alternative separation and detection scheme for inorganic anions, in which ion-exchange resins with low capacities are used and directly coupled to a conductivity cell to deal with eluents with low ionic strengths. In addition, the eluent ions should exhibit low equivalent conductances, thus enabling sensitive detection of different sample components.