CHAPTER 7

SUMMARY

Ion-exchange resins of the conventional type are insoluble, infusible, cross-linked polymers containing a high concentration of acidic or basic groups. The conventional ion-exchange materials have been exhaustively studied and their applications well understood. Unfortunately these well known conventional ion-exchange resins are not very effective in removing a specific ion in the presence of a high concentration of a host of other ions. In recent years syntheses and studies of resins for this specific purpose have drawn much attention and have been undertaken by number of research workers. The importance of such specific resins cannot be overlooked when the problems of recovery of valuable metal traces from industrial wastes and from mineral ores, the removal of metal traces from chemicals to be useful as analytical grade reagents and the isolation of radioactive traces to prevent pollution of water are confronting the research workers all over the world.

During the course of the investigation reported here, a series of such resins have been synthesised from indigenously available raw materials, viz. commercial cashew nutshell liquid and the cold extracted commercial cashew nut shell liquid and characterised. Commercial CNSL contains 90% a monohydroxy phenol, called cardanol and the
cold extracted commercial CNSL contains about 70% of a hydroxy carboxylic acid, called anacardic acid. In brief, the commercial CNSL is reacted with tetraethylenepentamine and the cold extracted CNSL is reacted with gallic acid, or anthranilic acid or 2-methylcaptobenzothiazole, in the presence of a suitable catalyst using formaldehyde as a cross-linking agent. Another monomer utilized is melamine and its production in the country is envisaged shortly. The polymers thus obtained are cured under suitable conditions and the cured products are crushed to proper mesh size and stored for further experimental work.

The preliminary characteristics of the resins, such as capacity, wet absolute density and the pH-titration curves are studied by the conventional methods as adopted for ion-exchange resins. An attempt is made to throw some light on the structure of the resins synthesised by their infrared and nuclear magnetic resonance spectra. These preliminary characteristics show that the anion exchangers prepared are weakly basic and the cation exchangers are weakly acidic. In general, the structures of the resins are complex heterogeneous ones, invariably exhibiting multifunctionality.

In order to study the pH-dependence of the distribution of metallic cations, all the resins are subjected to an exhaustive batch absorption study with solutions of Cu++, Ni++, Co++, Fe++, Ca++ and Mg++ at different pH values. Resins are buffered at the desired pH before absorption study and
the metal ion solutions are also buffered at the pH under investigation. This study of the pH-dependence of distribution of metallic cations gives a general idea about the absorption pattern of different metal ions studied on each of the resins prepared, under a particular set of experimental conditions. In the present investigations, the temperature of equilibration, the period of equilibration, volume of the equilibrating solution, the ionic strength of the equilibrating solution and the initial concentration of the metal cations are held constant throughout to permit the study of more resins and at wider range of pH values. For comparison, the conventional strongly acidic cation exchanger of sulfonic acid type viz. Amberlite IR-200 has also been simultaneously studied. The performance of the resins is compared with the literature values of (i) conventional weakly basic anion exchangers like Amberlite IR-45, Amberlite IR-40 and Dowex 3, (ii) conventional weakly acidic cation exchanger like Amberlite IRC-50, and (iii) o-aminophenol, m-phenylene diglycine and 8-quinolinol chelating resins.

The study of pH-dependence of distribution of metal ions thus carried out shows that the unbuffered MFH anion exchanger is specific for copper ions, the CNSL-TP anion-exchange resin is more selective for copper ions at pH 4 and 5, the C-CNSL cation exchanger is virtually specific for Fe$^{++}$ ions at pH 1 and the C-CNSL-GAL cation exchanger is more selective for Fe$^{++}$ at pH 2 to 4.
Based on this data, the quantitative isolation of copper ions from a mixture of copper, cobalt and nickel ions on unbuffered MFH anion-exchange resin bed is achieved. Similarly, a quantitative isolation of cobalt ions from a mixture of copper, cobalt and nickel ions on CNSL-TP anion-exchange resin bed is also achieved at pH 4. However, about 97% of nickel and 84% of copper from a mixture of copper, cobalt and nickel ions are isolated in one single operation on the same anion exchanger at pH 4.

Copper at a concentration level of 0.25416 ppm and nickel at 0.2347 ppm are isolated from a solution containing sodium ion concentration of about 12500 ppm. Copper traces are isolated on the unbuffered free-base forms of both CNSL-TP and MFH anion exchangers and nickel traces on unbuffered free base form of CNSL-TP anion-exchange resin.

These results point to the potential usefulness of these materials for the isolation, concentration and recovery of trace metals in industrial applications.