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Microscale Experiments on Ion Exchangers

Kazuko Ogino

College of Medical Sciences, Tohoku University,

Aoba-ku, Sendai 980-8575, JAPAN

Laboratory experiments on ion exchangers are not popular in Japanese high schools and colleges. It may be because the experiments are time consuming. As the importance of ion exchangers in modern technology is increasing, the experiments on ion exchangers are indispensable. We have developed various laboratory experiments using tiny columns of SP- and QAE-Sephadex which are cation and anion exchangers, respectively. The column size is only about 1 cm in diameter and 3 cm in height.

Characteristics of these exchanger columns are as follow:

1. As the exchangers are completely colorless, the colors of adsorbed ions can be observed clearly.
2. The handling of the columns is very easy. Either the control of flow rate or the care to avoid the inclusion of the air is not necessary: the surface of the exchanger bed will not become dry easily.
3. As the columns are short, experiments can be done in a short time.
4. The exchange bed volume varies considerably with the nature of eluents.
5. Though the Sephadex ion exchangers are rather expensive, the experiments do not cost much, as the amount needed is small and they can be used repeatedly.
6. It is easy to regenerate the exchangers. Even the tervalent cations adsorbed on the SP-Sephadex column can be replaced by sodium ions by eluting the column with 3 M NaCl solutions.

Experiments on various topics have been developed using the Sephadex columns. The levels of the experiments are from junior high school to college. Below are some examples of such topics:

1. Experiments on electrolytes and non-electrolytes: Through the observation of color changes of the exchanger beds and the qualitative analyses of eluted solutions, basic

concepts such as electrolytic dissociation of electrolyte can be dealt with. The principles involved in the ion exchange phenomenon can also be taught.

2. Evaluation of ionic charge of ions: The volume of the exchanger bed of an SP-Sephadex column is linearly dependent on the ionic charge of adsorbed cations (see Figure). The volume decreases with the increase of the charge. By the use of this relation, the charge of cations can be estimated.

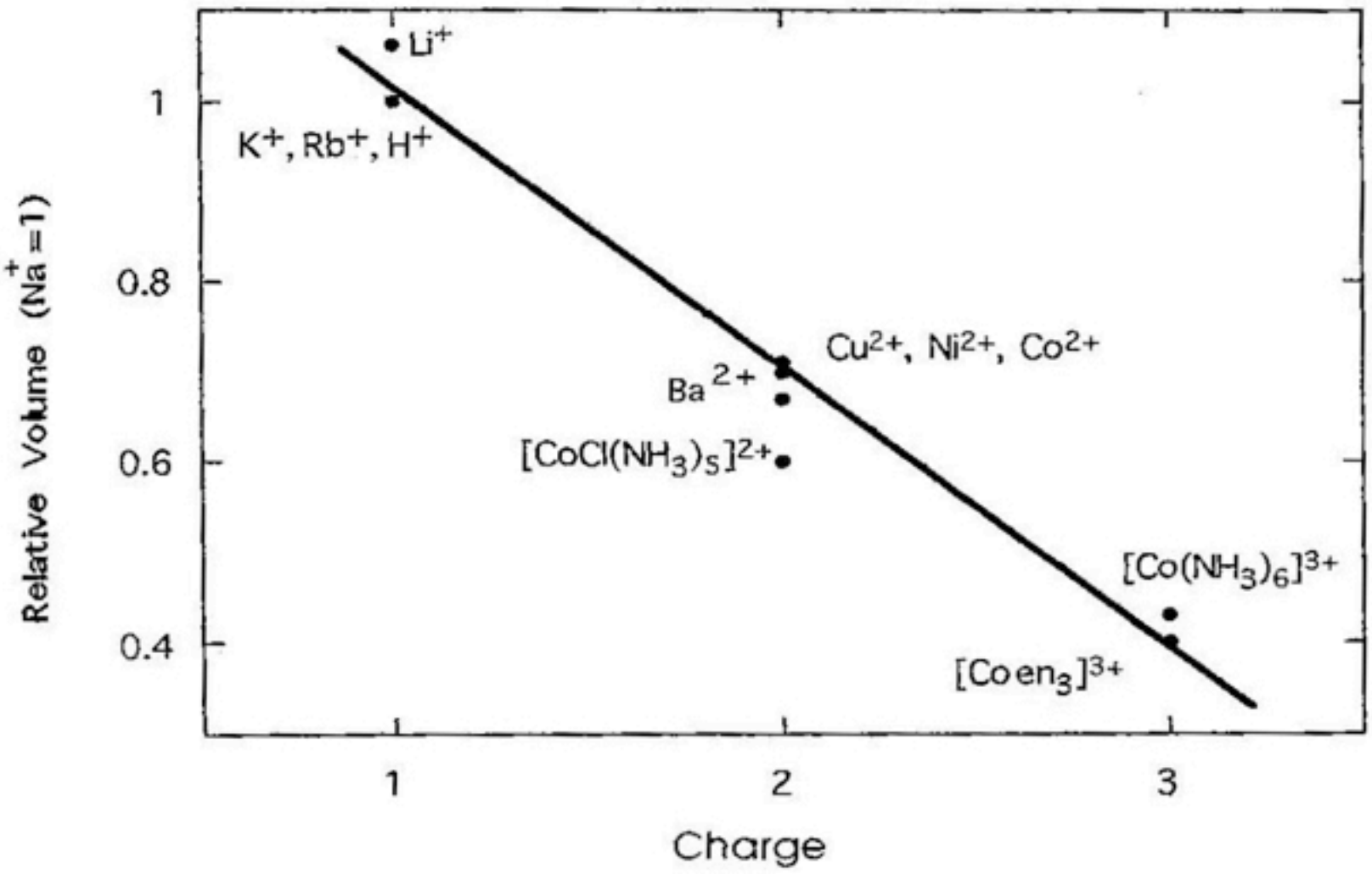

Figure Relation between the Volume of Exchanger Bed of SP-Sephadex Column and the Charge of Cations Adsorbed

3. Separation of ions: Mixture of several ions of various charges can be separated on the column. Complex ions of various charges and colors are covenient for this experiment, as the bands of each ions can be observed clearly.

4. Experiments on complex ions: The transition metal cations adsorbed on the column undergo complex formation when solution containing an appropriate ligand is passed through the column. The complex ions thus formed can be decomposed by the action of some reagents. Through these experiments, the behavior of complex ions can be visualized: The colors and charges of various transition metal complex ions are shown clearly, and lability, stability and redox properties of complexes can also be demonstrated.

These experiments have been successfully carried out in several high schools and in College of Medical Sciences. Tohoku University. It has been shown that these experiments have extra merit of diminishing the amount of reagents, wastes, and thus the cost.