

Modification of a Few Anion Exchangers to Electron Exchangers

H. K. ACHARYA, N. KRISHNASWAMY,* and B. D. DASARE, *Central Salt and Marine Chemicals Research Institute, Bhavnagar 364002, Gujarat, India*

Synopsis

Three anion exchangers, namely, MFH, PVC-TP, and De-Acidite FF-IP (a commercially available strong base anion exchanger) were converted into a copper complex, and the resulting complex was preferably reduced with an alkaline solution of sodium hydrosulfite and studied for the redox properties.

INTRODUCTION

The literature shows that anion-exchange resins¹⁻³ generally contain amino groups. These amino groups in the resin are capable of forming complexes with copper or silver salts which are poorly dissociated. The resulting complex is then preferably reduced with an alkaline solution of sodium hydrosulfite and yields metallic copper or silver, which is useful for the removal of oxygen dissolved in water.⁴ So far there are no reports concerning their redox properties, and therefore we chose to investigate these properties in MFH, PVC-TP, and De-Acidite FF-IP anion exchangers.

Experimental

Determination of Redox capacity

All three anion exchangers (two synthesized in the laboratory and one commercial) were converted into the OH form using 1.0*N* sodium hydroxide solution and washed free of alkali with distilled water.

Exactly 10 g of dry resin was converted into the copper complex using copper sulfate solution, and the resin was treated with alkaline sodium hydrosulfite solution to reduce the resin into metallic copper. Effluent and a blank sodium hydrosulfite solution were estimated for oxidation as per standard iodometric procedure.⁵ The redox capacity of the resin was calculated from the difference in burette readings.

Determination of Redox Potential

Exactly 1.0 g of dry resin was converted into the copper complex as described earlier. Then the resin was filtered and transferred to a beaker containing 100-ml 0.01% methylene blue solution (mediator). The complete apparatus for po-

* Present address: Research and Development Division, I.A.E.C., Baroda, Gujarat, India.

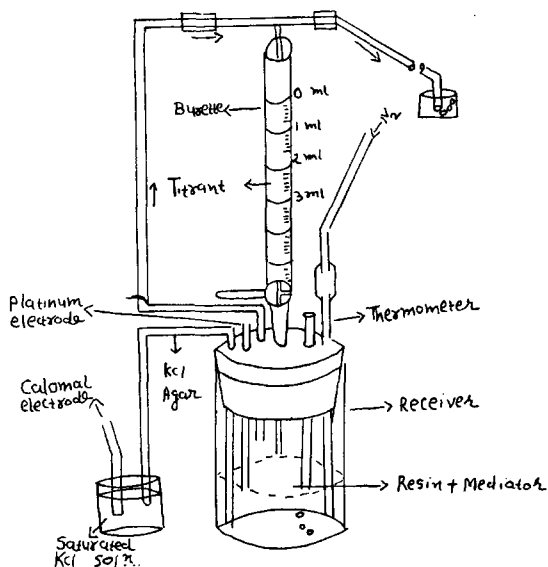


Fig. 1. Schematic of the apparatus for potentiometric titration of dissolved redox couples and electron exchangers.

tentiometric titrations of dissolved redox couples and electron exchanger was set up as shown in Fig. 1.

The potential difference between a platinum electrode and a calomel electrode was measured after each addition of the reducing agent (0.5 *N* sodium hydro-sulfite in 1.25*N* sodium hydroxide) from the burette to the receiver, and the change in potential during the redox reactions was a convenient indicator when the addition of titrant should be stopped.

Determination of Rate of Exchange

Approximately 7 to 8 g of the resin (in OH form) was converted into the copper complex by using 350–400 ml 1.0*M* copper sulfate solution. Then the resin was washed free of copper sulfate with distilled water, filtered, and dried.

Exactly 0.50 g of the dry resin was placed in a number of different 100.0-ml conical flasks. Then 10-ml 0.5*N* sodium hydrosulfite in 1.25*N* sodium hydroxide solution was added to each flask. After a predetermined interval, 5.0-ml aliquots of the sodium hydrosulfite were removed from each flask, diluted to 50.0 ml with distilled water, and exactly 10 ml of the diluted solution and a blank were titrated by adopting the standard iodometry procedure.⁵ The redox capacity of the resin was calculated at different intervals of time from the difference in burette readings.

RESULT AND DISCUSSION

Among the three redox resins studied, De-Acidite FF-IP resin showed the highest redox capacity due to the higher uptake of copper ion. MFH resin showed the highest redox volume capacity due to its poor swelling property, and PVC-TP resin showed the lowest redox volume capacity due to its higher swelling property

TABLE I
Effect of Copper Sulfate Concentration on the Dynamic Redox Capacities of MFH, PVC-TP, and De-Acidite FF-IP Resins^a

No.	CuSO ₄ Concentration (N)	Anion exchanger					
		MFH		PVC-TP		De-Acidite FF-IP	
		Dynamic Redox (meq/g)	Redox Capacity (meq/ml)	Dynamic Redox (meq/g)	Redox Capacity (meq/ml)	Dynamic Redox (meq/g)	Redox Capacity (meq/ml)
1	1.4 (saturated sol.)	0.88		1.30		1.90	
2	1.01	0.88		1.25		1.90	
3	0.74	0.92	0.46	1.25	0.22	1.85	0.44
4	0.49	0.92		1.30		1.93	
5	0.25	0.92		1.30		1.90	
6	0.10	0.88		1.30		1.85	
Average		0.90		1.28		1.89	

^a Resin quantity, 1 g; resin form, OH; copper sulfate solution passed through the resin bed, 50.50 meq.

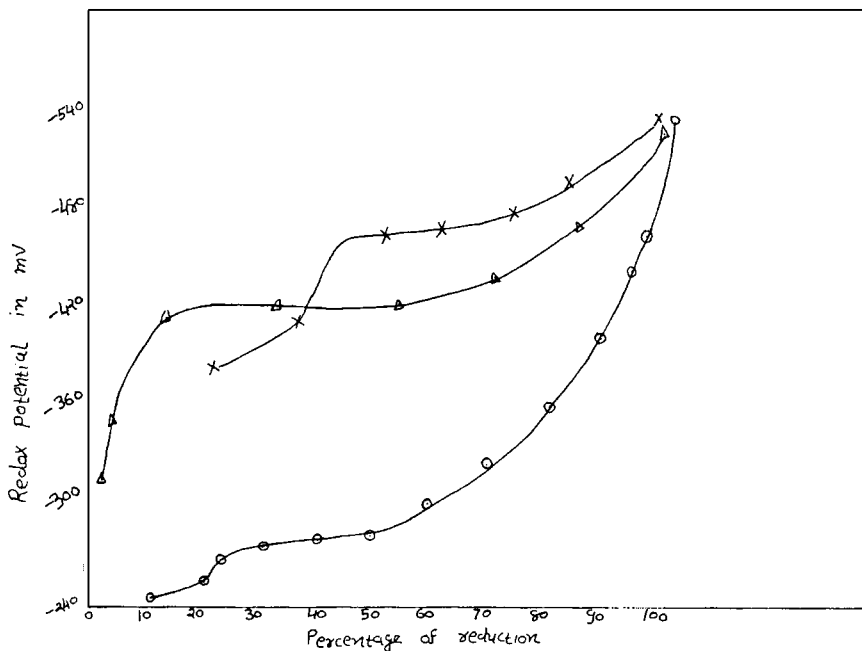


Fig. 2. Redox potential curves of PVC-TP (O), De-Acidite IP (Δ), and MFH (X) resins.

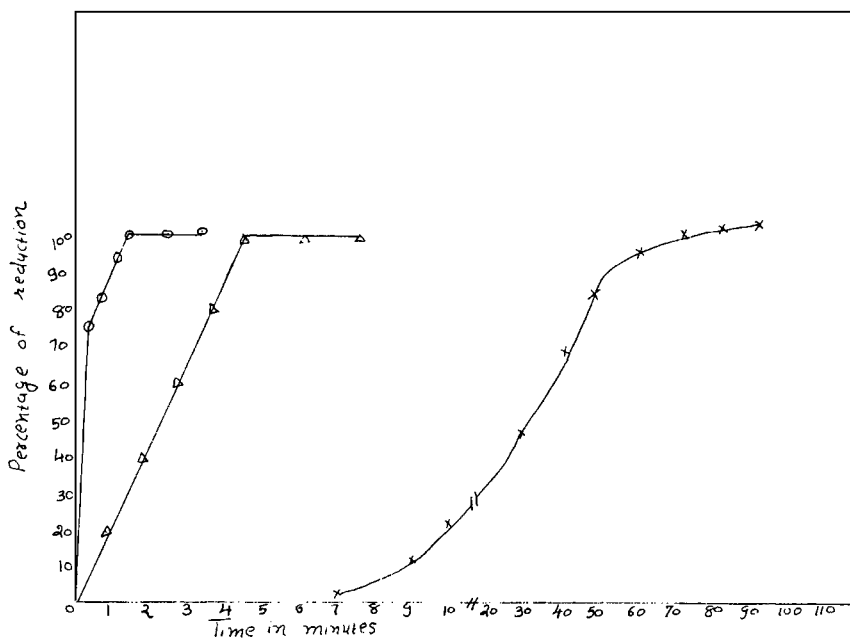


Fig. 3. Rate of exchange of PVC-TP (Δ), De-Acidite-IP (O), and MFH (X) resins.

(Table I). Figure 2 reveals that the MFH resin was the strongest oxidizing agent. The midpoint redox potential of MFH resin was -464 mV as compared to -410 mV of De-Acidite FF-IP and -291 mV of PVC-TP (Fig. 2).

Among the three redox resins studied, the rate of exchange was extremely fast with De-Acidite FF-IP and comparatively slow with MFH resin (Fig. 3) because the diffusion of the reducing agent in the matrix of MFH resin was so slow that during the first 7 min, there was no reduction at all (Fig. 3). Thus the possibility of using some of the available anion exchangers as redox exchangers is brought out.

References

1. N. Krishnaswamy and B. D. Dasare, *J. Sci. Ind. Res., Sec. D*, **21**, 438 (1962).
2. N. Krishnaswamy, K. P. Govindan, and B. D. Dasare, Indian Pat. No. 71.190 (1962); *Chem. Abstr.*, **58**, 4701f (1963).
3. B. D. Dasare, P. B. Trivedi, and N. Krishnaswamy, *Indian J. Tech.*, **8**, 21-22 (1970).
4. G. F. Mills and B. N. Dickinson, *Ind. Eng. Chem.*, **41**, 2842 (1949).
5. A. I. Vogel, *A Textbook of Quantitative Inorganic Analysis*, Longman, Green, London, 1964.

Received April 13, 1978