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NOTE

Application of Radioactive Tracers in Upgradation of Industrial Grade Ion Exchange Resin (Amberlite IRA-400)

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The exchange rates of ion exchange resin are determined by application of ^{131}I as a tracer isotope. The exchange study carried out in this investigation deals with understanding the effectiveness of ion exchange resin (in iodide form) Amberlite IRA-400 at different concentrations of potassium iodide solution (electrolyte) with temperature of solution varying from 27–48°C by keeping amount of ion exchange resin constant (1.0 g). The exchange study is also carried out by varying amount of ion exchange resins, for fixed temperature (27.0°C) and for fixed concentration of potassium iodide solution (0.005 M).

The knowledge of factors like temperature, concentration of electrolyte and amount of ion exchange resin which largely influence the rate of ion exchange is of great importance for the effective use of ion exchangers in various industrial processes. As regards utilisation of ion exchange resin for industrial purposes, the first worthwhile attempt was made by Gans[1] for softening of water and also for decolourising sugar solution. Reents[2] reported the use of ion exchange technique followed by decolourisation and vacuum evaporation for glycerine purification. Smith and Eisenmann[3] have employed ion exchange technique for removal of phosphate from secondary effluent. The present study may be helpful in understanding and upgradation of resins which are the integral part of many chemical industries.

Amberlite IRA-400 which is a strongly basic anion exchanger in iodide form was employed in the present investigation between radioactive iodide ions in solution and iodide ions on exchange resin. The typical ion exchange reaction can be represented by:

$$RI + I^{*-}(aq) \rightleftharpoons RI^{*} + I^{-}(aq)$$

where RI represents the exchangeable iodide ions on the resin and $I^{*}(aq)$ represents the radioactive ^{131}I ions in solution.

In the present investigation 0.0025 M potassium iodide solution is prepared and the solution is labelled by ^{131}I isotope solution. To this labelled solution of known initial activity 1.0 g of ion exchanger resins in iodide form are added, and

under continuous stirring of solution activity of 1.0 mL of solution is measured at an interval of 1.0 min.

From the decrease in activity of solution, amount of iodide ions exchanged (millimoles) and specific reaction rate (min^{-1}) are calculated.

Similar set of experiments are performed for different concentrations of potassium iodide solution for different temperatures and also by varying the amount of ion exchange resins.

During the kinetic study of ion exchange reaction, it is observed that with rise in temperatures from 27.0–48.0°C, the specific reaction rate increases from 0.126–0.177 min^{-1} when both concentration of potassium iodide solution and amount of ion exchange resin are kept constant (Table-1). Also for fixed concentration of potassium iodide solution and for fixed temperature, specific reaction rate is 0.121 min^{-1} for 1.0 g of ion exchange resin which increases to 0.368 min^{-1} for 5.0 g of ion exchange resin (Table-3). With increase in concentration of potassium iodide solution the amount of iodide ion exchanged in millimoles increases (Table-3) but the increase in amount of iodide ions exchanged is more pronounced with increase in amount of ion exchange resin (Table-3). However, it is interesting to note that this increase takes place at constant temperature of 27.0°C.

TABLE-1
EFFECT OF TEMPERATURE ON REACTION RATES OF ION EXCHANGE REACTION

Concentration of labelled iodide ion solution = 0.100 M
Amount of ion exchange resin = 1.0 g

Temperature (°C)	27.0	32.0	38.0	43.0	48.0
Reaction rates (min^{-1})	0.126	0.147	0.156	0.165	0.177

TABLE-2
EFFECT OF CONCENTRATION OF LABELLED IODIDE ION SOLUTION ON AMOUNT OF IODIDE ION EXCHANGED

Amount of exchange resin = 1.0 g, Temp. = 27.0°C
Volume of labelled iodide ion solution= 200 cm^3

Concentration of labeled iodide ion solution (M)	Initial amount of iodide ions in 200 cm^3 of solution (millimoles)	Amount of iodide ion exchanged (millimoles)
0.005	1.00	0.680
0.020	4.00	1.650
0.100	20.00	5.537

TABLE-3
EFFECT OF AMOUNT OF ION EXCHANGE RESIN ON AMOUNT OF IODIDE ION EXCHANGED

Concentration of labeled iodide ion solution = 0.005 M, Temp. = 27°C
Amount of iodide ions in 200 cm^3 of solution = 1.0 millimoles

Amount of ion exchange resin (g)	Specific reaction rates (min^{-1})	Amount of iodide ion exchanged (millimoles)
1.0	0.121	0.680
3.0	0.230	0.838
5.0	0.368	0.931

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