DESALTING OF SEA WATER FOR EMERGENCY PURPOSES

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Silver salts of synthetic cation exchange resins have been prepared and evaluated for their possible use in desalting sea water for emergency purpbses. Details of a composition based on sulphonated polystyrene cation exchanger are given.

The importance of the problem of desalting sea water from the point of view of Defence need not be emphasised. A stranded soldier in sea, either due to ship wreck or plane crash, for example, has to carry in his emergency kit sufficient quantity of drinking water or desalting material which will help him to obtain drinking water from sea water[1,2]. Canned water or desalting chemicals are usually provided in emergency kits. However, in view of the low storage life of canned water and the weight and volume occupied by it in the kit, the provision of desalting chemical is usually preferred. A number of such desalting materials, based on ion-exchange properties of silver barium zeolite, have been developed [3,4] but as these are not available in India, it was considered worthwhile to develop suitable composition from materials indigenously available in the country.

EXPERIMENTAL PROCEDURE

Materials employed—Carbion, a sulphonated coal developed by the Fuel Research Institute, Dhanbad, Wasoresin, a synthetic cation exchanger based on cashew nut shell liquid resin marketed by Tulsi Industries, Poona, a swellable form of polystyrene resin and a sulphonated styrene divinyl benzene copolymer (wet and dry beads), both developed by National Chemical Laboratory, Poona, were employed in this study.

Preparation of desalting chemical—Silver salts of the five cation exchangers were prepared by treating known amounts of them with varying concentrations of silver nitrate solution (10 ml per gm. of resin) for different periods. The resins were washed and dried at room temperature ($35°\pm2°C$). The exchange capacities of the five cation exchangers as well as their silver salts were determined by the standard method[5]. Synthetic sea water[6] was used in determining exchange capacities.

A quantity of silver salt of sulphonated polystyrene (in dry bead form) sufficient to remove chloride from 475 ml of sea water[6] was taken and mixed with sufficient quantity of barium hydroxide to remove sulphates and a small quantity of activated charcoal. This composition was tested to the American specification for desalting kit[7] using a filter bag similar to that specified, but having, in addition, filter paper No. 42 on both sides and a cotton pad in between so as to completely avoid contamination of filtered water by precipitated silver chloride.

For the purpose of comparison, three different imported desalting kits based on silver barium zeolite were also examined.

Coliform and lactic group of bacteria as obtained from sewage and sour curd respectively were purposely introduced into the sea water and the desalting composition tested to evaluate the performance against contaminated sea water.

TABLE 1

EXCHANGE CAPACITY OF RESINS AND THEIR SILVER SALTS

(Each gm of resin treated with 10 ml of Silver Nitrate Solution)

Resin	Capacity of air dried form (meq/gm)	Capacity of silver salts, air dried (meq/gm)				
		Concentration of silver nitrate solution				
		0·1	0·2	0·5	1·0	2·0
Carbion	1·8	1·0	1·0	1·1	1·2	1·2
Wasoresin	2·0	1·3	1·4	1·6	1·9	1·9
Swellable form	3·6	2·1	2·2	2·6	3·0	3·0
Sulphonated polystyrene (wet)	4·8	2·0	2·1	2·4	2·5	2·5
Sulphonated polystyrene (dry)	4·2	2·3	2·5	2·7	3·0	3·0

RESULTS AND DISCUSSION

The exchange capacities of the various resins examined are presented in Table I along with the exchange capacities of silver salts obtained by treating the resins with various concentrations of silver nitrate solution. The data pertains to resins treated with ten ml. of silver nitrate solution (of varying N) for every gram of air-dried resin and kept in contact for a period of not less than 24 hours. It is seen from Table 1 that silver salts of the swellable resins and sulphonated polystyrene have the maximum capacity of 3 milli equivalent per gram. The capacities of these two resins are comparable with those of imported resins.

The silver salt of swellable resin on treatment with sea water for a period of 30 min. to 1 hr. yields a precipitate which is not completely removed even on passing through filter paper No. 42. Also the amount of water taken up in swelling and the volume occupied by the swollen material are large in comparison with those of other resins. In view of these draw-backs, silver salt of sulphonated polystyrene was considered most suitable. Detailed studies, therefore, were carried out with this resin. The final composition of the mixture for treating 475 ml. of sea water consisted of 84·6 gm. of silver salt of sulphonated polystyrene (moisture content, 4·5%), 3·9 gm of barium hydroxide (recrystallised) and 1·5 gm. of activated charcoal. The volume occupied by the mixture is 78 c.c. Efforts to compress this mixture in the form of tablets after incorporating adhesives, diluents, etc.[8] did not prove successful.

The performance characteristics of the composition, as compared to three different imported materials of U.K., U.S.A., and Japanese origin, is shown in Tables 2 and (3).

TABLE 2

TREATMENT OF SEA WATER WITH DESALTING CHEMICALS

Material	Qty. of chemical per packet (gm)	Qty. of sea water treated (ml)	Period of treatment (min)	Qty. of desalted water (ml)
Polystyrene based chemical	90·0	475	30	375
Imported silver barium zeolite :				
(*i*) U. K.	74·7	350	45	310
(*ii*) U.S.A.	70·7	450	45	415
(*iii*) Japan	74·0	450	45	420

TABLE 3

ANALYSIS OF DESALTED WATER

Details	Water using based polystyrene chemical	Water using imported chemicals			Maximum limit (based on Amer. Specn.[7])
		(*i*) U.K.	(*ii*) U. S.A.	(*iii*) Japan	
Physical appearance	Colourless	Colourless	Colourless	Colourless	..
Odour	Nil	Nil	Nil	Nil	..
Taste	Palatable	Palatable	Saltish	Saltish	..
pH	10·4	9·3	9·6	8·4	11·0
Total dissolved solids (ppm)	1,002	2,886	5,168	12,784	...
Cl^- (ppm)	256	219	2,446	5,112	1,950
SO_4^{--}	95	1,484	630	1,915	1,296
Alkalinity (ppm)					
(*i*) HCO_3^-	87	200	72	173	427 (Calculated as HCO_3^-)
(*ii*) OH^- CO_3^{--}	214	18	71	nil	
Ca^{++} (ppm)	nil	nil	10	51	124 (Calculated as Ca++)
Mg^{++} (ppm)	16	62	46	813	
Ba^{++} (0ppm)	nil	nil	nil	nil	nil
Ag^+ (ppm)	Practically absent	Practically absent	Practically absent	Practically absent	0·5
Na^+ (ppm)	400	950	1,850	2,900	1,904 (Calculated as Na+)
K^+ (ppm)	4	3	1	4	
Microbiological test	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Shall be free from pathogenic and coliform bacteria

It is of interest to note that the mixture developed by this laboratory compares favourably with imported materials. The quantity of desalted water obtained in the present kit is equivalent to that of U.K. kit, but slightly less than that obtained from the other two. However, the quality of desalted water is better in all respects.

Synthetic sea water[6,7] and two batches of sea water obtained from Bombay harbour, were free from coliform and other pathogenic organisms. In order to verify the usefulness of the chemical when such organisms are present, two batches of sea water were purposely contaminated with lactic and coliform types of bacteria. Contaminated waters which had developed bad odours, when treated with the polystyrene composition gave clear water free from the microorganisms and odour.

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