THE EFFECT OF OSMOTIC DEHYDRATION ON REVERSE OSMOSIS MEMBRANE PERFORMANCE

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ABSTRACT

Skin type (asymmetric) reverse osmosis membranes undergo an irreversible osmotic dehydration upon coming into contact(skin - side) with salt solutions.The extent of consequent changes (in appearance;decrease in:linear dimension,water flux and salt rejection)are dependent on the salt concentration.These observations are correlated with the expected morphological changes taking place during dehydration (drying).It is thus speculated that such phenomena may inadvertently happen during the start-up phase of new RO units treating high salinity waters.To avert such event it is recommended the start up phase to be programmed in such a way that feed concentration is gradually elevated to its ultimate level.

INTRODUCTION

Asymmetric reverse osmosis membranes possess a delicate skin which can be easily affected by various environmental and operational factors.It is common practice by the manufacturers to preserve (after quality control tests) and ship their membrane modules with a dilute aqueous solution of bactericides.When installed and ready for operation,it is necessary at the start,to flush the membrane modules with the saline feed water before any pressure is applied.A puzzling phenomenon occasionally noticed by many practioners is that some new RO units exhibit deteriorated behavior (lower salt rejection and lower water flux) right from the start.The causes of these undesired effects seem to have escaped attention of investigators.

It is the purpose of this brief report to show some experimental clues to one of the possible causes of such observations. It is our belief that it is probable that, during the start-up phase,membrane undergoes an inadvertent osmotic dehydration accompanied by irreversible changes in its skin properties.

EXPERIMENTAL

To test the above hypothesis,experiments were designed to observe the effects of osmotic dehydration on membrane properties.Membrane discs (7.5 cm diam.)cut out from the same sheet were exposed (from their skin side) to varied concentrations of salt solutions (NaCl and KCl) A recirculating RO system with three cells was used to evaluate the properties of the unexposed and exposed membranes under identical conditions (@1.5×10^{7} pa against $5gL^{-1}$ NaCl).

RESULTS

Upon exposure,membrane's appearance and dimensions quickly change.Concomitant with these changes their RO properties alter as well.In general,changes in appearance resemble those seen during early stages of air drying of membranes.Exposures from back side of the membrane (even against saturated salt solutions) showed no changes of the kind seen for the skin side exposure.Results on changes involved in membrane dimension,water flux and salt rejection as a function of salt concentration are depicted Figs(1)-(3).It is seen that they all follow essentially the same general pattern.

DISCUSSION

Needless to say,osmotic dehydration can occur and has detrimental influence on membrane properties.Departure of water molecules from the intermolecular spaces within the polymeric matrix of membrane is inevitably accompanied by the loss of volume on the one hand and formation of extensive interchain bonds (i.e.tighter domains) on the other.Obviously such morphological changes lead to lowering of water flux.Formation of these tight domains out of an originally uniform skin layer is expected to be concomitant with appearance of defective and less selective skin (i.e.lower salt rejection).

CONCLUSIONS

Inadvertent osmotic dehydration of the skin layer which can occur during an improper start-up of new RO installations is deleterious to their membrane performance and may thus explain the early deteriorations noticed under some circumstances.It is therefore,recommended that in the case of high salinity feed waters the start-up phase should be programmed in such a way that feed concentration is gradually elevated to its ultimate level

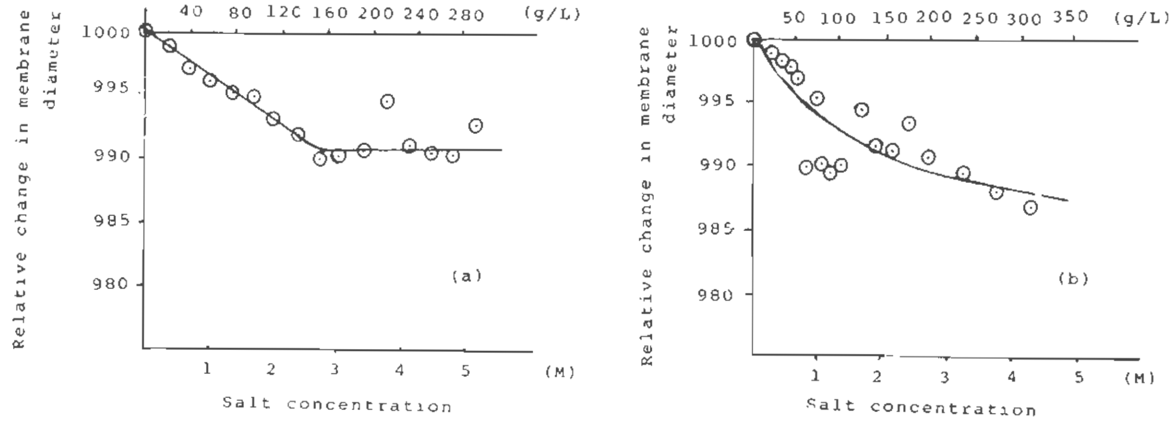

Figure (1) Relative Changes in membrane dimension vs.Salt concentration a) NaCl b)kCl

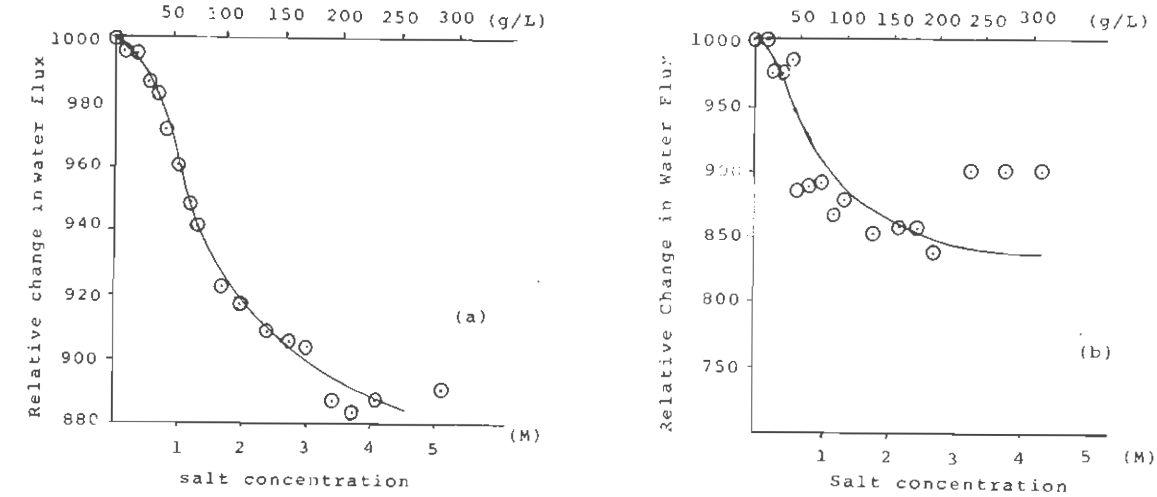

Figure (2) Relative Changes in water flux vs.Salt concentration a)NaCl b)kCl

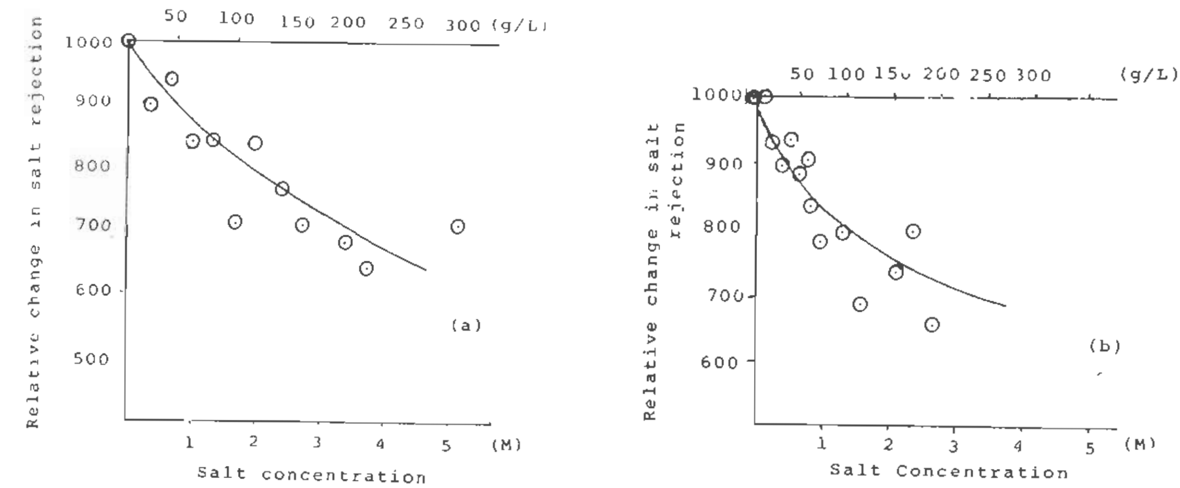

Figure (3) Relative changes in Salt rejection vs.Salt concentration a)NaCl b)kCl