Kinetics of the Osmotic driven Watertransport through a Celluloseacetate Membrane

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Although osmosis due to its great biological, medical and technological importance has been studied for many years, so far no reports have appeared on the kinetics of this process. The recent availability of artificial membranes with pores which permit the passage of water but retain even small electrolytes has rendered such detailed investigations feasible.
Solutions of NaCl, sucrose, NaCl + sucrose and $CaCl_2$ were used in the entire accessible concentration range with the DDS-RO-membrane M999 to produce the osmotic pressure. When pure substances were employed, the simple relation:

$$\ln v = a \ln m + b,$$

where v is the water flux in $kg/(Min\ m^2)$, m the molarity and a, b constants, was valid. The flux which was obtained with NaCl-sucrose solutions (1 $\underline{M}$ NaCl, 0.1 - 4.3 $\underline{M}$ sucrose) was smaller as the one calculated ($v = \exp(b_s + b_N) m_S{}^{a}S \cdot m_N{}^{a}N$) which probably was due to complex formation between Na+ and sucrose. The flux was pulsed in most concentration ranges. This could be predicted from the coupling between the transport processes (adsorption, diffusion, boyancy, capillary forces, and friction). The logarithmic relationship between v and m could also, in spite of the non-conservative nature of some of them, be verified theoretically.

Data from three publications on technical filtrations with and without membranes and with and without incompressible filter cakes were reevaluated using the above mentioned relationship (ln v vs the driving force: $nRT\ln a + \pi V$). This model satisfied the data better than the one traditionally used, the socalled filtration equation (derived from Poiseulle's law). The power a which seems to correlate with the solubility is probably related to intermolecular interactions since the activity coefficients are included in b.