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Competitive association of cations with poly(sodium 4-styrenesulfonate) (PSS) and heavy metal removal from water by PSS-assisted ultrafiltration

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Abstract: Complexing metal cations with water-soluble nano-sized ionic polyelectrolytes, combined with a separation process such as ultrafiltration (UF), is a potential strategy to remove or recover ionic heavy metals from water or wastewater. However, competition from naturally occurring cations (e.g., Na^+, K^+, Ca^{2+} and Mg^{2+}) may adversely influence target cation removal. To investigate this competition effect, the affinities of both common aqueous cations commonly found in natural surface waters, groundwaters or wastewaters and toxic cationic metals for a typical, commercially available anionic polyelectrolyte, poly(sodium 4-styrenesulfonate) (PSS), were evaluated using a simple ion exchange model and a binary-system ultrafiltration process. Selectivity of these cations for PSS complexation decreased in the order $Ba^{2+} > Pb^{2+} > Sr^{2+} > Ca^{2+} > Cu^{2+} > Co^{2+} > Ni^{2+} > Mg^{2+} > H^+ > K^+ > Na^+ > Li^+$. For cations with same valence, their affinity for PSS is proportionally related to their ionic radii. Competitive interactions among different cations complexing with PSS were also investigated in a multi-ion experimental system and the results were compared with estimates obtained using a simple model based on binary-system selectivity coefficients and mass balances. The cation distribution observed in the experimental multi-ion system was consistent with the model calculations. Experimental results also indicate the model can be applied to predict heavy metal (Cu^{2+} and Pb^{2+}) removal by PSS-assisted UF in a