



UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Atti del XXV Congresso della Divisione di Chimica Analitica della Società Chimica Italiana

Trieste, 13 – 17 Settembre 2015

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GLUCONIC ACID: THERMODYNAMIC PROPERTIES AND COMPLEXING ABILITY TOWARDS METAL CATIONS

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Gluconic acid is a noncorrosive, nonvolatile and nontoxic mild organic acid, derived from glucose by a simple oxidation reaction (enzyme glucose oxidase and glucose dehydrogenase). Gluconic acid and its derivatives have wide applications in food, medical, pharmaceutical and environmental fields. It is a good chelating agent at alkaline pH and its action is comparatively better than EDTA, NTA and other ligands. As consequence of the importance and the wide use of this natural ligand, a detailed speciation study has been carried out. In particular, the acid-base properties of the ligand were studied in NaCl and NaNO₃ aqueous solutions at different ligand concentrations, ionic strengths ($0.5 \leq I(\text{NaCl}) / \text{mol dm}^{-3} \leq 4.0$ and $0.15 \leq I(\text{NaNO}_3) / \text{mol dm}^{-3} \leq 2.9$) and temperatures ($283.15 \leq T/\text{K} \leq 318.15$).

The complexing ability of gluconic acid (L) was studied towards two metal cations, Zn²⁺ and Sn²⁺ by two different analytical techniques: potentiometry and voltammetry, that allowed the determination of the ML and ML₂ species for both systems, together with, in certain conditions of ligand concentration ($c_L > 0.1 \text{ mol dm}^{-3}$), various M(OH)_iL_k species.

The formation constant values of the Sn²⁺/L⁻ species are higher than the corresponding Zn²⁺/L⁻ species.

The formation of the insoluble species Sn(OH)L and Zn(L)₂ was evidenced at pH ~ 5.0 and 7.0, respectively, and the values of their total and specific solubility were determined in NaCl and in NaNO₃ aqueous media. The solubility measurements allowed us to determine the Setschenow and the activity coefficients of the neutral species. The dependence of the protonation and formation constants on ionic strength was modeled by means of the extended Debye-Hückel equation and the Specific Ion Interaction Theory (SIT).

Calorimetric experiments were performed to obtain the protonation and Sn²⁺ complex formation enthalpy changes at different ionic strengths in NaCl_(aq).

The choice of these two cations is related to the fact that zinc-gluconate is used as an ingredient for treating various diseases caused by zinc deficiencies, such as mental lethargy and skin changes, whilst some Sn²⁺ compounds are employed in different industrial fields, therefore, the knowledge of the complexing ability of a natural, nontoxic chelating agent as the gluconic acid is of great importance from an environmental point of view (as in remediation of polluted sites).