**Concentration, pH, counter ion and charge effect of metal ions in the treatment of heavy metals using nanofiltration.**

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**Highlights**

* Zeta potential measurements reveal important information on electrostatic rejection.
* Increase the cation valence shows an inverse charge of the membrane.
* The co-ion showed an important change in the membrane IEP.

The presence of heavy metal ions in the environment has received important attention due to increased discharge, toxicity in the environment, and other adverse effects which heavy metal ions have on receiving waters [1]. In Chile, copper mining is one of the main industrial activities and has become one of the major discharging heavy metal wastewater. One of this kind of wastewater is associated with the generation of acid mine drainage (AMD). AMD is formed by oxidation of sulfide minerals such as pyrite when it is placed in direct and simultaneous contact with water and oxygen [2]. The main characteristics of this dangerous pollutant are the high degree of acidity (pH of 2-4), the elevated concentrations of sulfate (1-20 g/L), and the presence of metals such as iron, copper, calcium and aluminium, among others [3].

In the literature are reported many methods for the treatment of acid mine drainages such as neutralisation, ion exchange, bioadsorption, biological treatments and solvent extraction [2, 4, 5]. However, all these technologies have disadvantages in their application; most of them have many serious economic, technical, environmental, and efficient limitations. An alternative such as membrane-based technologies such as pressure-driven processes has high performances in the removal of ions and contaminants. Nanofiltration (NF) is an attractive membrane separation technology more used to wastewater treatment and industrial applications. NF offers the advantage of operating at lower pressure and obtaining high permeate flux, leading to lower capital investment and decreasing the cost of operation and maintenance.

The application of NF membranes to treat AMD has been previously studied [3, 6-10]. The performance depends on the constituent membrane characteristics. Typically, NF are thin-film composites (TFC) made from various polymers such as polyamides, polysulfone, sulfonated polysulfone, polyamide and poly(piperazine amide) [11]. The separation mechanism of NF membranes includes the diffusion and convection transport in addition to electromigration related to the charge of the functional groups of the surface of the membrane. The charge acquired on the surface membrane can be by mechanisms as adsorption of ions, adsorption of polyelectrolytes, ionic surfactants and charged macromolecules [Artug]. Interfacial attraction and adhesion forces are expressed as the electrostatic, acid-base, van der Waals, and hydrophobic forces between the surface of the membrane and feed stream ionic contaminants. Therefore, electrokinetic surface properties are of vital importance to understand the phenomena of electrostatic rejection of NF membranes.

At present, zeta potential can be measured by electrophoresis or measuring streaming potential methods. Electrophoresis method can be used to describe the migration and separation of charged particles (ions) under the influence of the electric field. In contrast, the streaming potential is the potential difference at zero current produced by the convective flow of an electrolyte solution through a stationary capillary or porous plug. Streaming potential measurements have been widely used to characterise charged materials such as membranes [12-17], root surface [18], textile [19], fibres [20] and polymers [21]. Several studies were dedicated to evaluating the performance of a commercial NF with electrolyte solutions containing divalent (MgSO4, CaSO4, MgCl2, and CaCl2) and monovalent (NaCl, KCl, LiCl, and K2SO4) ions relating to their behaviour to the surface charge by zeta potential measurement. However, the behaviour of electrolytic solutions of metals such as copper, calcium and aluminium has not been fully studied.

In the present work, the retention properties of a negatively charged commercial NF membrane are investigated with three electrolytes (calcium, copper and aluminium) having co-ion of sulphate and chloride at acid and normal pH condition. The concentration or ionic strength of sulphate electrolyte solution on membrane zeta potential and the effect of co-ion (chloride) were investigated using a combination of streaming potential measurements and theoretical modelling.