

# Coupled reaction and solvent extraction process for HCl regeneration from a CaCl<sub>2</sub>-based solution

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## Abstract

The growing interest of hydrometallurgical plants for reducing environmental footprint has made spent acid regeneration an important requirement to transform conventional linear processes into circular alternatives. During acid leaching, protons are consumed either through the reaction of the acid with solid particles or by neutralising the excess acid with a base after leaching. As long as the acid anions remain in the system, the acid can be regenerated by reintroducing the consumed protons to the system. The use of carbon dioxide (CO<sub>2</sub>) gas represents a cheap, safe and clean chemical that can provide sufficient protons indirectly through the reaction with water, allowing also the formation of metal carbonates. This approach can be coupled with acid extraction by solvent extraction, so that the precipitation of carbonate compounds can be promoted in the acid-free aqueous phase. In this work, it is demonstrated how aqueous CO<sub>2</sub> can be used in the regeneration of hydrochloric acid (HCl) from a synthetic CaCl<sub>2</sub>-rich solution (with 30 g/L of calcium) by a coupled reaction and solvent extraction process. The tertiary amine tri-*n*-octylamine was used as the extractant, whereas 1-octanol and Shellsol D70 were selected as diluents. With the continuous introduction of CO<sub>2</sub> into the system, high calcium conversion (into CaCO<sub>3</sub>) and acid extraction was obtained during the extraction/carbonation stage, particularly when using 1-octanol as diluent and at high organic-to-aqueous ratios (O/A = 6). In the presence of the aliphatic diluent Shellsol D70, crud was formed which limited both the calcium conversion and acid extraction. This was avoided by adding 1-octanol (10 vol.%) as an active diluent and modifier. Both the vaterite and calcite CaCO<sub>3</sub> polymorphs were formed. HCl was stripped from the loaded organic phase with water by using an aqueous-to-organic ratio (A/O) of 3. The resulting raffinate had an acid concentration of about 0.3 g/L, but optimisation is ongoing.

**Key words:** Carbon dioxide, hydrometallurgy, circular economy