

Electrification of lime and cement production through the exploitation of the pH gradient created by water electrolysis

Steel and cement production are major sources of CO₂ emissions to the extent that these two sectors are usually separated from the chemical sector in carbon accounting. In particular, the cement production generates 8% of total CO₂ emissions each year. Two-thirds of these emissions are coming from unavoidable process emissions caused by the calcination reaction of the limestone. The remaining emissions are mainly coming from the combustion of fossil fuels. Due to the high temperature requirement ($\approx 1500^{\circ}\text{C}$), direct electrification is difficult to consider. For these two reasons, this industry is therefore known as a challenging sector to decarbonize.

A new electrochemical pathway has gained prominence in the scientific literature in recent years. This technology has the potential to electrify the cement and lime production while producing valuable gases (O₂, CO₂, H₂). It is based on a new type of hybrid electrolyser capable of working with solid, liquid and gaseous phases. Thanks to the acidity generated by water oxidation at the anode, the limestone (CaCO₃), the precursor of cement, is dissolved. This dissolution produces some CO₂, (mixed with the O₂ generated by electrolysis) which is easily captured for later use. The calcium ions are then migrating towards the cathode under the effect of the electric field. The hydroxide ions, produced at the cathode by water reduction, meet the calcium to form the final solid product, the hydrated lime (Ca(OH)₂). This lime can be used as such or converted into cement by additional steps. The parameters affecting the different steps of the process have been investigated and optimized to see if the expected stoichiometry of the process can be respected.

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