Modelling study of CO_2 sequestration by mineral waste carbonation

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Nowadays, the development of new technologies is geared towards sustainable development, among which one of the objectives is either to reduce the production of carbon dioxide or to develop efficient methods of carbon dioxide sequestration. Within the overall waste generated globally, the mineral wastes such as those produced in demolition or industrial fumes treatment make up a large percentage (~ 74%) [1]. With the aim of contributing to the recycling of this type of waste, a method of CO2 capture by mineral waste carbonation is proposed.

This study is part of the Walloon Region Mineral Loop project and the objective of this work is to model the carbonation reaction applied to mineral wastes. The influence of key design and operation parameters is studied such as the carbonation capacity of each sample, the water content in the system and the concentration of carbon dioxide in the gas phase. The results will contribute to identify an optimal design for the carbonation process and equipment.

Carbonation is a reaction that takes place in a heterogeneous system in which CH and C-S-H (according to cement notations, C=CaO, H=H2O, S=SiO2 and C=CO2) react with CO2 through interactions between physical phenomena and chemical phenomena [2]. In the present case, it is assumed that the type of waste to be treated is fully composed by Ca(OH)2. In this modelling approach the CO2 is transported by axial dispersion through the granular bed composed by cement paste particles (CPP) without considering convection and by diffusion inside each CPP. The carbonation of the ore is modelled in COMSOL with the aim of evaluating the impact of the parameters explained beforehand. Finally, to improve the mathematical model, the variation of the pellet porosity and the liquid water saturation along the process have been introduced.

In conclusion, this model is developed to study the carbonation reactions of construction waste with the aim of being able to analyse how the different parameters mentioned above influence the carbonation process of the ore and, eventually, to design an optimal process equipment.

References

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