

Porosity development during carbonation reactions

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The reduction in industrial emissions of CO₂ is one of the major challenges of this century. Anthropogenic CO₂ capture and injection into geological formations is considered a promising strategy for the permanent storage of this greenhouse gas. This process is based on the dissolution of silicate rocks in contact with CO₂-rich fluid and the precipitation of carbonates, so that CO₂ is trapped as a stable mineral phase. The generation of product layers on the surface of the carbonating material occurs by an interface-coupled dissolution-precipitation reaction (Putnis, 2009). The study of the processes of dissolution and carbonation of portlandite, Ca(OH)₂, is crucial due to the great potential of this reaction for CO₂ capture and storage, as well as for understanding the carbonation behavior of artificial mineral associations such as mortars or cements.

A critical aspect to consider in mineral replacement processes described above is the porosity evolution. The porosity created depends on the difference between the molar volumes of reagent and the product as well as the relative solubility of the two phases in the reaction fluid. The generation of porosity enables the progress of the replacement reaction, providing pathways for the fluid to be in permanent contact with the reacting solid. On the contrary, if porosity does not form during the reaction, fluid advancement is hampered and the reaction stopped. The maximum capability of CO₂ storage in a geological formation will thus depend on the porosity generated during the carbonation reaction.

This work is aimed at determining how certain physicochemical parameters of the solutions (hydrodynamic conditions, pH or composition) may affect the development of porosity during replacement reactions. Geochemical modelling and experimental studies of the replacement of wollastonite (CaSiO₃) and portlandite by calcite (CaCO₃) are used for illustrating the influence of such parameters.

Putnis A. (2009) Mineral Replacement Reactions. In: Thermodynamics and Kinetics of Water-Rock Interaction. Oelkers E. H & Schott J (eds). *Reviews in Mineralogy & Geochemistry* **30**, 87-124

Toxic element balances in small scale wood combustion systems

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In Europe, wood combustion in stoves and boilers is widely applied for residential heating. In Germany, approximately 15 million of 40 million households own small-scale wood-burning furnaces, which deliver 7% of Germany's heat consumption. Using state-of-the-art small-scale combustion systems, we investigated how the air quality changes due to the emissions of harmful elements and organic pollutants during the combustion of wood and straw.

Beside the fuel, we analysed all the originating ashes – grate ash, heat exchanger ash, and fly ash – to reconstruct element fluxes. As the input/output balance calculations show, some elements – such as cadmium, zinc, tin, thallium, lead, bismuth and antimony – may also be retained within the cooler zones of the furnace, in the chimney, or in the refractory lining material where samples could not be taken (Fig. 1). The elements collected by filters correspondent to the element amount in the flue gas, which is emitted into the ambient air. At most, these element portions represent 30 percent of the amount contained in the fuel [1, 2].

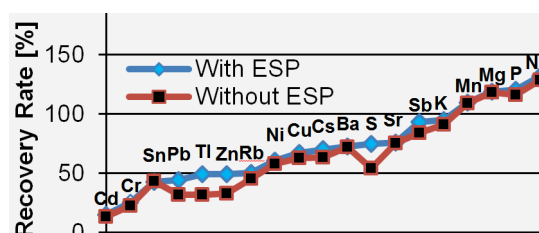


Figure 1: Element recovery rates with and without electrostatic precipitator ESP (combined element amounts in all ashes divided by the amounts contained in the combusted wood)

The pollutants are bound in fine (< 1 μm) particles or gaseous compounds and may enter the lungs' alveoli and contaminate the body. Clearly, effective emission reduction measures are necessary.

[1] Orasche *et al.* (2012) *Energy & Fuels* 26(11), 6695-6704.

[2] Seidel *et al.* (2013) Emissions of Organic and Inorganic Pollutants During the Combustion of Wood, Straw and Biogas. In Ruppert *et al.* (Eds.): *Sustainable Bioenergy Production - An Integrated Approach*. Chapter 13, Springer, Dordrecht, (in print).