Discipline: Chemistry

Title: Low-CO2 cements, from waste products

Abstract: Our world is built upon concrete. Concrete is the most-used man-made material in the world. The main component is ordinary Portland cement (OPC) which is responsible for 8-10% of global anthropogenic CO2 emissions. In our group we use different strategies to lower the environmental impact of cement and the derived mortars and concrete.

One way to reduce the CO2 emissions is to lower the cement content by using SCM (supplementary cementitious materials), i.e. by-products from other industrial processes such as fly ash or slag. However, due to their limited reactivity the amount of OPC that can be replaced is limited (approx. 30%). To achieve higher replacements, alkali-activation could be a path forward. In this subject you will focus on the production and properties of a new type of cement, starting from a solid waste (non-ferrous metallurgical slag) and a liquid activator. The mechanical properties of the cement must be optimized (ratio solid waste to activator). This implies some physicochemical characterization, as well as mechanical characterization. The aim is to minimize the eco-footprint of the final product, while retaining decent mechanical properties.

The metallurgic slags can also be used to make alkaline activated cements. These have some interesting properties, such as fire resistance. Opposite to OPC based concrete, a concrete based on such a an alkali activated cement will not lose much of its strength upon a fire.

Another way to reduce the eco-impact is to recycle concrete or mortar. Concrete can be crushed into its initial components (gravel, sand and hydrated cement). We are currently looking into the reuse of this hydrated cement, which currently is still a waste.

The last step we take, is making textile reinforced cementitious composites (TRCs). Cements are brittle materials but with the addition of fibres, they can also withstand tensile stresses. The advantage is that thinner structures can be made, without steel reinforcement.

Research is done on any of these subjects by PhD students in our group. Our research activities of FYSC (Physical Chemistry and Polymer Science) are focused on 'molecular and supra-molecular structure - processing - property' relations in organic and inorganic polymers for developing materials with improved performance. We are renowned for the application of thermal analysis, and molecular characterization, also in the field of non-traditional cements. The possibilities go from fundamental (molecular scale) to applied research, often in collaboration with other institutes and companies.

Supervisors: Hubert Rahier, hrahier@vub.ac.be

Website: https://www.vub.ac.be/MACH/FYSC/

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