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Viability of the sustainable valorization of the dicalcium phosphate residues: towards the safe management of NORM residues

Like many other industries, decommissioning a dicalcium phosphate production facility generates different waste streams. Generic wastes include dismantled equipment, contaminated soil, a mixture of soil and sludge, scale, and other miscellaneous materials. Residues generated in the dicalcium phosphate production consist of sludge of undissolved phosphate rock, SiO_2 and fluoride compounds such as CaF_2. When simultaneous calcium chloride production occurs at the same facility, another type of sludge is formed, mainly composed of $Mg(OH)_2$.

The conventional dicalcium phosphate production process involves reacting the phosphate rock with acid sulphuric to produce phosphoric acid. Several methods and modifications are used to separate fluoride –an undesirable impurity in the production process; iron; aluminium; magnesium; manganese impurities, and silica. Fluorspar is on the EU's Critical Raw Materials (CRMs) list and therefore is one of the materials considered crucial to Europe's economy. The CRMs form a solid industrial base, producing various goods and applications used in everyday life and high-tech industries. Reliable and unhindered access to certain raw materials is a growing concern within the EU and across the globe.

A critical aspect of the potential valorisation or recycling of these residues comes from the presence of radionuclides. Among the radionuclides that may be present in the sludge are U-238, U-234, Th-230, Ra-226 and Pb-210. The IAEA Safety Standards No. SSG 60 (Section 6) elaborates on strategies for NORM residue management, including exemption and clearance. In addition, the Safety Report N.º 49 addresses the Radiation Safety Basis for the Management of NORM Residues (Section 4).

This work intends to study the viability of the valorization of dicalcium phosphate residues by developing a methodology to evaluate the potential use of these residues as a source of CRMs and as secondary resources, for example, to manufacture sulfur polymer concretes.

The first step is to develop a detailed characterisation protocol of the dicalcium phosphate residues: radiological, physical-chemical, and mineralogical. The protocols should also include natural leaching tests and studies on the geotechnical and mechanical properties (laboratory-scale tests). The second step is to compile the existing valorization processes with similar residues from the bibliography. The results will define possible applications of these residues as CRMs sources and as secondary resources from the technical characteristics and define exposure scenarios, pathways and dose calculation from the safety and radiological protection point of view.

Primary author: PROENÇA DE AMORIM DINIS, Maria de Lurdes (CERENA/FEUP - Centre for Natural Resources and the Environment, FEUP - Faculty of Engineering, University of Porto, Portugal)

Presenter: PROENÇA DE AMORIM DINIS, Maria de Lurdes (CERENA/FEUP - Centre for Natural Resources and the Environment, FEUP - Faculty of Engineering, University of Porto, Portugal)

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