Purification of phosphogypsum from ^{226}Ra for its further utilization in construction: technological utopia or reality?

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Phosphogypsum (PG) is a waste product of the phosphate fertilizer industry. Approximately 3 Mt are produced annually in Israel alone and up to 280 Mt globally. PG consists of ~90% calcium sulfate dihydrate (gypsum), and is contaminated with small amounts (usually <1%) of phosphoric acid left over from industrial processing, other chemical contaminants (most notably fluorides), rare earth elements and radionuclides (most notably ^{226}Ra, which is past the legal limit allowed in construction materials in many countries). Because of these contaminants, the use of PG as a construction material is impractical, and 85% of PG produced worldwide is dumped in stacks, where it poses environmental and human health hazards.

Several solutions for the purification of PG have been tested on a laboratory scale in different research labs. One approach is to create phase changes in the calcium sulfate between the hemihydrate (HH) and dihydrate (DH) states. This allows purification of the phosphogypsum from phosphates, but not from radionuclides. Another approach is separation of the phosphogypsum grains by size, as smaller grains tend to contain a higher portion of contaminants. Radionuclides may also be removed by sulfuric acid extraction. However, these and other approaches have failed to produce a breakthrough in the industry, and have remained confined to the laboratory, largely due to cost considerations.

The project conducted now at the Technion deals with purification of PG. The suggested method is based on mixing hot PG suspension containing special chemical reagents to extract the impurities. The best results achieved demonstrated reduction of ^{226}Ra content by an order of magnitude. The NORM activity concentrations for ^{226}Ra, ^{232}Th and ^{40}K in PG before the treatment were respectively 902.3 ± 45.8; 2.0 ± 4.7 and 91.7 ± 51.3, and after the treatment - 93.0 ± 6.0; 3.6 ± 3.5 and 42.5 ± 28.0. The content of chemical impurities was still high, but the solution to the problem has been identified. The efficiency of the suggested improvements will be studied in detail in the 2nd stage of the project.

An important step would be to estimate an economic efficiency of the suggested process, taking into account that the amount of PG discharged often exceeds significantly the demand of the local construction sector.