Recycling contaminated industrial residues for sustainable construction

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Motivation

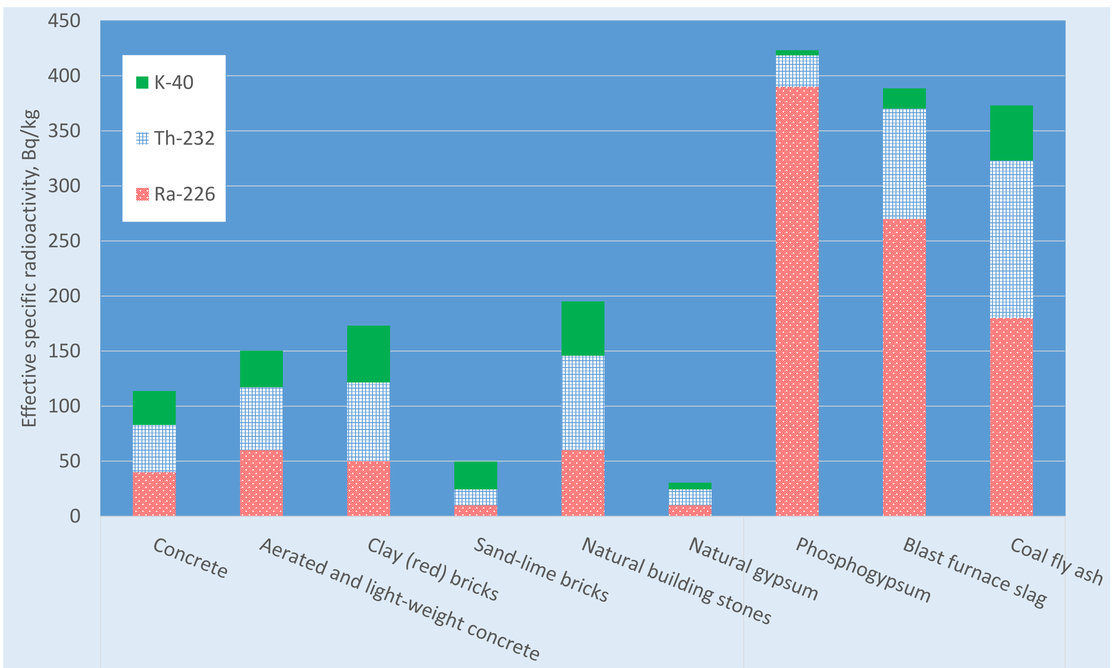
- We consume huge quantities of exhaustible or non-renewable resources
- Industrial production increased for the last century more than by 50 times
- 4/5 of this growth - in the 2nd half of XX century
- Huge consumption of natural resources doubles the production of raw materials ~every 15 years
- Only 5% of natural resources turns to end products
- The rest goes to… **a waste** - often ecologically harmful and unsafe
- Construction does not only consume about 40% of materials produced in the world and about 1/3 industrial energy, but also pollutes the environment
- Extraction of construction minerals, including sand, gravel, clay, limestone and natural stones, causes noise, vibrations and air pollution
- Transformation of land into built-up area

Landfilling contaminated residues

- These wastes should more likely be regarded as resources placed in the wrong place
- Considerable research is being conducted worldwide on the re-use of waste materials in order to deal with the increasing threat of the release of toxic elements to the environment, or to streamline the present waste disposal techniques by making them more affordable
- An economically viable solution should include the waste utilization for new products rather than land disposal

NORM (Naturally Occurring Radioactive Materials) enter the materials cycle

- Ores contain naturally occurring radionuclides
- Upon processing the ores in industrial processes residues containing enhanced concentrations of NORM are produced
- Environmental concerns depend on application
- Economic efficiency???



Phosphogypsum as an example

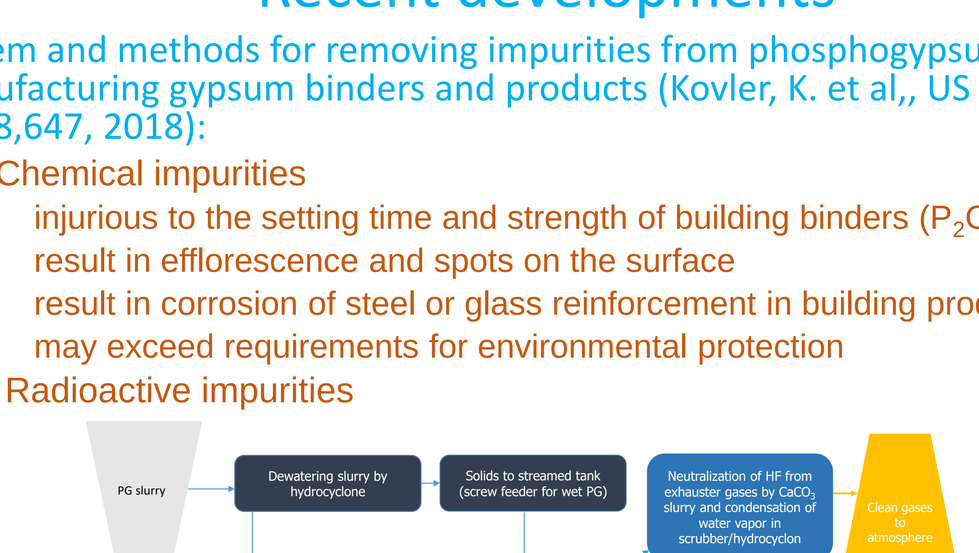
Industrial By-product (Contaminated Phosphogypsum)

- Extraction of Phosphoric Acid from Phosphogypsum
- Extraction of Cd, Radioactive Salts, Rare Earths and Other Impurities
- Obtaining Ecologically Friendly Gypsum
- Recycling to the Main Operating Line of Phosphoric Acid Plant
- Possible Production of Concentrated Products of Some Valuable Metals
- Production of Granulated Gypsum for Cement Industry and Gypsum Binders

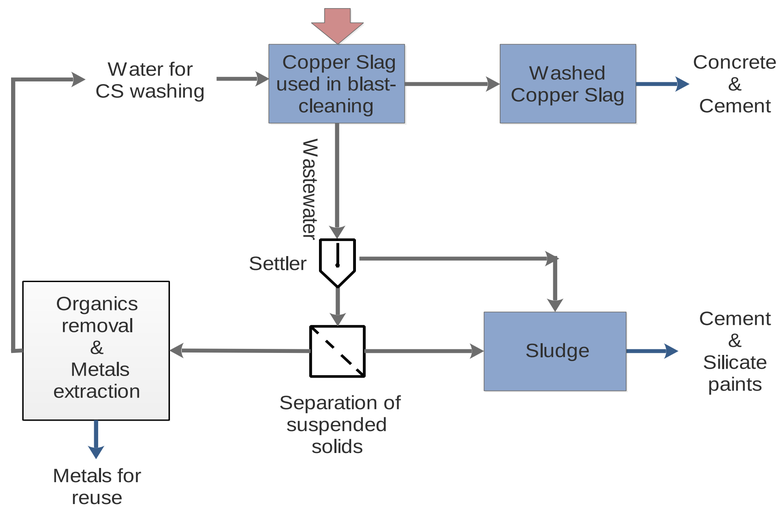
Recent developments

System and methods for removing impurities from phosphogypsum and manufacturing gypsum binders and products (Kovler, K. et al,, US Patent 9,868,647, 2018):

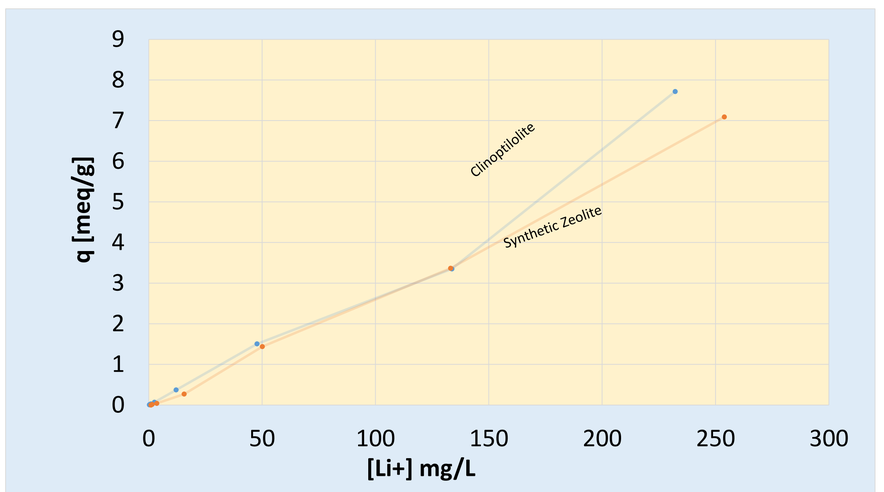
- Chemical impurities
  - ✓ injurious to the setting time and strength of building binders (P_2O_5)
  - ✓ result in efflorescence and spots on the surface
  - ✓ result in corrosion of steel or glass reinforcement in building products
  - ✓ may exceed requirements for environmental protection
- Radioactive impurities



Process proposed for the recycling of copper slag applied in blast-cleaning operation and for the recycling and treatment of produced wastewater:



Adsorption of heavy metals by synthetic zeolites made from coal fly ash:



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Department of Building Materials, Performance and Technology, National Building Research Institute, Technion, seeks a cooperation with academic and industrial partners interested in further implementation of the results obtained in our labs in a larger scale as a joint R&D project