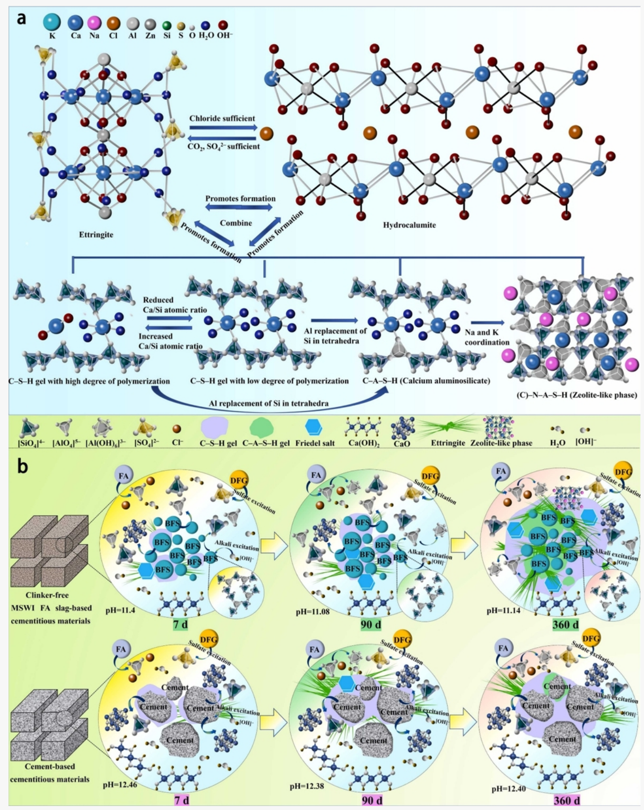
Blast Furnace Slag Substitution for Cement in Low-Cost, Carbon-Reduced Stabilized Cementitious Materials

GA, UNITED STATES, November 6, 2024 /EINPresswire.com/ -- Researchers used municipal solid waste incineration fly ash (MSWI FA), blast furnace slag (BFS), and desulfurization gypsum (DFG) as raw materials to prepare low-carbon, low-cost cementitious materials with no leaching toxicity. This is a first in achieving not only the disposal of hazardous waste but also showing significant potential in the field of backfilling mined-out areas.



Hydration mechanisms of BFS-based and cement-based cementitious materials: (a) microstructure transformation mechanism of the hydration products; (b) comparison of the hydration control mechanisms of BFS-based and cement-based cementitious materials.

China's waste incineration industry has grown rapidly, with about 90% of projects using the mechanical grate furnace process. However, municipal solid waste incineration fly ash (MSWI FA), classified as HW18 on China's hazardous waste list due to pollutants like chlorine salts, dioxins and soluble heavy metals, poses disposal challenges. By 2025, annual fly ash production is projected to hit 10 million tons, around 10% of China's hazardous waste.

In a new study (doi:https://doi.org/10.1016/j.gsme.2024.01.001) published in the KeAi journal Green and Smart Mining Engineering, a team of researchers made strides toward addressing this environmental problem.

"A key insights from our study is the potential of MSWI FA, when combined with blast furnace slag (BFS) and desulfurization gypsum (DFG), to form a low-carbon, cost-effective cementitious material that meets environmental safety standards," shares lead author Siqi Zhang. "This approach not only provides a sustainable solution for hazardous waste disposal but also offers a viable alternative to traditional cement in various industrial applications."

Notably, this new composite material has the ability to solidify and stabilize heavy metals, such as lead, zinc and chromium, within its structure. "This research opens up new possibilities for utilizing hazardous waste in a way that is both environmentally friendly and economically viable," explains Zhang. "By using advanced microscopic analysis methods, we found that heavy metals can be effectively immobilized, forming stable compounds that significantly reduce the leaching of these toxins."

This study also sheds light on the hydration process of BFS-MSWI FA-DFG composites, revealing how the glassy structure of BFS disintegrates into unstable units, which then form compact crystalline structures. X-ray absorption fine structure (XAFS) analysis provided detailed insights into atomic bond lengths and microstructural evolution throughout this transition.

"A surprising outcome was the high fixation efficiency (99.8%) for both lead and arsenic when using sulfate-based binders, outperforming," adds Zhang. "This suggests that phosphate and sulfate cements could be more effective for stabilizing hazardous elements in MSWI FA, potentially reducing the environmental impact of waste disposal."

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