Mineralizing emissions: Advanced reactor designs for CO_2 capture

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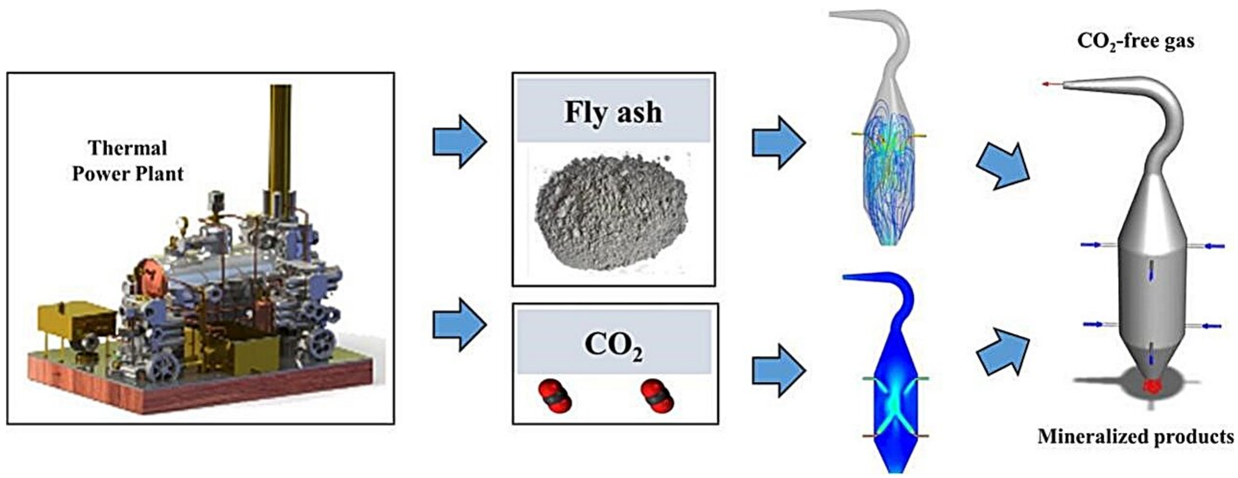

Credit: *Energy Storage and Saving* (2024). DOI: 10.1016/j.enss.2024.04.002

In advancing sustainable waste management and CO_2 sequestration, researchers have crafted reactors that mineralize carbon dioxide with fly ash particles. This avant-garde technique is set to offer a sustainable and lasting solution to the pressing issue of greenhouse gas emissions, repurposing an industrial by-product in the process.

The relentless march of industrialization has corresponded with a surge in CO_2 emissions, a key driver of global warming.

Existing carbon capture, utilization, and storage (CCUS) technologies grapple with issues of efficiency and cost. Fly ash, a coal combustion by-product, offers a promising avenue for CO_2 mineralization, turning waste into a resource and curtailing emissions.

Yet, prevailing reactor designs struggle to achieve the desired synergy between gas-particle interactions and operational efficacy. These hurdles underscore the imperative for an in-depth investigation into innovative reactor configurations and operational fine-tuning.

Shanghai Jiao Tong University's research on fly ash mineralization reactors was published in the *Energy Storage and Saving* journal on May 7, 2024.

The study, subjected to meticulous computational optimization, unveils a pioneering reactor design anticipated to escalate the efficacy of CO_2 capture and mineralization.

The research introduces a duo of reactor designs, each meticulously sculpted for CO_2 mineralization via fly ash, with computational fluid dynamics at the helm of optimization. The impinging-type inlet design stands out for its capacity to amplify interfacial interactions, extending particle dwell times and significantly augmenting mineralization rates.

The quadrilateral rotary-style inlet, conversely, champions streamlined flow for comprehensive mixing and reaction efficacy. A rigorous exploration of operational parameters—flue gas velocity, carrier gas velocity, and particle velocity—yielded optimal ranges that promise to propel reactor performance to new heights, ensuring efficient CO_2 mineralization and phase separation post-reaction.

Dr. Liwei Wang, the study's principal investigator, said, "Our findings mark a significant leap forward in carbon capture and utilization technologies. By refining reactor designs and operational parameters, we've achieved a substantial leap in CO_2 mineralization efficiency.

"This work is not only a boon to sustainable waste management but also presents a pragmatic strategy for curtailing industrial carbon emissions, aligning with global climate action initiatives."

The research bears profound implications for coal-fired power plants, offering a transformative use for the fly ash they generate. By channeling this by-product into CO_2 mineralization, the study paves the way for diminished carbon emissions and a reduction in the environmental burden of fly ash disposal.

The broader applications of this research are expansive, presenting a harmonious solution to waste management and CO_2 sequestration that could very well redefine CCUS technology approaches.

More information: Duoyong Zhang et al, Simulation Design and Optimization of Reactors for Carbon Dioxide Mineralization, *Energy Storage and Saving* (2024). DOI: 10.1016/j.enss.2024.04.002

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