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From waste to value - Sustainable recycling of ashes and flu gas CO2 by mineralization in an advanced pH shift process

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Limited resources and climate change, these two major challenges are currently driving the chemical industry towards change and innovation. There is a clear need to find alternatives to fossil fuel to still produce all necessary goods for our society. One effective source of carbon should be carbon dioxide which accumulates in our atmosphere driving temperatures up everywhere on the planet. But at 420ppm the concentration of CO_2 is very low and large and expensive efforts are needed to capture the CO_2 directly from the air. Much higher CO_2 concentrations are available in processes where carbon oxidation is applied, namely in a typical power plant for heat and electricity production. The flu gas contains up to 15% CO_2 and in the coal-fired power plants, another source for an alternative process idea is available as well, the ash from the carbon burning process. At the moment, flu gas and ash are considered as waste, to be disposed of, with an economically and environmentally negative impact. But this can be changed and I will present an innovative process idea of extraction, filtration, precipitation and separation using the “wastes” as educts and a clever pH-shift process to produce a valuable product applicable for example in the paper and color industry.

The main steps are the extraction of Calcium ions from the ash under mild acidic conditions at around pH 2-4, the filtration of the slurry to obtain a clear Calcium ion containing solution, the shift of pH to mild basic conditions of pH 9-11, the addition of CO_2 to induce a reaction between the Calcium ion, Ca^{2-}, and the carbonate ion, $(CO_3)^{2-}$, the precipitation of $CaCO_3$ as a solid and finally the separation of the solid particles as the product. As straightforward as this sounds, a number of small and big obstacles along the way will be shown and also some detours highlighted.

The presented research is part of a collaborative effort in a German priority program SPP2364 and additional information can be found in a recent publication [1].

[1] Volker Bächle, Chinmay Laxminarayan Hegde, Andreas Voigt, Kai Sundmacher and Marco Gleiß: *Tailings as a Source for Generating Valuable Magnesium and Calcium Carbonates by Leaching and Carbonization*, Industrial & Engineering Chemistry Research **64**(24) 12064–12073 (2025). https://doi.org/10.1021/acs.iecr.5c00797