

Synthetic Calcium Carbonate Production by Carbon Dioxide Mineralization of Industrial Waste Brines

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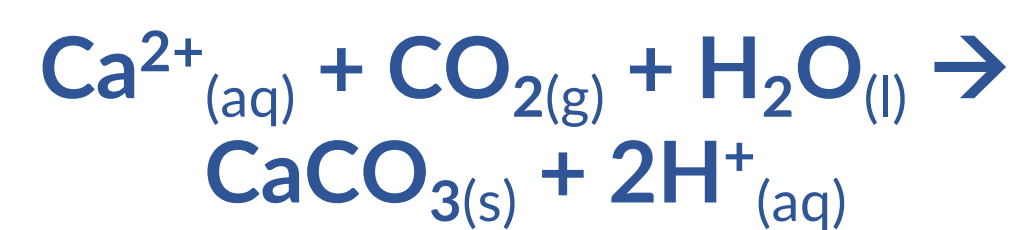
#equal contribution by authors



UCLA

Background

Carbon dioxide mineralization converts CO₂ into stable carbonates. Fine carbonates, such as precipitated calcium carbonate (PCC), are high-value commercial additives to a wide range of consumer and industrial products.



CO₂ mineralization at atmospheric conditions is **thermodynamically favorable** but require,

- Ca²⁺ source,
- Alkalinity

We are looking at two approaches to generate alkalinity and Ca concentration.

Problem statement

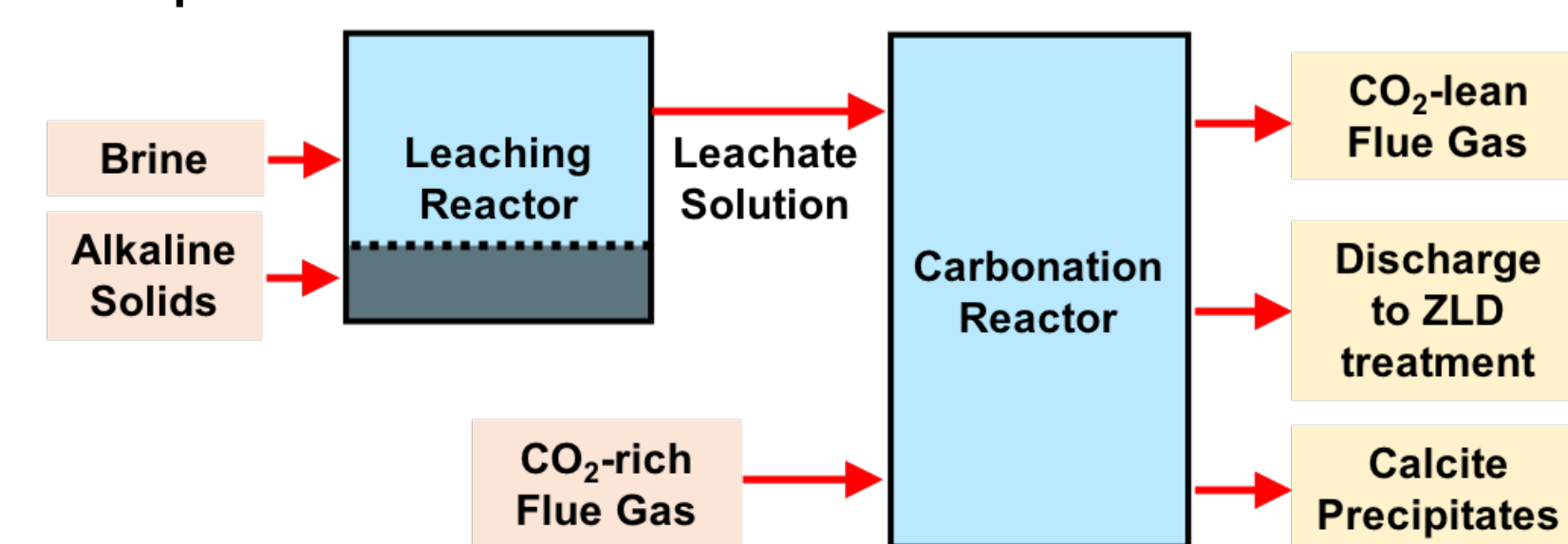
CO₂ mineralization is intrinsically carbon negative and has potential to sequester CO₂ at gigaton scale. However, to maximize CO₂ capture and commercial viability, we need to develop mineralization processes with minimum life-cycle CO₂ footprint and energy input.

Approach

In this project, we develop two CO₂ mineralization methods.

Process A: Coal ash carbonation

Ca and alkalinity source: coal ashes non-compliant with ASTM C618

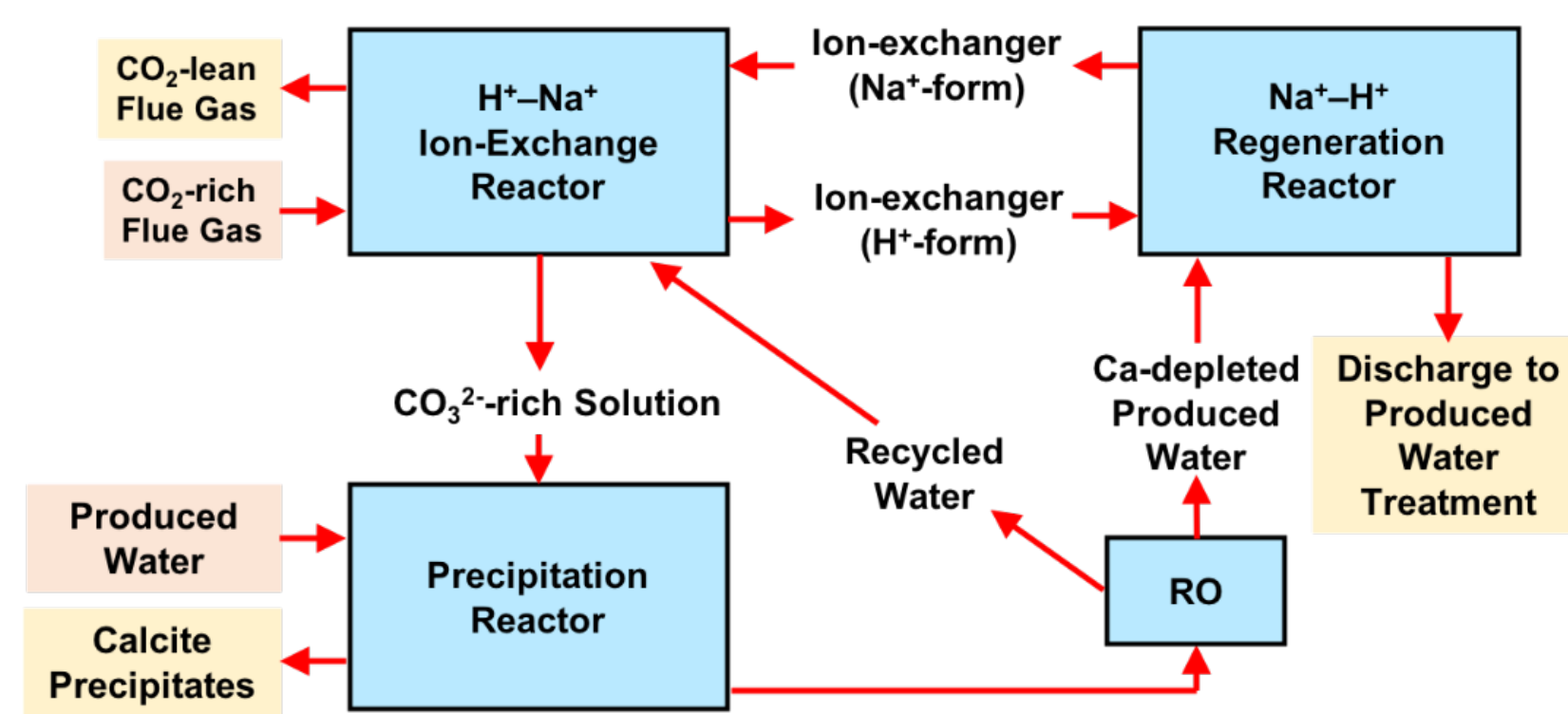


Coal ashes tested in this work:

Ash/wt. %	CaO	MgO	SO ₃
High-sulfur flyash (FA)	25.90	3.95	10.44
Bottom ash (BA)	20.50	4.09	0.56

Process B: Produced water carbonation

Ca source: produced water from oil and gas operations; Alkalinity source: ion-exchange

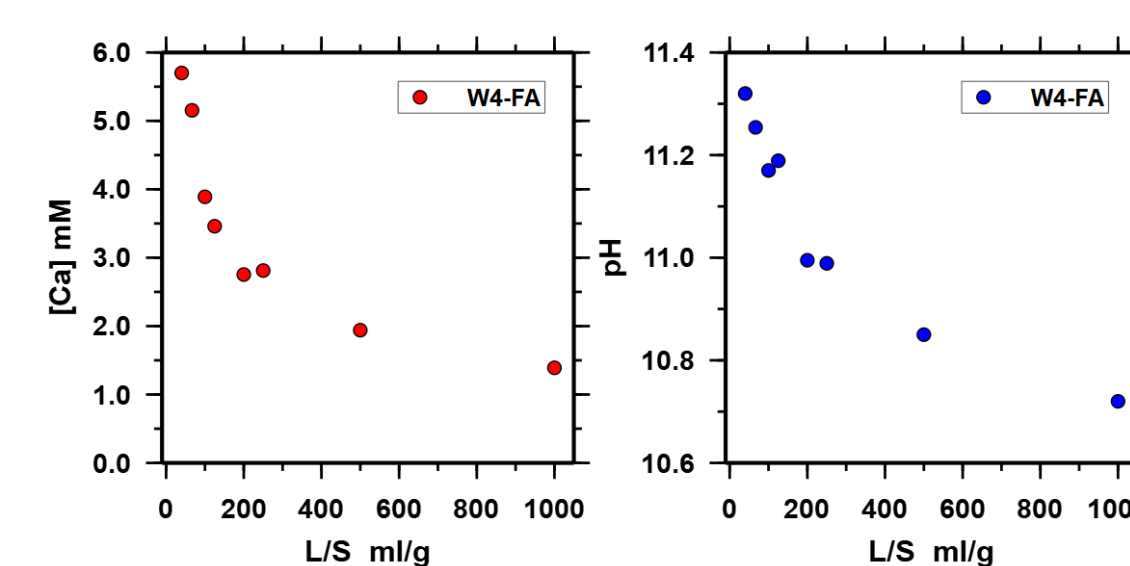


Commercial Ion-exchange resins tested:

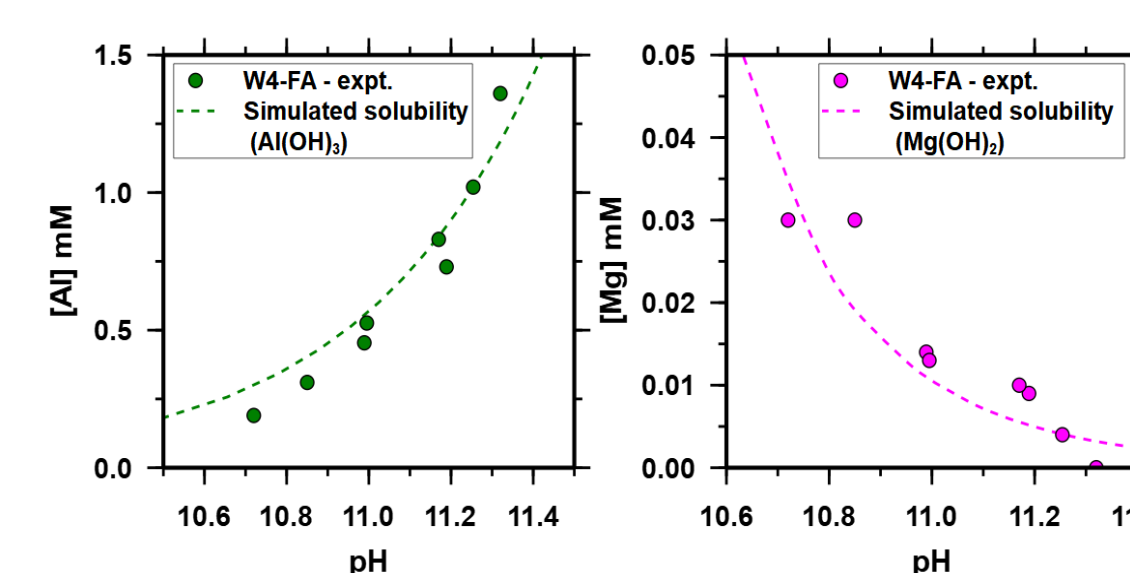
Weak Acidic Resins	Zeolites
Lewatit TP 207 (R1)	Zeolite 4A (Z1)
Lewatit TP 260 (R2)	Zeolite 13X (Z2)

Process A: Coal ashes dissolution characteristics

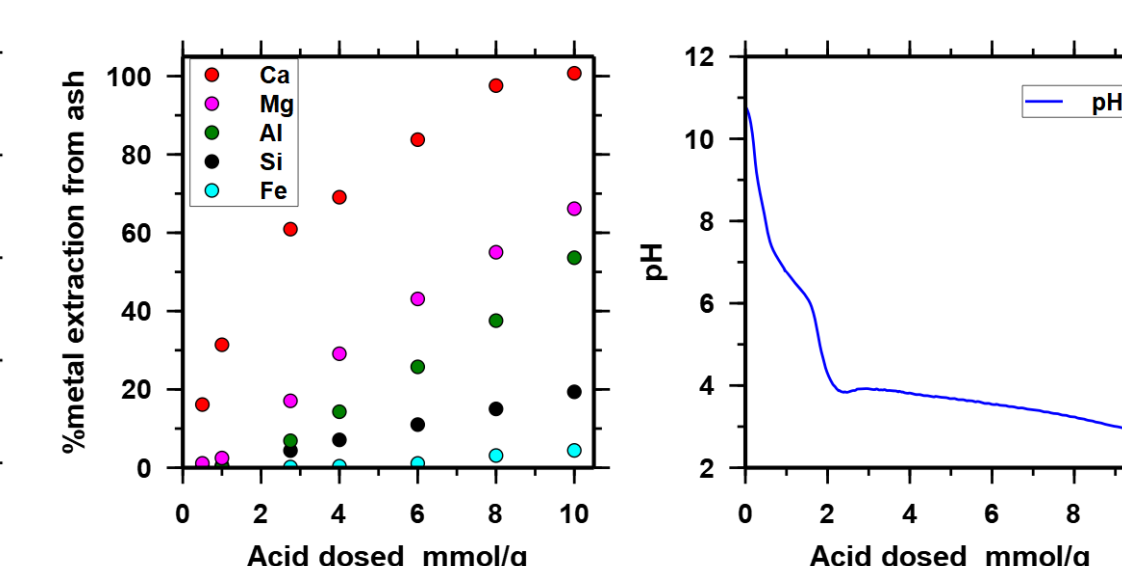
Effect of Liquid-to-solid ratio (L/S) in de-ionized water for FA



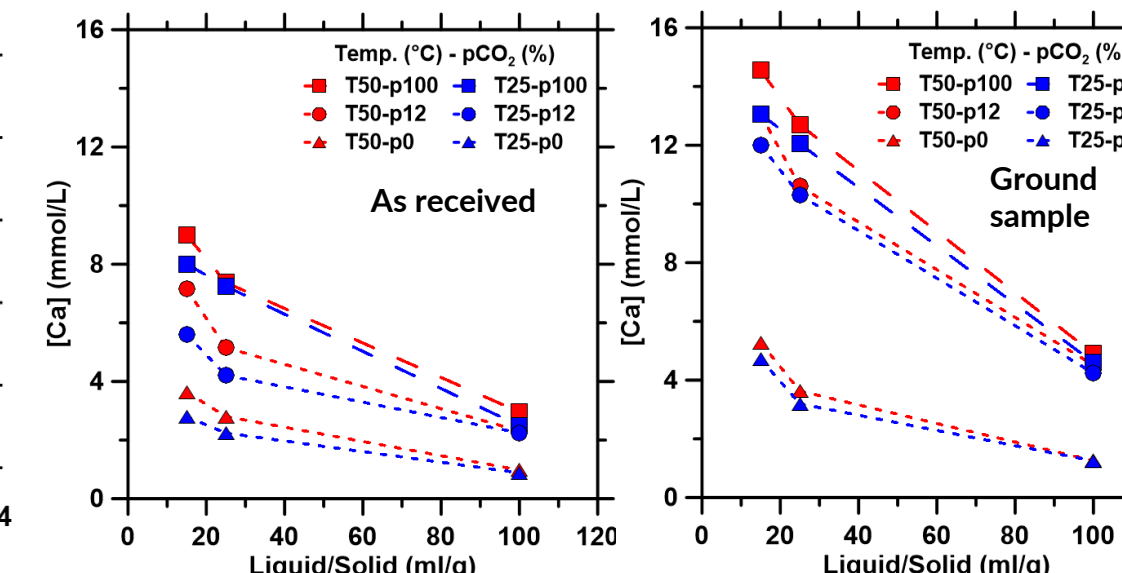
Solubility control on FA leaching:



Neutralization characteristics of FA in mineral acid

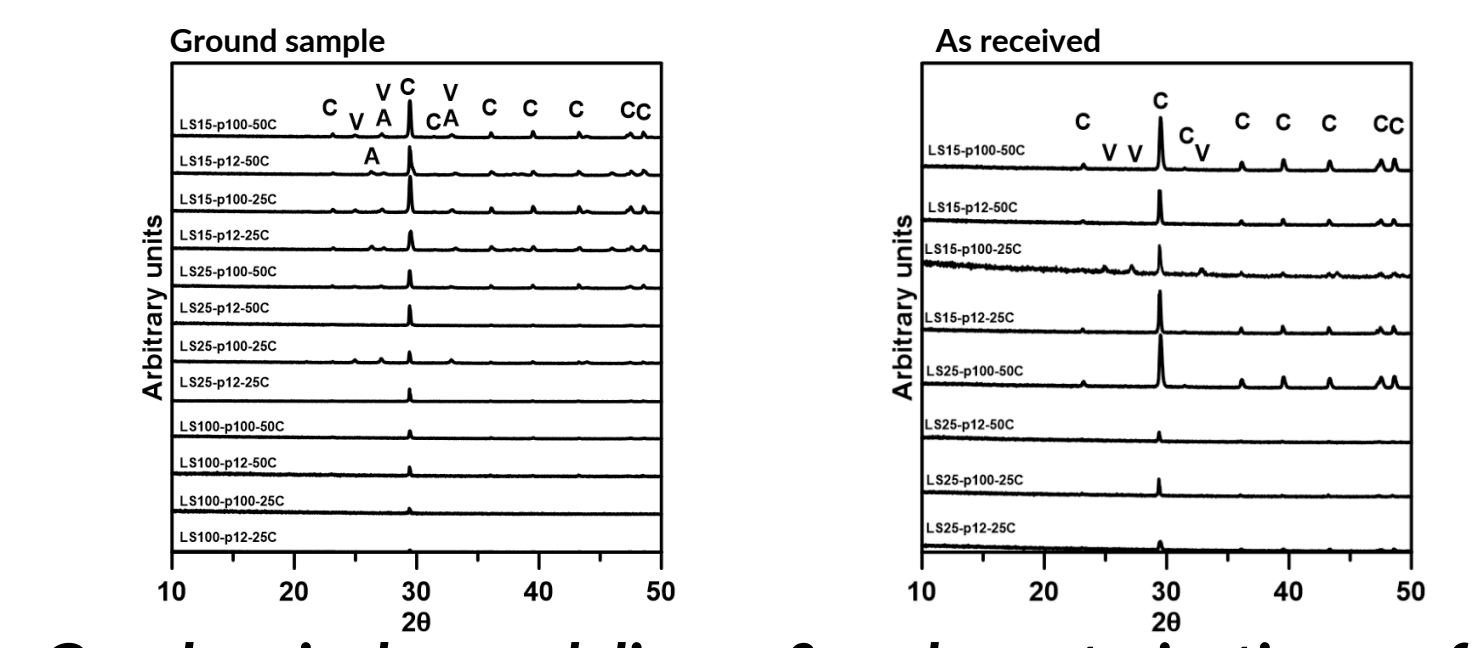


Solubility control on BA leaching:

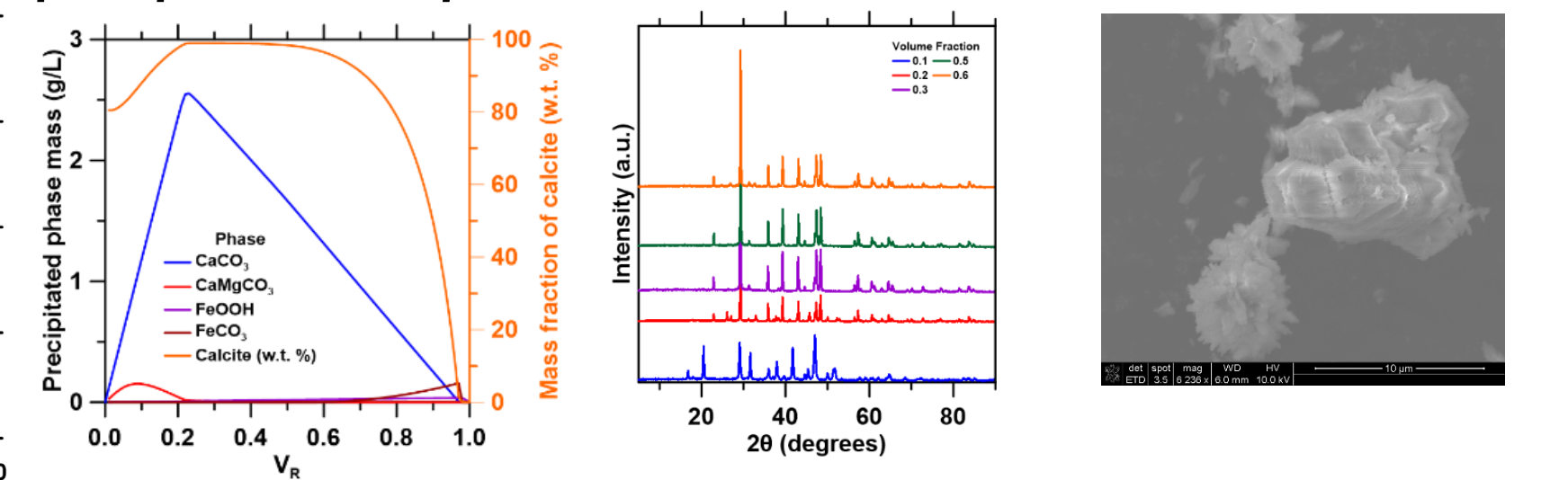


CO₂ mineralization & PCC characterization

Characterization of PCC precipitate from coal ash

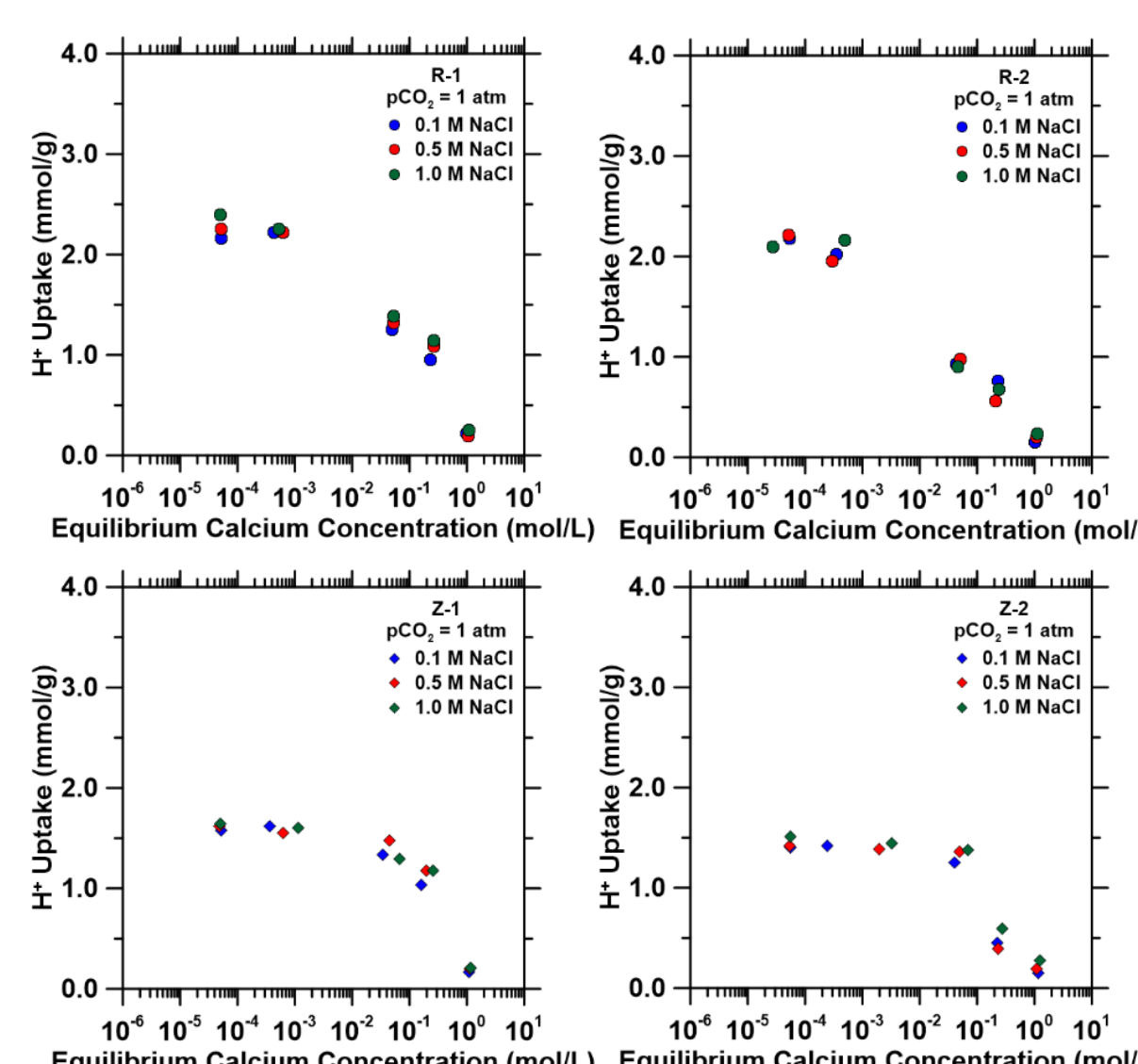


Geochemical modeling & characterization of PCC precipitate from produced water

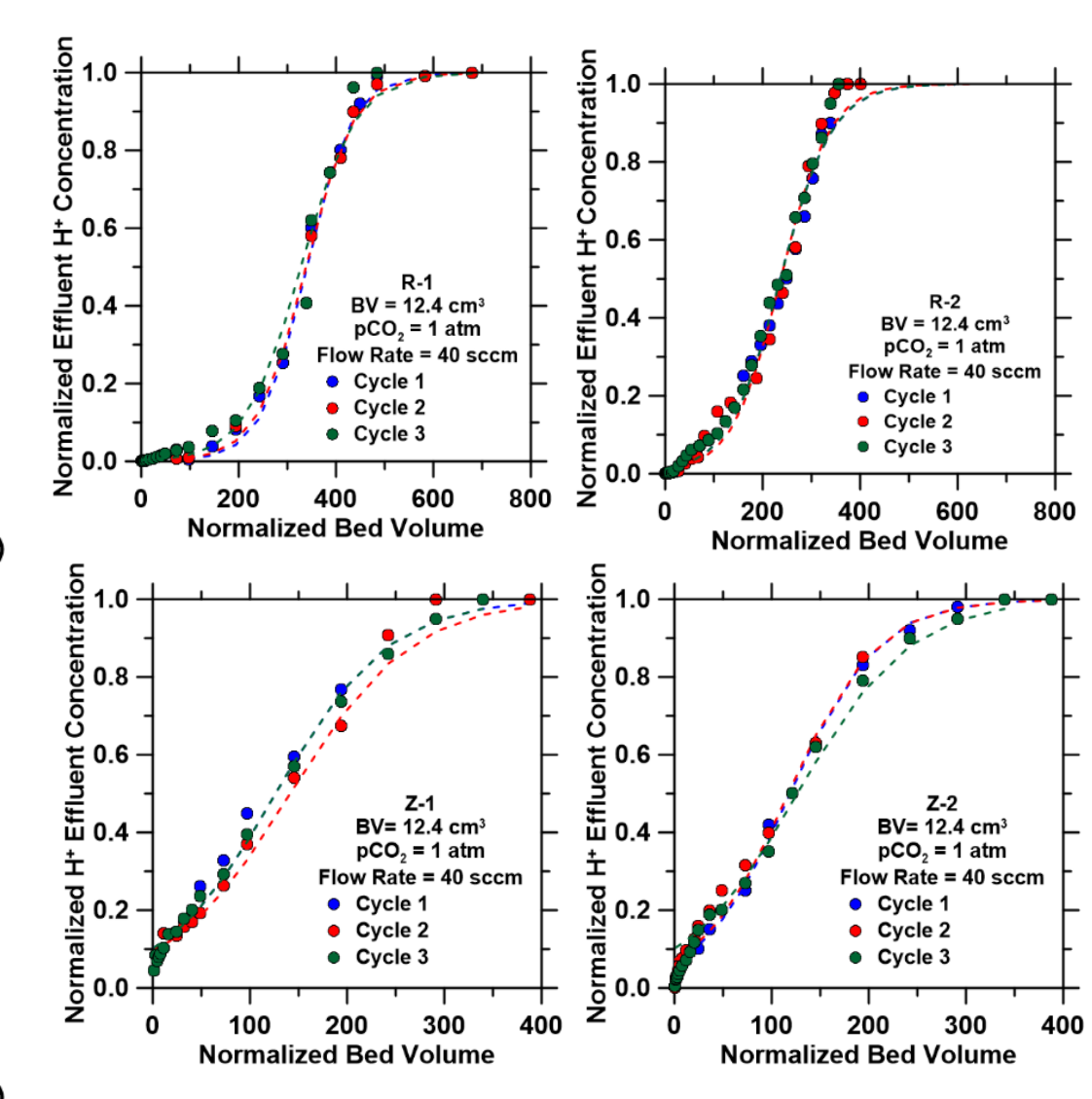


Process B: Kinetics characteristics of ion-exchange process

IEX H⁺ exchange capacities & competitive ion exchange



Break-through curves for H⁺ exchange & regeneration characteristics



Conclusions:

- Higher [Ca] concentrations obtained by leaching coal ash using CO₂(g). CaCO₃ precipitated from degassed solutions.
- Acid neutralization capacity of high-sulfur fly ash is 2 mmol/g, which corresponds to 50% Ca extraction.
- A maximum of 88 g CO₂/g of ash can be mineralized by direct carbonation.
- IEX is a functional means of producing PCC from carbonate-alkaline solutions and produced water
- Can reach up to 26 mmol of CaCO₃ per liter of produced water

Email bu.wang@wisc.edu for more information

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