Pilot-scale mineralization of flue gas desulfurization gypsum in waste alkali medium

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1. Introduction

• **Principle of CO_2 mineralization in industrial solid waste**

$Ca^{2+}+H_2CO_3 \rightarrow CaCO_3+2H^+$ (1)

$H_2CO_3 \rightarrow HCO_3^-+H^+$ (2)

$HCO_3^- \rightarrow CO_3^{2-}+H^+$ (3)

$Ca^{2+}+HCO_3^-+H^+ \rightarrow CaCO_3+2H^+$ (4)

$Ca^{2+}+CO_3^{2-} \rightarrow CaCO_3$ (5)

• **Materials**

-Solid mineralized feedstock: desulfurization gypsum (FGDG) produced by power plants ($CaSO_4$ accounts for 97% of the dried FGDG).

-Liquid reaction medium: NaOH effluent.

• **Mineralization reactor**

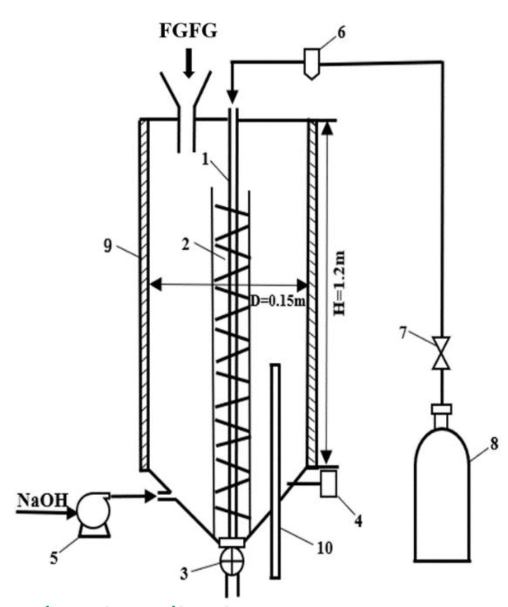

Fig.1 Structure of a pilot-scale mineralization reactor：1- gas tubes，2- heating coils，3-valve，4- pH meter，5- liquid pump，6- gas flow meter，7-gas pressure reducing valves，8- CO_2 cylinders，9- insulation，10- reclaimer tube

2.Result and discussion

• **Effect of reaction parameters on CO_2 mineralization efficiency**

- The CO_2 mineralization efficiency reaches its maximum and the mineralization reaction tends to stabilize when the mineralization reaction is carried out for 6 min.

- The highest CO_2 mineralization efficiency can reach 92% under optimal conditions.

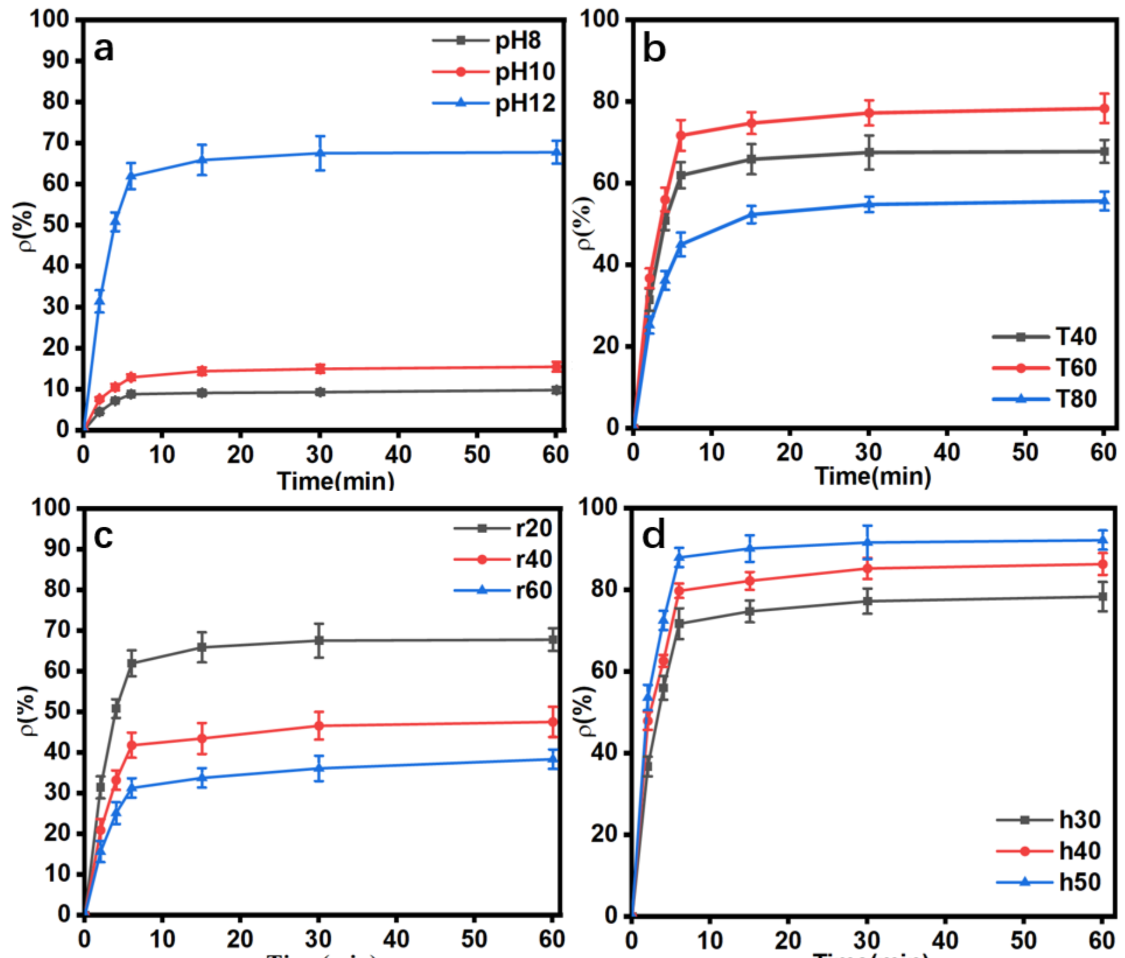

Fig.2 effect of reaction parameters on the mineralization efficiency; a: initial pH of NaOH effluent, b: CO_2 flow rate, c: reaction temperature, d: liquid level

• **Effect of reaction parameters on product particle size**

- The minimum average particle size of the reaction product reaches 4.5μm.

- The increase in gas flow rate and the decrease in liquid level height cause the particle size distribution curve to shift to the right.

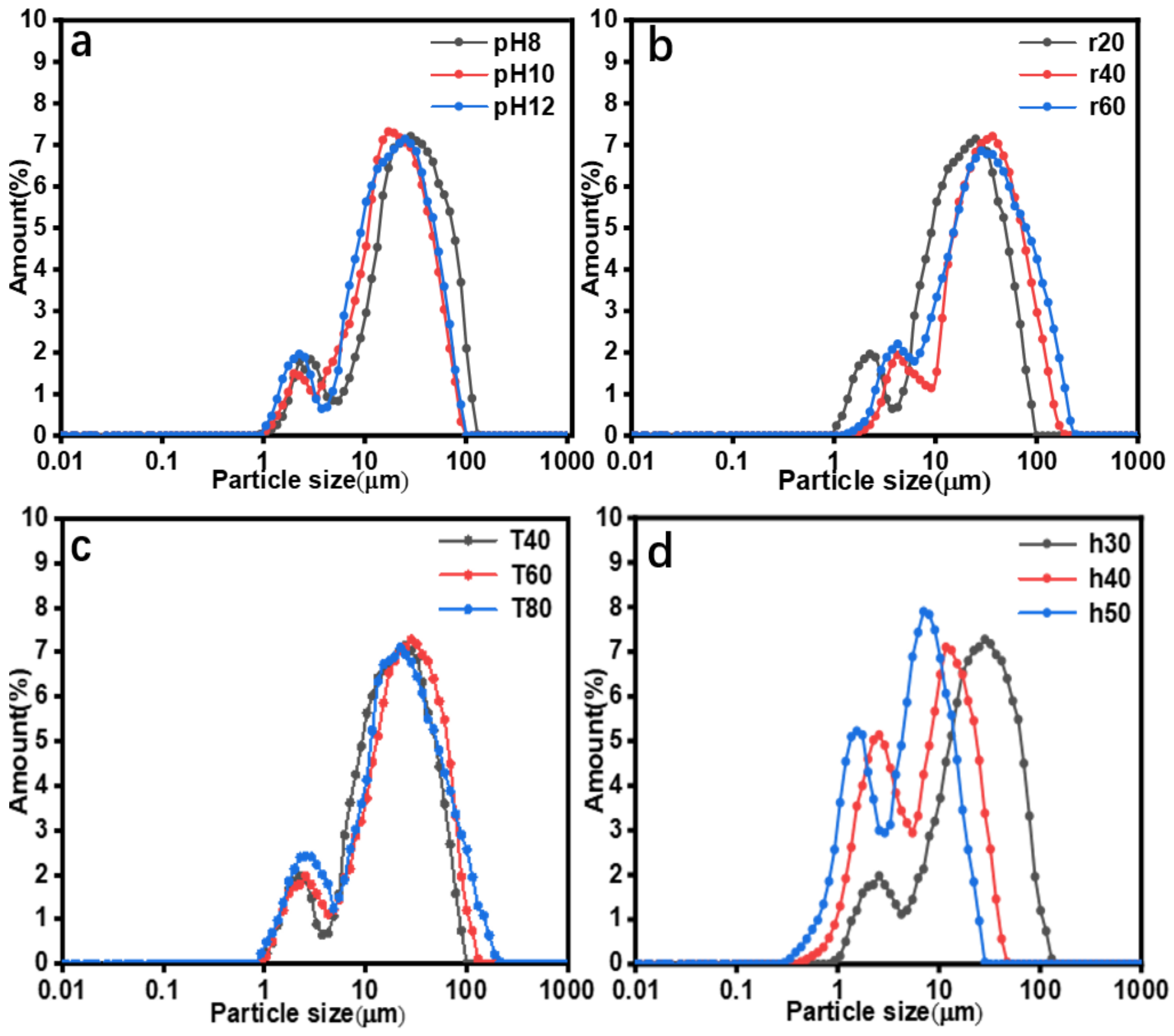

Fig.3 effect of reaction parameters on product particle size; a: initial pH of NaOH effluent, b: CO_2 flow rate, c: reaction temperature, d: liquid level

• **Characterization and analysis of product**

- The plate-like $CaSO_4$ particles are transformed into $CaCO_3$ aggregate particles after 60 minutes of mineralization reaction**.**

- The product obtained after carbonization is composed of amorphous nano-sized particles with an aggregate structure.

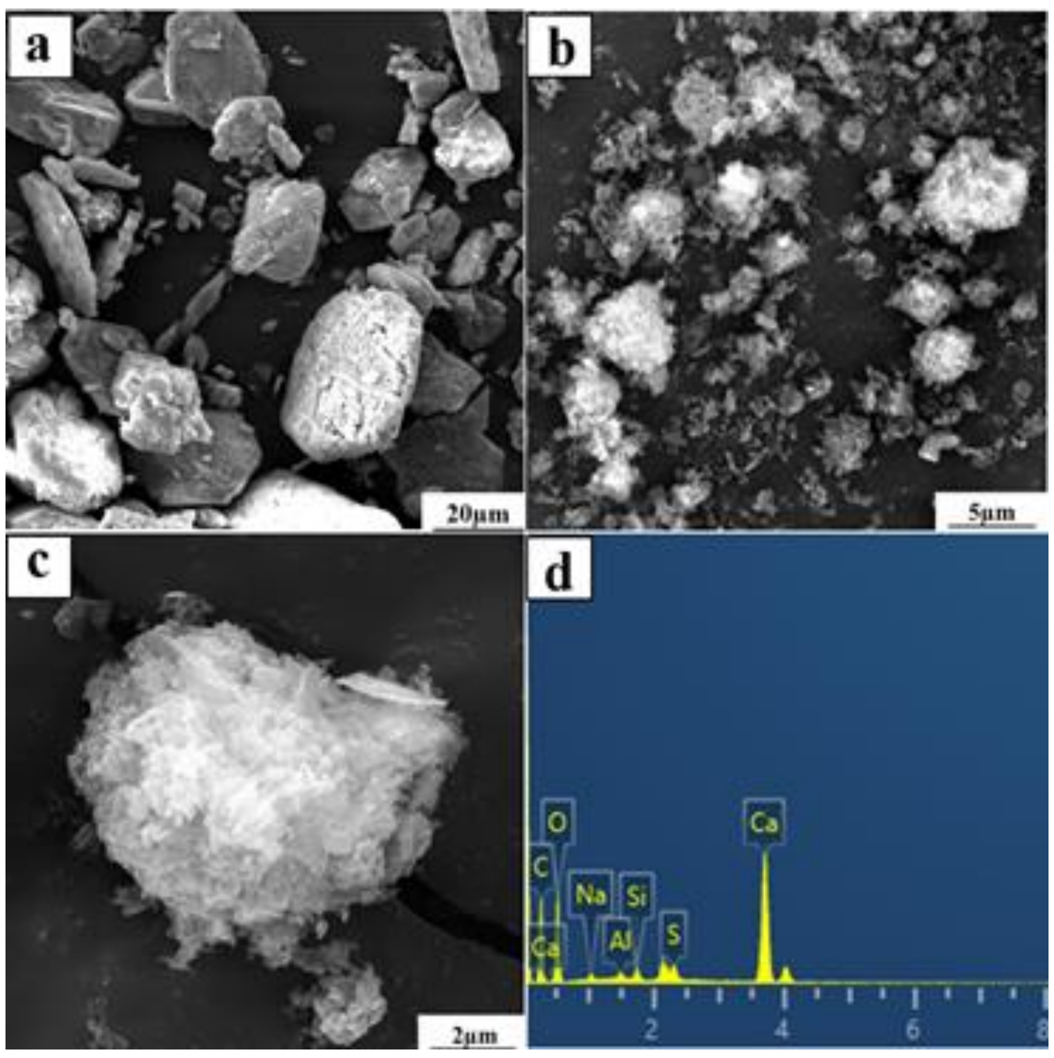

Fig.4 a: The SEM images of raw FGDG; b-c: The SEM images of FGDG mineralization product; d: EDS mapping of FGDG mineralization product

3. Conclusion

• The increase in initial pH of NaOH effluent, liquid level and the decrease in CO_2 flow rate are beneficial for achieving high CO_2 mineralization efficiency. As the temperature increases, the CO_2 mineralization efficiency first increases and then decreases.

• The increase in liquid level and the decrease in CO_2 flow rate are beneficial for obtaining small particle products. The cost of product recovery is relatively high. The initial pH of NaOH effluent and reaction temperature do not have a significant impact on the particle size distribution of the products.