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# The adsorption and transformation of $SO_2$, $H_2S$ and $NH_3$ by using sludge gasification ash: Effects of Fenton oxidation and CaO pre-conditioning

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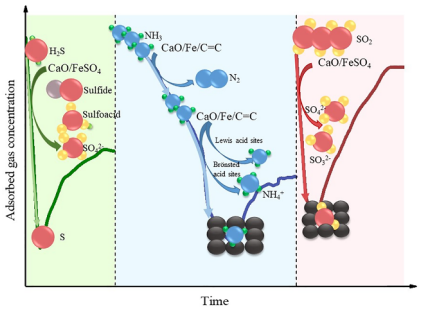
## HIGHLIGHTS

- Fenton/CaO-treated sludge gasification ash is used as adsorbent.
- The sludge gasification ash shows the best $H_2S$ and $NH_3$ adsorption performance at 1173 K.
- The CaO conditioned ash with better pore structures boosts the $SO_2$ adsorption performance.
- The conversion of $H_2S$ to sulfate and sulfide is improved by iron-calcium compounds.
- The adsorption of $NH_3$ mainly depended on the acid sites carbon structures at 873 K.

## GRAPHICAL ABSTRACT




## ARTICLE INFO

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## ABSTRACT

Gasification technology can effectively convert the organic substances to combustible gas, but the high content of inorganic matter in sludge will cause a large amount of gasification ash needed to be utilized remaining. On the basis of our previous study, Fenton's reagent ($Fe^{2+}/H_2O_2$) and CaO conditioning brought more Fe- and Ca-containing compounds, providing the potential for gasification ash as adsorbent. This study explored the mechanism of sludge gasification ash sorbent for sulfur and nitrogen containing pollutants removal. Conditioned sludge was gasified in a lab-scale fixed bed at 873 and 1173 K, then $SO_2$, $H_2S$ and $NH_3$ adsorption experiments were conducted in a self-designed reactor to evaluate in situ adsorption capacity of gasification ash. According to the results, gasification ash was more suitable for the adsorption and degradation of $H_2S$ and $NH_3$ at high temperature with outlet concentration reaching the minimum of 14 and 30 ppm respectively. Iron substances can promote the surface structure of ash, while the surface area pretreated with CaO was increased twice as large as that of raw sludge ash, which can partly explain the $SO_2$ adsorption performance. The raw sludge gasification ash mainly promoted the decomposition of $H_2S$ to sulfur, while the iron and calcium salts in gasification ash converted $H_2S$ to sulfides and sulfates cooperatively. As for $NH_3$, the adsorbents also showed great removal effect at 873 K, mainly depending on the carbon structure and surface Lewis acid sites measured by in situ FTIR. With temperature increasing, the catalytic effect of calcium and iron compounds, which can react with $NH_3$ to form intermediates, played a dominant role in the decomposition of $NH_3$.

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