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Full Length Article

Emission control of NO_x precursors during sewage sludge pyrolysis using an integrated pretreatment of Fenton peroxidation and CaO conditioning

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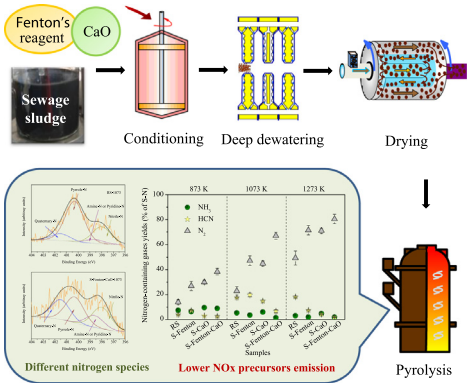
HIGHLIGHTS

- A novel integrated sludge pretreatment method was proposed to control NOx emission.
- Iron conditioner prevented some N-containing organics of sludge from deamination.
- Active Fe derived from conditioner reacted with NH_3 through the formation of $Fe_\alpha N$.
- Composite conditioner reacted with protein-N and char-N to form $Fe_\alpha N$ and CaC_xN_y.
- $Ca_2Fe_2O_5$ formation facilitated the decomposition of $Fe_\alpha N$ and CaC_xN_y to release N_2.

GRAPHICAL ABSTRACT



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ABSTRACT

In order to control the emissions of NO_x precursors during sewage sludge pyrolysis, we proposed a novel integrated pretreatment method based on Fenton peroxidation and CaO conditioning. Nitrogen transformation was investigated using a self-designed drop-tube/fixed-bed furnace, and the mechanism of influence of residual conditioners was further clarified by employing model compounds. According to the results, the conversion of sludge-*N* to gas-*N* at 873–1273 K was strengthened by composite conditioning during the pyrolysis process. The remaining iron salts prevented some nitrogenous organic matter from deamination, whereas calcium compounds promoted the decomposition of proteins and amine to release NH_3. Active iron atoms derived from an Fe-bearing conditioner reacted with NH_3 through the formation of $Fe_\alpha N$. Furthermore, combined conditioning hampered the conversion of amine-*N*/pyridine-*N*, pyrrole-*N* and nitrile-*N* to HCN, therefore enhancing their yields in char. The residual Ca compounds, which presented as $Ca(OH)_2$, facilitated the hydrolysis of HCN and hampered HCN generation from amine-*N*, nitrile-*N* and heterocyclic-*N* in tar. Both residual iron and calcium conditioners were capable of reacting with protein-*N* in sludge and char to form $Fe_\alpha N$ and CaC_xN_y, respectively. The formation of complex $Ca_2Fe_2O_5$ facilitated the decomposition of these intermediates, thus facilitating the conversion of sludge-*N* and NOx precursors (tar-*N*, NH_3, HCN) to N_2, achieving a highest non-polluting gas yield of 80.5%.

1. Introduction

Thermal disposal is an efficient process to realize sewage sludge management with a potential benefit of energy recovery [1–3]. In

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