



## Full Length Article

# Nitrogen conversion during the homogeneous and heterogeneous stages of sludge steam gasification: Synergistic effects of Fenton's reagent and CaO conditioner



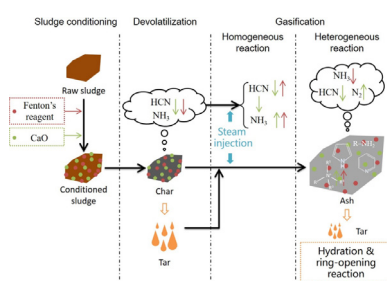
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## GRAPHICAL ABSTRACT



## ARTICLE INFO

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## ABSTRACT

Fenton's reagent ( $\text{Fe}^{2+} + \text{H}_2\text{O}_2$ ) and CaO are the conditioners during sludge dewatering, which also showed abilities in NO<sub>x</sub> precursors control during drying and pyrolysis process that we have found before. This study further refined the effects of conditioners on homogeneous and heterogeneous processes during sludge steam gasification using a self-designed decoupling reactor. The results show that compared with raw sludge, the NH<sub>3</sub> and HCN yields of conditioned sludge decreased by 13.71–17.67 mL/g and 17.77–23.45 mL/g at 873–1073 K respectively. 50.59–98.76% of decrement attributed to the synergistic effect of conditioners on volatiles homogeneous reforming, owing to the less NH<sub>3</sub>, HCN and tar-N yields in devolatilization product as well as the indirect enhancement of HCN hydrolysis. Fenton's reagent added alone exhibited a significant effect on volatiles heterogeneous reforming. During the interaction between volatiles and char, iron salts could catalyze the nitrile-N and pyrrole-N in char conversion to stable indoles in tar and inhibited the hydrolysis of amine-N to release NH<sub>3</sub>. Calcium salts also showed a certain capability on the co-decomposition of quaternary-N in char and indoles/quinolones in tar to harmless N<sub>2</sub>. Thus, the combination of Fenton's reagent and CaO can complementarily reduce the emission of NO<sub>x</sub> precursors at each stage of gasification.

## 1. Introduction

The sustainable development of economy cannot materialize

without energy consumption. Nowadays the clean utilization of municipal solid waste (MSW) has gained increasing and widespread attentions because of its renewability [1,2]. Sewage sludge, a special kind of

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