Mechanism of conditioner CaO on NO\textsubscript{x} precursors evolution during sludge steam gasification

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Abstract

NH\textsubscript{3} and HCN are the predominant NO\textsubscript{x} precursors generated from sludge steam gasification. CaO is a traditional chemical conditioner for sludge dewatering and it can also help control the emission of NO\textsubscript{x} precursors when used as an additive in coal pyrolysis. This work investigated the influence of conditioner CaO on NO\textsubscript{x} precursors evolution using an improved drop-tube/fixed-bed reactor at temperatures ranging from 873 K to 1273 K. An NH\textsubscript{3} decomposition experiment was conducted to further verify the mechanism underlying the effects of char. Results showed that by changing the compositions and proportions of volatile-N, conditioner CaO reduced HCN production by 9.9\% and 5.3\%, whereas increased NH\textsubscript{3} yield by 8.4\% and 11.5\% at 873 K and 1073 K, respectively. The hydrolysis of nitrile-N and HCN occurred readily in the gasification of volatiles in CaO conditioned sludge (named S-CaO). When char participated in the steam reforming of volatiles, S-CaO char showed good capacity for NH\textsubscript{3} decomposition at 1073 K. The final amount of NH\textsubscript{3} emissions was 11.3\% lower than that of the gasification of raw sludge (named RS). CaO was able to catalyze the conversion of NH\textsubscript{3} to N\textsubscript{2}, which can be promoted by steam. S-CaO ash was likely to oxidize NH\textsubscript{3} to NO. However, for S-CaO char, with the synergic effect of char carbon and conditioner CaO, NH\textsubscript{3} and NO were transformed into N\textsubscript{2} within a short time. This demonstrated that reusing conditioner CaO during sludge steam gasification at high temperatures is a promising technology for the control of NO\textsubscript{x} precursors emissions.

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Keywords: Sewage sludge; Conditioner CaO; NO\textsubscript{x} precursors; Steam gasification

1. Introduction

Steam gasification is a promising technology for the conversion of solid fuel to H\textsubscript{2}-rich gas, which may help meet the increasing demands for clean en-

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