



## Full Length Article

## Mercury stability of byproducts from wet flue gas desulfurization devices

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## HIGHLIGHTS

- We investigated mercury release behaviors from gypsum when additives were used.
- The rates of mercury release under different calcination methods were acquired.
- TMT with slow-speed calcination had the best effect on inhibiting mercury emissions.
- Speciation of mercury in gypsum was obtained to explain mercury release behaviors.

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## ABSTRACT

Mercury released from wet flue gas desulfurization (WFGD) devices can be inhibited by additives that can transfer mercury to its solid phase. However, the use of additives increases the mercury content in desulfurization gypsum, and the mercury is released again during the calcination process. In this study, NaHS, 2,4,6-trimercaptotiazine, trisodium salt nonahydrate ( $\text{Na}_3(\text{C}_3\text{N}_3\text{S}_3) \cdot 9\text{H}_2\text{O}$ , or TMT) and sodium dithiocarbamate (DTCR) were used as additives to control mercury emissions in simulated WFGD devices. Then, different calcination methods were adopted to study mercury release behaviors from calcination process. The transformation of mercury compound species on gypsum was also investigated to explain its behavior during calcination. The result showed that the mercury content in the solid phase increased significantly in the presence of additives. Among three additives, simulated desulfurization slurry with TMT had the highest trapping efficiency over mercury. The mercury thermal stability in gypsum increased in the order of using DTCR, TMT and NaHS. Due to the migration of mercury to the solid phase and the stronger thermal stability of resultants, the residual content of mercury in gypsum with additives after calcination were higher than that without additives. In general, using TMT coupled with slow-speed calcination had the best effect on controlling mercury contamination from WFGD slurry and WFGD byproducts. Moreover, it was verified by temperature programmed decomposition experiments that, after using NaHS, TMT and DTCR, the mercury compound in the gypsum was mainly in the form of  $\text{HgS}$ ,  $\text{Hg}_3(\text{TMT})_2$ ,  $\text{Hg}(\text{DTCR})_2$ , respectively, which explained the mercury release behaviors during calcination.

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## 1. Introduction

Mercury is one of the most pernicious heavy metal elements in the environment because of its high toxicity, long range transport, persistence and bioaccumulation [1]. In recent years, mercury contamination has increased considerably due to the rapid economic growth with insufficient environmental awareness [2]. Human

activities are responsible for the mercury pollution and worldwide mercury emissions from human activities accounts for 30–55% of global atmospheric mercury emissions [3]. Coal-fired power plants are the primary sources of anthropogenic mercury discharge in China [4]. Currently, some effective strategies such as electrostatic precipitator (ESP), fabric filter (FF) and wet flue gas desulfurization (WFGD) has been adopted to synergistically remove some particulate mercury ( $\text{Hg}^p$ ) and oxidized mercury ( $\text{Hg}^{2+}$ ) from flue gas [5–7]. Compared with  $\text{Hg}^p$  and  $\text{Hg}^{2+}$ , element mercury ( $\text{Hg}^0$ ) is less soluble, high volatile and it can hardly be captured by above equipment. Nevertheless, selective catalytic reduction (SCR) devices can enhance the oxidation of  $\text{Hg}^0$  to  $\text{Hg}^{2+}$  which will be typically

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