

Article

Study on the Effect of Mineral Compounds on the Behavior of Heavy Metals During Oily Sludge Incineration

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Abstract: Incineration is a highly effective method for treating oily sludge. However, during the incineration process, heavy metals may either be released into the air via flue gas or remain in the bottom ash in an unstable form, posing significant environmental threats. Mineral compounds can provide adsorption sites for heavy metals and promote the stable existence of heavy metals in incineration bottom ash. In this paper, the incineration experiments of oily sludge with CaO, Fe₂O₃, Al₂O₃ and MgO were conducted using a horizontal tube furnace. The total amount, leaching characteristics, and morphological distribution of heavy metals in the obtained incineration bottom ash were analyzed. The results showed that CaO had a significant adsorption effect on Cu, Cr, Pb, As and Cd. Al₂O₃ exhibited the best leaching inhibition effect on Cr, Zn, Pb, As, and Cd. The influence of mineral compounds on the morphological distribution of heavy metals during incineration was highly dependent on the type of metal. This work will provide crucial theoretical support for the source control of heavy metals during oily sludge incineration and hold important practical significance for achieving the harmless treatment of oily sludge and promoting the development of oily sludge incineration technology.

Keywords: mineral compounds; heavy metals; behavior; oily sludge; incineration



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1. Introduction

Oil is a vital pillar of the national economy and an indispensable strategic resource for the survival and development of a country. In the processes of oil exploration, transportation, and refining, large amounts of oily sludge are generated [1]. In China, the annual production of oily sludge exceeds 6 million tons, resulting in a historical accumulation of approximately 143 million tons. Oily sludge contains harmful substances such as benzene compounds, phenols, and heavy metals and is classified as hazardous waste under Chinese law. If not treated properly and in a timely manner, it can cause severe pollution to soil, water, and the atmosphere, posing significant risks to human health [2,3].

Incineration technology cannot only carbonize all harmful substances but also significantly reduces the volume of oily sludge and shortens its treatment time [4–6]. In addition, the heat generated from incineration can be harnessed for power generation, making it the fastest and most effective method to achieve the reduction, harmless and recycling of oily sludge. Due to the high content of heavy metals in oily sludge, during the incineration process, heavy metals are released into the air along with fly ash, or will exist in the incineration bottom ash in unstable form, and eventually be converted into more toxic compounds, which contain lead, cadmium, and zinc [1]. If not properly managed,

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