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Desulfurization Wastewater Evaporation Technology: Field Test, Product Analysis and Potential Risk Assessment

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Extended Abstract

Desulfurization wastewater evaporation technology is an effective approach to achieve zero liquid discharge. However, limited information on the practical engineering performance and the evaporation product properties was a lack of awareness. In this study, we conducted a field test of desulfurization wastewater evaporation technology in a demonstration project. The results indicated that the technology was highly feasible and applicable to operating conditions with varying desulfurization wastewater flow rates. Maintaining the low moisture content of the evaporation product was crucial for successfully implementing wastewater evaporation, and exceeding a certain threshold may lead to issues such as wall sticking and blockage of the conveying pipeline. The moisture content of the evaporation product for operation conditions I, II, and III were 1.2%, 0.9%, and 0.7%, respectively, which could meet the engineering standards. The migration characteristics of chloride were investigated, revealing that less than 3% of Cl was released into gaseous HCl. The concentrations of other typical pollutants, such as NOx and SO_2, remained unchanged after treatment, indicating that the wastewater evaporation technology did not significantly affect the distribution of gaseous pollutants. For the influence of wastewater evaporation on comprehensive fly ash utilization, the chloride mass fraction in the final product was lower than 0.06%, indicating that it could meet strict regulations and would not affect comprehensive fly ash utilization. Moreover, the study found that the evaporation process promoted the agglomeration of particulate matter, as confirmed by larger particle sizes and XRD analysis. It may slightly promote the dust removal efficiency of the electrostatic precipitator due to the aggregation effect of fine particles and the enhanced specific resistance. In this study, the single droplet drying method and spray drying system revealed the evaporation characteristics and product properties. The wastewater droplet evaporation process could be divided into two periods: constant rate and falling rate in the evaporation process. Besides, a shell would form when the critical concentration was achieved on the droplet surface. Then, the inflation, rupture, and re-inflation stages would be involved in the history of shell evolution. The components of the evaporation product mainly consisted of $MgCl_2$, $CaCl_2$, NaCl, and $CaSO_4$. The total operating cost of wastewater evaporation ranged from 25 to 30 yuan per ton of wastewater, primarily consisting of coal consumption for extracting flue gas. The data obtained in this work complements and verifies existing research on wastewater evaporation technology. However, some potential risks and existing challenges of wastewater evaporation technology must be assessed. When the chloride content of the fly ash had more stringent requirements, installing a small bypass dust collector after the evaporation drying tower could be considered. By this means, all evaporation products were collected separately, avoiding any impact on the downstream equipment. Besides, the collected evaporation product could be mixed with the boiler slag, used in bricks and other industries that did not limit the chloride content or require low requirements to avoid the negative impact of wastewater evaporation products on the comprehensive fly ash utilization.