Online Monitoring of High-Temperature Corrosion in Solid Waste Incineration: From Laboratory Validation to Industrial Demonstration

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Abstract

Boiler tube failures due to corrosion can lead to significant energy and economic losses, highlighting the importance of clean and efficient solid waste combustion. Investigating the corrosion mechanisms of key components during high-chlorine solid waste incineration and conducting in-situ online corrosion rate measurements are crucial for ensuring the safe and stable operation of boilers. This study employed electrochemical online monitoring, known for its sensitivity and importance in early detection. It was used to explore the corrosion mechanisms of TP347h heat exchanger tubes under various temperature gradients on the high-temperature flue gas side. Firstly, laboratory experiments were conducted with metal surface temperatures set at 450°C, 550°C, 650°C, and 800°C, while maintaining the flue gas temperature at 800°C to simulate the temperature gradient inside the furnace, and using incineration fly ash as the corrosive medium. Corrosion rates between 450°C and 650°C peaked at around 48 hours and increased significantly from 550°C to 650°C, indicating the activation of corrosion reactions. At 800°C, corrosion rates decreased due to the formation of dense chromium oxide layers. SEM analysis showed elemental stratification (Fe, Cr, Ni), and XRF results suggested that Na and Cl stabilized at 800°C by forming high melting point compounds, thereby reducing corrosion.Thereafter, field tests were conducted in a full-scale circulating fluidized bed (CFB) boiler in China, lasting for approximately 20 days. The steam temperature was around 450°C and the sampling port temperature was around 800°C. Results showed that corrosion rates surged initially as corrosive agents rapidly accumulated and penetrated the metal surface, but gradually decreased and stabilized as surface temperature dropped with continued deposition. This study Introduced an online system for monitoring ash deposition and corrosion rates, offering valuable guidance for optimizing material selection and anti-corrosion strategies in waste incineration processes.

Keywords High-Temperature Corrosion; Solid Waste Incineration; Corrosion Online Monitoring; Chlorine Corrosion

Graphic abstract: