

DEVELOPMENT OF A CONTROL ALGORITHM FOR THE MUNICIPAL SOLID WASTE INCINERATION PROCESS IN AN INDUSTRIAL FURNACE WITH OPTIMIZED VALVE REGULATION

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Incineration of municipal solid waste (MSW) in industrial furnaces is an effective method for waste disposal with the potential for energy generation. However, the complexity of the process, encompassing combustion (CSP), flue gas treatment (FGT), steam production (WSC), and auxiliary processes (BOP), requires precise control to ensure energy efficiency and environmental safety [1]. This study aims to develop a control algorithm for the MSW incineration process in an industrial furnace based on a computer-integrated control system (CICS). The proposed algorithm focuses on key process parameters: combustion zone temperature, air supply, waste feed rate, and flue gas composition. It utilizes data from sensors monitoring these parameters in real-time during the CSP stage, combined with machine learning algorithms to predict variations in MSW composition. The algorithm incorporates an adaptive controller that adjusts air and fuel supply, maintaining temperature stability (deviation within 4%) and minimizing the formation of toxic compounds like dioxins. At the FGT stage, the algorithm optimizes reagent injection, reducing gas treatment costs.

Building on this algorithm, the study further optimizes the combustion section (CSP) by integrating valve regulation within the CICS. The process begins with the delivery of MSW from a bunker via a dosing device, where slide valves regulate the waste feed rate onto the grate, ensuring uniform loading (up to 500 kg/m²) and preventing furnace overload. In the combustion zone, waste is incinerated at 850–1000°C, facilitated by primary air supplied through valves beneath the grate (flow rate of 2–3 m³/kg of waste), supporting intense combustion of organic components. Secondary air, controlled by rotary valves above the combustion zone, is introduced for the afterburning of volatile compounds (flow rate of 1–1.5 m³/kg), reducing the formation of dioxins and furans. The heat generated is transferred to heat exchange surfaces, where water is heated to 400°C, producing steam at 40 bar for turbine operation. The CICS integrates these valves with the adaptive regulator, analyzing real-time data from temperature, pressure, and gas composition sensors (CO, O₂) to adjust valve positions [2]. This ensures temperature stability (deviation within 4%), reduces NO_x emissions by 15%, and increases process efficiency by 8%. The combined approach confirms the effectiveness of the developed algorithm and valve regulation within the CICS framework. Future research will focus on integrating the system with CO₂ capture technologies and automating valve regulation using IoT technologies.

References:

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