Influence of Stoichiometry and Mixing on NOx Reduction in Waste-to-Energy Plants

Abstract:
NOx emissions and their intermediate species NO, HCN, and NH3 have been investigated in an industrial waste-to-energy plant for the first time. Therefore, an innovative gas probe was designed accordingly to meet the challenging requirements of HCN and NH3 measurement. The N intermediates were measured in three different sample positions close to the grate. The highest concentrations were detected on the front side of the grate where the lowest local excess air ratio occurs. The NOx reduction potential, which is defined as the ratio of HCN and NH3 to NO, was above 1 during most of the relevant position sampling; hence, the selective high-temperature reduction does not seem to be a suitable technology for a further reduction of NOx emissions. The operating points investigated were conventional operation, flue gas recirculation (VLN-GM), air staging, and air staging with improved mixing. Conventional operation leads to emissions of about 450 mg/m³, which could be reduced to 200 mg/m³ by VLN-GM. Since the emissions are strongly dependent on the primary air ratio $\lambda_1$, they show an almost linear correlation. The pretreatment of waste by shredding stabilizes the combustion and simplifies NOx control. The lowest emissions (around 100 mg/m³) were achieved during air-staged
operation with additional air injection, due to improved mixing and the additional staging.