

# **Pyrolysis of Municipal Sewage Sludge to Investigate Char and Phosphorous Yield together with Heavy-Metal Removal—Thermodynamic Equilibrium Calculations**

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## **Abstract**

Thermodynamic equilibrium calculations (TEC) were employed to investigate the influence of original sewage sludge characteristics on the composition of sewage sludge-based chars intended for land applications. The study involved pyrolyzing sewage sludge from two wastewater treatment plants in Sweden at temperatures of 500, 700, and 900 °C, followed by analysis of the resulting chars. TEC, in conjunction with chemical fractionation, was used to simulate the composition of the chars at different pyrolysis temperatures and interpret experimental results. The findings revealed that phosphorus (P) was significantly retained in the chars across all temperatures for the municipal sewage sludge (MSS) samples. FactSage 7.3 software, together with novel TEC databases, GTOX and SGPS, was employed to perform the TECs. The modeling strategy focused on predicting P and inorganic compounds in the char residue, utilizing the non-reactive elements obtained from the chemical fractionation. The calculations were carried out under an inert atmosphere with an inlet gas composition replicating that of the pyrolysis process. The TEC results facilitated the investigation of the distribution of P-bearing compounds, char melting behavior, and the fate of P in the char. The study highlights the importance of thermodynamic equilibrium calculations in understanding char formation and provides valuable insights for the application of sewage sludge-based chars in land management practices.