

Investigations on release and fate of phosphorous species during co-gasification of sewage sludge with coal and wood

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Phosphorus is mostly mined from phosphate rock and 80% is globally used as plant fertilizer. Germany is almost completely dependent on the import of phosphorus. Since sewage sludge from wastewater treatment plants contains high amounts of phosphorous, it has to be recycled for the recovery of phosphorus from 2029 onwards according to the current German Sewage Sludge Ordinance to reduce this dependency and close the phosphorous cycle.

Against this background, several processes for recovery of phosphorous from sewage sludge, where phosphorous can be either organically or inorganically bound, or incineration ash, where phosphorous is mainly present as phosphates of iron, aluminum or calcium, are currently under development. Beside wet-chemical processes, carbo-thermal reduction is a promising option, where the phosphates react with silica and carbon at high temperature and very low oxygen partial pressure to form gaseous phosphorous, CO and slag. While for example an inductively heated reactor is used in the RecoPhos process [1] to minimize the oxygen partial pressure in the system, also a controlled release of phosphorous in a co-gasification process is under consideration. However, fundamental knowledge on the influence of boundary conditions, e.g. oxygen partial pressure, temperature and composition of sewage sludge and fuel, on the release and fate of phosphorous from several phosphorous compounds contained in sewage sludge is still missing.

Therefore, lab-scale gasification experiments were performed using molecular beam mass spectrometry (MBMS) for hot gas analysis to investigate the influence of aforementioned boundary conditions on the release of phosphorous. Furthermore, thermodynamic calculations using FactSage and the GTOX database developed by IEK-2 and GTT were conducted to predict the release and fate of phosphorous species under equilibrium conditions. Beside mixtures of sewage sludge and coal or wood, also mixtures of phosphorous compounds, selected ash minerals and coke or fuel were used to elucidate underlying mechanisms.

References

- [1] S. Arnout, Thermodynamics of phosphorus recovery, GTT Annual Workshop 2015, Herzogenrath,

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