

# **Model-Based Optimization and Pilot-Scale Validation of Phosphorous Recovery from Sewage Sludge**

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Phosphorus (P) is an indispensable nutrient in agriculture. To close the P cycles, P will have to be recovered during wastewater treatment in Germany by the end of this decade. In a NW-Europe Interreg project, several processes have been tested on pilot scale by partners from industry and research.

The PULSE process developed at the University of Liège was validated on pilot scale with sewage sludge from three wastewater-treatment plants. Since sewage sludge changes its properties during storage, the plant was operated at a total of three locations with fresh sludge from the wastewater treatment. The key point of the process, in addition to dissolving the P from dried sewage sludge, is the removal of heavy metals using reactive extraction. The operating parameters were in each case optimized for the respective properties of the sewage sludge with the aid of simulations. One of the plants delivered undigested sludge, the other two digested sludge with very different concentrations. The key point of the simulations is the thermodynamic description of the equilibria of speciation in the aqueous phase as well as during extraction and precipitation, considering different approaches to describe the non-ideality of up to concentrated systems. The optimized operating parameters were then experimentally realized and slightly varied in the pilot plant. Thus, by comparison between model and experimental results, it could be shown that, on the one hand, the model is able to describe the equilibria in the system well. On the other hand, the optimum operating parameters could be confirmed. The product obtained after precipitation was tested by project partners and showed good performance as fertilizer component in pot trials and could easily be incorporated into granulation of a commercial fertilizer recipe.

In the presentation, first the principles of the PULSE process, the pilot plant and the basics of the simulation are introduced. Then, it will be shown, how well the results from laboratory experiments and the pilot plant are comparing with the simulations. Special focus will also be given to the challenges operating the extraction, which included e.g. solids precipitation in the re-extraction step.