SPONTANEOUS AND DIRECTED ENVIRONMENTAL MINERAL FORMATION IN WASTEWATER TREATMENT TECHNOLOGY

BENYÓ, J.[1], HARMAN-TÓTH, E. [1,2], MÁRIALIGETI, K.[3], MIREISZ, T.[4] & WEISZBURG, T. G.[1,5]
[1] Department of Mineralogy, Eötvös Loránd University, Budapest, Hungary
[2] Eötvös Museum of Natural History, Eötvös Loránd University, Budapest, Hungary
[3] Department of Microbiology, Eötvös Loránd University, Budapest, Hungary
[4] Budapest Waterworks, Budapest, Hungary
[5] Department of Environmental Sciences, Sapientia Hungarian University of Transylvania, Cluj-Napoca, Romania
E-mail: bejubor@staff.elte.hu

During the activated sludge process combined with biological phosphorus removal, widely used in wastewater treatment plants, dissolved forms of phosphorus are converted into bound polyphosphate by microbes. In a further step of the sludge line, due to the conditions of the anaerobic digestion technology, the polyphosphate bound by the cells is again dissolved in the form of anions. After the digesters, the solubility of the ions in the solution decreases due to temperature decrease in the heat exchangers and pipelines connecting tertiary treatment steps, which can lead to the appearance of mineral precipitates. These crystallizing solids – environmental minerals – may cause technological faults and financially significant expenses to wastewater treatment plants. The reason for this is that the solids precipitating on the walls of the equipment reduce the efficiency of purification, by reducing the internal diameter of or clogging the pipes, finally resulting in the premature wear and tear of the equipment. This places a significant additional burden on the wastewater treatment plant and is clearly a detrimental phenomenon from both the economic and the environmental point of view.

Mineral deposits appearing in the equipment of wastewater treatment plants are a worldwide problem. In addition to Asian countries (LE *et al.*, 2021), this field has been increasingly studied in the last decades in Europe, such as Belgium (SAERENS *et al.*, 2021), Poland (NUMVIYIMANA *et al.*, 2020), and Croatia (BABIĆ-IVANČIĆ *et al.*, 2006), Spain or Germany (RUFÍ-SALÍS *et al.*, 2020) and Austria (MUYS *et al.*, 2021).

The aim of our research at a large wastewater treatment plant in Budapest (Hungary) is to reduce the appearance of these spontaneous mineral precipitates (mainly struvite, $NH_4Mg[PO_4]\cdot 6H_2O^{orthorhombic}$, and vivianite, $Fe_3[PO_4]_2\cdot 8H_2O^{monoclinic}$) by fine-tuning the parameters of the wastewater treatment technology (e.g., pH, temperature, amount of additives). A further aim is to enable the targeted precipitation of struvite in the right quality at a specifically designed technological point by accurately mapping the technological process, as struvite can also be an increasingly important agricultural phosphorus fertilisation product due to its high and lasting phosphate content.

Acknowledgment

This work is supported by the Cooperative Doctoral Program (KDP-2020/999840) granted by The Ministry for Innovation and Technology (ITM) from the source of the National Research, Development and Innovation Fund.

References

BABIĆ-IVANČIĆ, V., KONTREC, J., BREČEVIĆ, L. & KRALJ, D. (2006): Water Research, 40: 3447–3455.

LE, V., VO, D., NGUYEN, N., SHIH, Y., VU, C., LIAO, C. & HUANG, Y. (2021): Journal of Environmental Chemical Engineering, 9: 105019.

MUYS, M., PHUKAN, R., BRADER, G., SAMAD, A., MORETTI, M., HAIDEN, B., PLUCHON, S., ROEST, K., VLAEMINCK, S. E. & SPILLER, M. (2021): Science of the Total Environment, 756: 143726.

NUMVIYIMANA, C., WARCHOŁ, J., IZIZYDOR-CZYK, G., BAŚLADYŃSKA, S. & CHOJNACKA, K. (2020): Journal of the Taiwan Institute of Chemical Engineers, 117: 182–189.

RUFÍ-SALÍS, M., BRUNNHOFER, N., PETIT-BOIX, A., GABARRELL, X., GUISASOLA, A. & VILLALBA, G. (2020): Science of the Total Environment, 737: 139783.

SEARENS, B., GEERTS, S. & WEEMAES, M. (2021): Journal of Environmental Management, 280: 111743.