Description for the general public

The rapid increase in the number of Wastewater Treatment Plants (WWTPs) and more restrictive regulations on the quality of treated wastewater constitute the reason for a systematic increase in the amount of sewage sludge, the quality of which rarely meets environmental standards, thus contributing to an increase in the level of ecological risk. It is particularly important that sewage sludge, beyond the soil forming values and fertilizer properties, is characterized by a high level of enrichment in selected metals, including these particularly toxic to the environment. The presence of these pollutants in sewage sludge often results in the inhibition of the most important stage of its processing, namely biological anaerobic stabilization. Moreover, processes of sludge treatment, such as its thickening, dehydration and hygienisation, finally aimed to produce ecologically safe sludge - inadequately managed, can contribute to the increase of metal concentrations in sewage sludge. In other words, any change that improves the characteristic of the sludge may constitute a factor that significantly affects the total metals concentration and the way of their binding in the sewage sludge (chemical form of their occurrence). For the most environmentally safe and friendly methods of intensification of sludge anaerobic stabilization, the ultrasonic disintegration, currently can be distinguished (to which mainly stream of excess sludge is subjected). This process induces profound changes in the physicochemical characteristics of sludge, which have a beneficial impact on their processing, including the increase in biogas production (the renewable energy source - RES). On the other hand, any change in the sludge characteristics due to its disintegration, may contribute to an increase in the total concentration of some metals or to increase their bioavailability in sludge, after the stabilization process ends.

Therefore, the basic objective of the research project is to demonstrate that changes in the physicochemical characteristics of sewage sludge, in successive stages of its processing, in particular disintegration and anaerobic stabilization processes, cause changes in the way and strength of metals binding in sludge, and thus conditioning the level of ecological risk that these elements pose to the environment and living organisms, including humans. This problem particularly concerns metals that express both high bioaccumulation and biomagnification (e.g. Hg).

So far, no attempt has been made to make the balance sheet of the level of ecological risk posed by metals, in a function of sludge processing, which is a milestone for this project. The issues raised in the project are filling the gaps in the current state of knowledge, particularly with regard to sludge which are undergoing to ultrasonic disintegration prior to anaerobic stabilization process.

Implementation of the project's main objective will require analyzes of elemental sludge composition (Cd, Cr, Cu, Hg, Ni, Pb, Zn), collected from several WWTPs, using spectrometric techniques (ICP-OES and CVAAS). The project will include both conventional WWTPs (traditional technological line), as well as those additionally using ultrasonic disintegration of excess sludge (urban - industrial catchment area). Research will be conducted throughout the entire sludge processing line. This will allow for the identification of mechanisms and factors that may influence the changes in the total content of metals in sewage sludge and transformation of their chemical forms. To demonstrate the significance of differences in the total content and way of metals binding, depending on the characteristics of sludge, i.a. correlation matrix and variance analysis, will be used. Based on the calculated risk indices, a comprehensive multidimensional balance sheet analysis of the level of ecological risk, posed by the metals and resulting from the characteristics of the sludge, in the successive stages of their processing, will also be made. In addition, demonstrating the influence of the sonication phenomenon on increase of metals mobility contained in excess sludge will provide the basis for the development of new a (author’s) indicator of disintegration. To identify the chemical forms of metals in the sewage sludge, the modified extraction procedure by Community Bureau of Reference (BCR), will be used.

The study will provide a completely new knowledge about the factors and mechanisms affecting the total contentration of metals and changes their chemical forms in the sewage sludge, in the successive stages of its processing. The results will be important for the science development and broaden of knowledge in the field of environmental protection, prior to its secondary pollution of sewage sludge components. The implementation of the project, in the future, will allow using the knowledge of chemical forms of metals occurrence in the sewage sludge, to assess the degree of their harmfulness to the water and soil environment, which is important in choosing the optimal method of their disposal (especially in the context of eliminating secondary soil contamination).