HUMILAT COMPO TECHNOLOGY FOR URBAN WASTEWATER TREATMENT FACILITIES AND FURTHER SLUDGE UTILIZATION

The most economical and widespread method for wastewater treatment of organic and non-organic anthropogenic toxic substances (oil products, pesticides, surfactants, heavy metals, chemical warfare detoxification products) has led to a new ecological problem – necessity to find a way to neutralize excess sludge and heavy metal deposits (copper, lead, chrome, arsenic, mercury, zinc, etc.), their high concentrations do not allow to use sludge and residue in agriculture.

The main method of neutralizing sludge and residue in the world is still burial in sludge receivers. About 300-450 thousand tonnes of residue per year on average are produced by wastewater treatment plants located in large cities with several million people and require an area of about 8-10 ha for their burial. The polygons should be located at a distance of 50-60 km from the wastewater treatment plants. Most often the large cities do not have such sites suitable for waste disposal, but the closest suitable areas are located at a distance of 100-150 km.

Notwithstanding the external attraction, the most generally known-methods of neutralizing excessive active sludge contained in heavy metals (thermal and/ or thermochemical treatment) are ecologically unsafe as they more or less pollute the atmosphere as well as they require complicated systems for purification of gas emissions from pollutants and for secondary treatment of sewage. These methods do not provide the utilization of useful organic substances found within sludge for replenishment of humus amount in soil, although humus losses in the top horizon of soil have reached 25 to 56% over the last 100 years in various regions. Other methods of heavy metal removal from sludge have not been practically used in wastewater treatment plants.

In accordance with the set goal the following was carried out:

- the regularities of heavy metal accumulation in active sludge components (biological, organic and non-organic) were researched and the heavy metal binding forms in active sludge were found in the process of biological treatment of sewage;
- the mechanisms of heavy metal accumulation in active sludge components were found as well as the mechanisms opposite to this process (heavy metal recovery from active sludge components);
- it was clarified that low soluble calcium (magnesium) salts (natural as well as technogenic origin) could be used in removal of heavy metals from the excess active sludge.
- method has been substantiated and developed for recovery of heavy metals from real industrial sludge which is based on the principle of trend change in processes taking place in the system ‘’sludge-calcium material’’ and does not include utilization of high temperatures, as well as treatment with acids or alkaline agents;
- mechanisms have been determined for the main forms of metal binding in aerobically stabilized residue and recovery of heavy metals from aerobically stabilized residue;
- ostensible constants were determined for stability of humic acid complexes extracted from sludge;

- approaches were elaborated for development of prognostic models with regard to the process where the recovery of heavy metals form sludge and residue took place by using various individual or mixed calcium materials.

Implementation of the developed technology will allow to reduce environmental pollution significantly in areas of sewage sludge and will create preconditions for utilization of active sludge as agricultural fertilizing agent after its composting with aerobic stabilization method. The technological instruction and regulations are elaborated for the product (biocompost) obtained as the result of active sludge composting.

The active sludge produced by biological treatment facilities comprise three components – biological, organic and non-organic. Each of them is capable to bind heavy metal ions from water environment. The most part of metal in untreated sludge is located in the organic component of the sludge at conditional solid phase. The high N content and H/C, O/C, N/C atom relation suggests the presence of functional groups containing aliphatic amines in sludge. The main components of sludge are polysaccharides and monosaccharides – 26%, amino acids and protein-like substances – 28%, lipids – 17%, non-organic compounds – 28 – 30%. It is found that the main role in metal binding is played by protein molecules and humic-like substances as well as the mineral components in sludge – silicates and aluminosilicates. The heavy metals are concentrated at sludge solid phase in the form of ions, in the form of soluble and insoluble complex compounds with non-organic or organic ligands, as well as in the sorbed form on clay minerals and humic substances by means of ion mechanism. The heavy metals are related with the functional groups of humic acids and other sludge organic components by means of complex creation mechanism and other sludge organic components and are contained in the structure of plants as well as microorganisms. The heavy metals are an integral part of sludge mineral phase (clay mineral, iron, aluminium oxide and hydroxide, calcium and magnesium carbonate).

The chemical analysis of aerobic stabilized residue and sludge deposits has shown that it is identical to the chemical composition of excess sludge in general, only certain parts of components differ. This allows to conclude that the metal binding mechanisms in stabilized deposits will be analogic to the described mechanisms for metal binding in excessive active sludge components.

The main regularities of heavy metal recovery from water suggest an option to change the process direction by applying the agent humilat compo. The heavy metal recovery from excess sludge by adding materials containing calcium to the system, occurs due to:

1) ion exchange (from compounds, in which metals are bound with organic substances and other sludge components in accordance with the ion exchange principle);

2) replacement reactions (from compounds, in which metals are bound with sludge components in accordance with the complex creation mechanism);

3) peptization process where the metals related to protein-like substances pass into sludge water phase;

4) disarrangement of the balance between the metal complex and the mineral components of the active sludge at conditional solid phase. The mineral regeneration from aerobically stabilized residue occur not so actively due to reduction of balance in metals related to organic matter and other residue components by means of ion exchange mechanism and increase in the proportion of metals which create stable compounds and are contained in silicate and aluminosilicate structure.

The physical and chemical conditions (pH, T, C), the duration, the added amount of humic fertilizer humilat compo determine the performance and speed of heavy metal recovery process from active sludge. It was found that 1 hour was sufficient in order to ensure the required recovery level by mixing the system ‘’sludge – humic fertilizer humilat compo’’ with air. The remaining concentrations of heavy metals in the treated residue depend on the initial content in the total mass of residue, the form of their combination in residue, the reactant dose as well as physical and chemical conditions.

A method is offered to compact the excess sludge during settling down by adding the fertilizing agentr humilat compo and mechanically mixing them. This allows to reduce moisture by 13% if settling lasts 60 minutes, as well as reduce the residue amount on filter presses by 2,7-3 times. The mix ‘’sludge – humilat compo’’ with air ensures the separation of the organic component from water phase, due to which the settling time is reduced to 30 minutes and the released volume of water phase increases by 55-65%. The amount of sludge, which needs further dehydration, decreases by 2,2-2,9 times. By adding calcium materials, it is possible to reduce residue and sludge dehydration costs.

Adding humic acids to the system will accelerate the electrocoagulation process and improve the performance of residue deposition. Taking into account the small amounts of the water phase, in comparison of the water amounts subjected to the biological treatment, the opportunity exists to recover 90-95% of heavy metals by reversing the water phase to the start of the cycle, which may be cost effective.

A method is developed allowing to reduce the amount of heavy metals in the excess sludge and aerobically stabilized residue to the minimum level, which does not exceed certain rates for residue allowed to be applied in agriculture. The processes take place under normal temperatures and in open tanks, their duration is short, expensive agents are not utilized. This method may be implemented into the existing biological treatment facilities maximally utilizing already existing facilities. It does not require large capital investments, but it can expand the functions of facilities. The quality of neutralized aerobic stabilized residue complies with the regulatory requirements.

It is advantageous to use the deposited sludge as soil to build green roads, streets and technical fields.