

Interactions in Natural Colloid Systems “Biosolids” – Soil and Plant

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The “biosolids” are complex biocolloid system arising in huge amounts (mln tons per year) from biological municipal wastewater treatment. These contain clusters of nanoparticles of heavy metal compounds (in slightly soluble or insoluble forms, such as phosphates, sulphates, carbonates, hydroxides, and etc.), cells, humic substances and so on, involved in exopolysaccharides (EPS) net matrix. One may consider that biosolids are the natural nanocomposite. Due to the presence of nitrogen, phosphorus, potassium and other macro- and microelements (heavy metals), vitamins, aminoacids, etc., the biosolids are a depot of bioelements for plant nutrition. Thus, it is generally recognized that most rationally to utilize them for land application.

For this purpose the biocolloid process was developed in biosolids system by initiation of microbial vital ability followed by the synthesis of EPS, propagation of ecologically important microorganisms, loosening of the structure and weakening of the coagulation contacts between biosolids colloids, but the structure integrity maintaining [1,2]. It was demonstrated that the applying of biosolids with metabolizing microorganisms to soil provided the improving soil structure, namely the increasing of waterstable aggregates content (70% vs. 20%). It occurs due to flocculation ability of biosolids EPS. The experimental modelling of mutual interactions in systems of soils – biosolids (with metabolizing microorganisms) were realized and their colloid and chemical mechanisms were formulated [3].

As it is known, the most harmonious plant growth comes at a prolonged entering of nutrients under the action of plant roots exudates which include pool of organic acids and polysaccharides [4]. Special investigations showed that under the influence of exudates excreted by growing plants, the biosolids microelements can release gradually from immobilized state into environment and are able to absorb by plants. Thus, the biosolids can serve as an active component of soil substrate.

Soil enrichment with biosolids nanocomposite resulted in an improving of its structures, a faster growth of plants and substantial harvest increase, as compared with control (unfertilized) soil.

1. Kalinichenko KV, Nikovskaya GN, and Ulberg ZR (2012) Bioextraction of heavy metals from colloidal sludge systems. *Colloid Journ.* 74(5): 553–557.
2. Kalinichenko KV, Nikovskaya GN, and Ulberg ZR (2013) Changes in the surface properties and stability of biocolloids of a sludge system upon extraction of heavy metals. *Colloid Journ.* 75(3): 274–278.
3. Nikovskaya GN, et al (2006) The influence of different reclamation agents and microorganisms on the aggregative stability of the colloidal fraction of meadow chernozem soil. *Colloid Journal.* 68 (3): 345–349.
4. Dakora FD, Phillips DA (2002) Root exudates as mediators of mineral acquisition in low-nutrient environments. *Plant and Soil.* 1: 35–47.