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ABSTRACT

DOCTORAL THESIS

**CHEMICAL PROCESSING OF SEWAGE SLUDGE  
WITH A VIEW TO THEIR AGRICULTURAL USE**

DETERMINATION OF THE EFFECTIVENESS OF METHODS OF  
HYGIENIZATION OF MUNICIPAL SEWAGE SLUDGE IN TERMS OF ITS  
AGRICULTURAL USE, TAKING INTO ACCOUNT THE PRESENCE OF  
SELECTED POLLUTANTS IN IT.

Current times are forcing us to increasingly focus on production based on the sustainable use of raw materials, creating a closed-loop economy. Emerging new technologies are orienting themselves toward the use of an increasing waste stream. Declining fossil resources and the cost of extracting them are also a factor significantly influencing the development of technologies that use waste from various sources. One such waste is municipal sewage sludge, which is produced in the wastewater treatment process and carries with it many nutrients for plant crops. Unfortunately, in view of the general increase in environmental pollutants and microbiological hazards, the direct use of sewage sludge is a major threat to the environment and, through the migration of pollutants to plants, also to human life and health. This paper presents the results of a study to evaluate the effectiveness of the conducted hygienization process of municipal sewage sludge carried out by two methods. Both methods meet the basic requirement for their further use in agriculture, i.e. they eliminate the biological hazard present in sewage sludge. The first method is the hygienization process carried out by treating municipal physically dewatered sewage sludge with calcium oxide, it allows to effectively obtain hygienized sewage sludge in accordance with current requirements. The second method studied is the method of treating sewage sludge with magnesium oxide followed by

sulfuric acid, in this method the product of the exothermic reaction is magnesium sulfate, and the temperature obtained is sufficient to achieve hygienization of sewage sludge. The effect of both methods was intensified by using peroxodisulfate. The research carried out concerned the evaluation of the effectiveness of removal or reduction of the amount of pollutants that are components of sewage sludge, and that affect its further management in the wider agriculture. The studies included: non-steroidal analgesics and anti-inflammatory drugs, polycyclic aromatic hydrocarbons, heavy metals and so-called microplastics. After analysis and literature research, diclofenac was chosen as a drug representative of non-steroidal analgesics and anti-inflammatory drugs, as it is difficult to remove and commonly used. Four polycyclic aromatic hydrocarbons were studied: anthracene, benzo[a]pyrene, phenanthrene, pyrene. Among the heavy metals, metals were selected, the maximum concentrations of which in agricultural products were determined by the Regulation of the European Parliament and of the Council (EU) 2019/1009 of June 5, 2019, effective from July 16, 2022. To study the effect of hygienization on microplastics, polyvinyl chloride was used as the polymer representing this group of pollutants. The conducted tests showed greater effectiveness of hygienization carried out with magnesium oxide and sulfuric acid, and the additional use of PDS, resulted in almost complete decomposition, used for testing PAHs and drugs (diclofenac). Both methods failed to significantly reduce the microplastic contained in the test material. Laboratory and semi-technical scale tests were carried out, confirming the results of the work. The final stage of the conducted tests was to obtain fertilizer granules with physical parameters that do not differ from market products.