Assessment of digestate treatment using physicochemical processes and activated sludge method with dosing of external carbon source

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Abstract

The development of a low-emission economy and restrictions on the use of non-renewable resources contribute to the increased interest in anaerobic digestion as a method of waste processing and green energy production. The growing number of biogas plants results in the generation of large amounts of digestate, the rational management of which is a serious challenge. The current way of using it, i.e. soil application, is associated with many problems. Therefore, it is necessary to look for alternative methods of processing post-fermentation residues.

This doctoral thesis presents the results of research carried out in cooperation with Südzucker Polska S.A., aimed at developing a treatment technology of digestate obtained from a biogas plant fed with sugar beet pulp using the activated sludge method, as well as physicochemical processes, i.e. ultrasonication, ozonation and membrane filtration.

The conducted research determined the operational parameters of the mechanical separation of digestate. It was also established that the digestate liquid fraction can be effectively treated using activated sludge in a system with a separate denitrification chamber. It was shown that the type of external carbon source and the COD/TN ratio have a significant impact on the structure of the activated sludge microbial community, the number and activity of bacteria belonging to its functional groups, and thus on the rate of denitrification and nitrification processes. It was found that flume water can be applied to intensify the biological treatment of the digestate liquid fraction. The removal efficiency of total nitrogen, ammonia nitrogen and organic compounds determined using this external carbon source and the COD/TN ratio of 11.2 averaged 85.18, 99.59 and 88.48%, respectively. Among the tested physicochemical processes, the highest reduction of total nitrogen, ammonia nitrogen and organic compounds concentration, amounting to 61.20, 63.18, 92.05%, were noted during ultrafiltration supported by biocoagulation with the addition of chitosan. The obtained results indicate that digestate treatment with physicochemical and biological methods may be an alternative to its management in periods when it cannot be used in agriculture.