Seasonality in sewage sludge dewatering

M. Hyrycz[1,2], M. Ochowiak[1], M. Pielach[2], A. Krupińska[1]

[1]Department of Chemical Technology and Engineering, Poznan University of Technology, Poznan, 60-965, Poland
[2]Aquanet S.A., Poznan, 61-477, Poland
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Presenting author's email: marek.ochowiak@put.poznan.pl

Municipal sewage sludge may be used if it has been stabilized and prepared appropriately for the purpose and manner of its use. This can be achieved by subjecting it to biological, chemical and thermal treatment, or to any other process that reduces its susceptibility to putrefaction and which eliminates any threat to the environment or to the life and health of people. Due to, e.g. the tourist character of a region, seasonal changes may result in an increase in the share of sewage from drainless tanks in relation to the amount of sewage flowing through the sewage system. A large share of sewage delivered in the summer months in relation to the amount of the so-called fresh sewage flowing into the network can contribute to disturbances in technological processes, and can also have a negative impact on the efficiency of treatment.

Microorganisms are used in the process of biological wastewater treatment. Their diversity depends on the quality of the inflowing wastewater and the conditions of the process, e.g. age of sludge, oxygen concentration, sludge recirculation rate, and used chemicals. The same parameters affect the quality of sewage sludge, including its rheological properties, the presence of pathogens and heavy metals, the degree of odor nuisance, and its susceptibility to dehydration. The costs of sludge management can account for up to 50% of the total operating costs, which is why it is so important to obtain an appropriate quality of produced sludge. The temperature of the wastewater that reaches a treatment plant depends on the air temperature. The lower the air temperature, the lower the wastewater temperature, and therefore there is a reduced metabolic rate of activated sludge's microorganisms (Zhu and Chen, 2002). In order to maintain an appropriate efficiency of the nitrogen removal process in winter, it is necessary to increase the concentration of activated sludge in bioreactors. In spring, when the sewage temperature increases, excess amounts of sludge are removed from the system as excessive sludge. A lower temperature has been shown to increase the production of extracellular polymer compounds (EPS) (Wang et al., 2010). An increase in the EPS concentration may reduce the dewaterability of sewage sludge (Sheng et al., 2010), and also increase the consumption of flocculants (Hyrycz et al., 2022).

According to the analysis of the literature, seasonality can play a significant role in sludge treatment. The seasonality of the incoming sewage is a phenomenon that significantly affects the operation of sewage treatment plants. This phenomenon is related to the intense supply of incidental water to the sewage network, such as rainwater, water from melting of the snow cover, or infiltration water. Intensive inflow of external water at particular times of the year can lead to the hydraulic overload of the sewage treatment plant, resulting in the disturbance of the processes of its operation (Młyńska, 2014). Land application of municipal sewage sludge has become an attractive option and disposal method used worldwide. Hence, the suitability of the sludge with regards to toxic and carcinogenic chemicals is crucial to prompt informed decisions regarding its use on agricultural areas (Yakamercan et al., 2021). Seasonal variation of endocrine disrupting compounds, pharmaceuticals and personal care products in wastewater treatment plants is observed (Yu et al., 2013). Seasonal variation of the compounds' concentration in the wastewater was significant: the total concentration of each compound in the wastewater was higher in winter than in summer, which is attributed to more human consumption of pharmaceuticals during winter and faster degradation of the compounds in summer.

The aim of this research is to assess the effect of the temperature of inflowing sewage on the degree of sewage sludge dehydration and the consumption of flocculant in a sewage treatment plant (on a full scale). Data from October 2016 to September 2022 from a sewage treatment plant with a size of 42,000 PE located in western Poland was analyzed. The following number of measurements were used for the analysis: sludge dry mass $n = 1757$, flocculant dose $n = 1810$, inflowing sewage temperature $n = 2191$. The obtained mean values and standard deviations are presented in Figure 1.

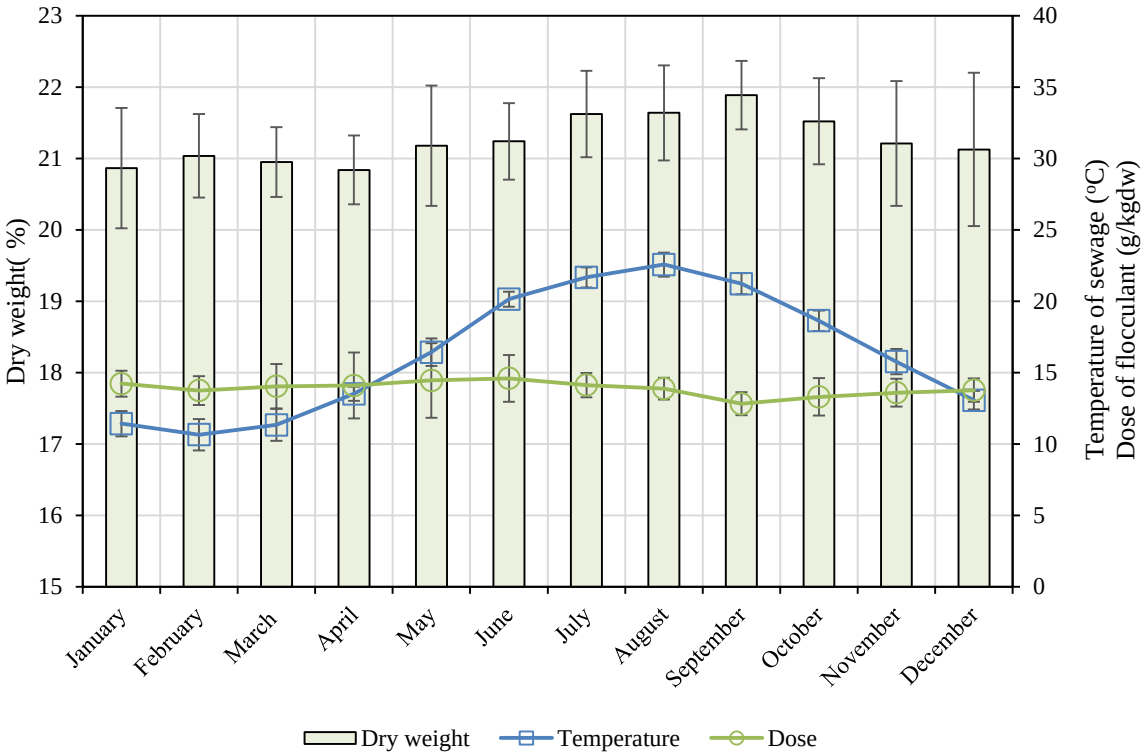

Figure 1. Average values of the dry weight of the cake, waste water temperature, and flocculant dose.

Based on the obtained results, it was found that the highest degree of excess sludge dewatering is obtained in the summer at a wastewater temperature of above 20°C. The greatest variability in the flocculant dose occurred in spring. With an increase in wastewater temperature, a decrease in the required dose of flocculant was also observed. The lowering of the degree of sludge dewatering in the spring period may also be caused by the need to reduce the concentration of activated sludge in biological reactors, and therefore by the occurrence of an increased load on dewatering devices. It was observed that the temperature of the inflowing sewage has a relatively low monthly variability.

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