The influence of the place of flocculants dosing on the efficiency of the decanter centrifuge

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Introduction

Separation processes are widely used in the treatment of industrial and municipal wastewater. They are used to concentrate and dewater the resulting sludge, the processing and management of which constitutes one of the main costs of operating the facility (Zhou et al., 2020). Their development usually takes place at a considerable distance from the place of their production. The concentration of excess and digested sludge produced is approximately 2 - 6% of dry matter. In order to reduce transport costs, sewage sludge must be concentrated and dewatered using e.g. decanter centrifuges. Due to the physicochemical characteristics of sewage sludge, to obtain high efficiency of the separation process, it is necessary to perform flocculation with chemical agents - polyelectrolytes (Wei et al., 2018). These are long-chain polymer compounds with an electrostatic charge, causing particles to join together to form flocs. After the mechanical dewatering process, sewage sludge has a moisture content of 70-80%, which is why it is important to continue research to optimize this process. The flocculation stage and the type of flocculant significantly affect the overall efficiency of the process. It has been shown that the use of sludge preflocculation can improve the efficiency of a decanter centrifuge (Demoz, 2018). Due to the large number of influencing factors, especially the shear forces acting inside the device, the efficiency of decanter centrifuges is difficult to predict (Mailler et al., 2021). This paper presents the results of research on the influence of the place of polyelectrolyte dosing on the efficiency of the full-scale sewage sludge dewatering process.

Materials and methods

The tests were carried out at the Central Sewage Treatment Plant in Koziegłowy (Poland) using Gea Westfalia Separator UCD 536 decanter centrifuges. The cationic Flopam EM 840 MEB with a concentration of 0.4% was used as a flocculant. The tests were carried out simultaneously on two decanters DC1-2. The flocculant solution was dosed into DC1 immediately before the inlet to the device. The flocculant solution was dosed into DC2 through a four-inlet module approximately 10 m in front of the centrifuge. The installation diagram is shown in Fig. 1 below. During the tests, a stable flow to both devices was maintained at 30 m3/h. The suspended solids in the effluent were maintained at <800 mg/L and the torque was maintained at 50–55%. Digested sludge with a concentration of 3.2±0.1% dw, organic matter content 62±3% was fed into the decanters. The obtained dry weight of the cake was determined using a moisture analyser.

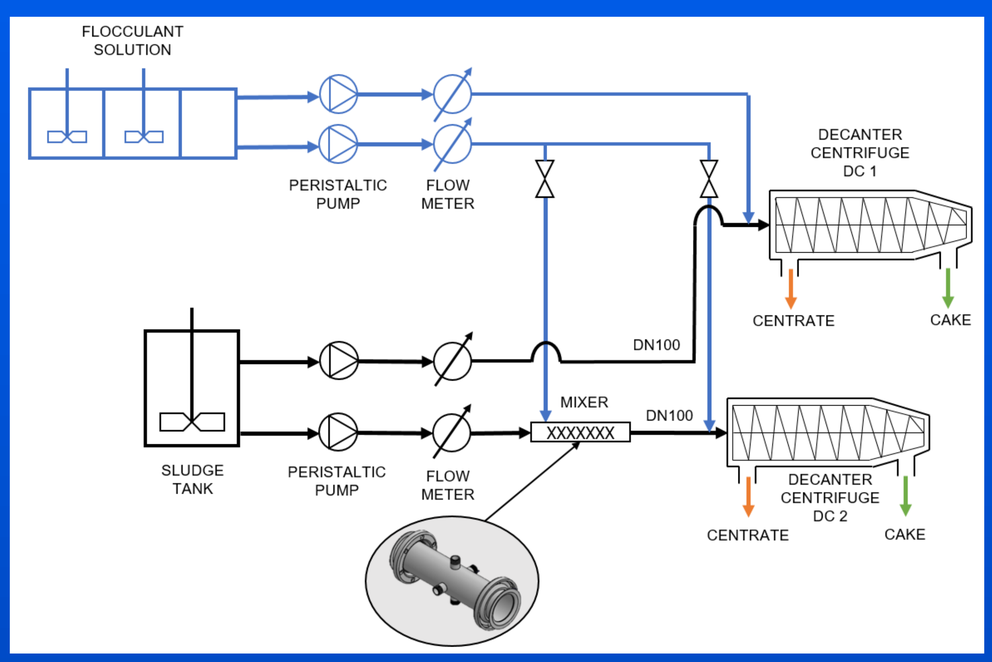
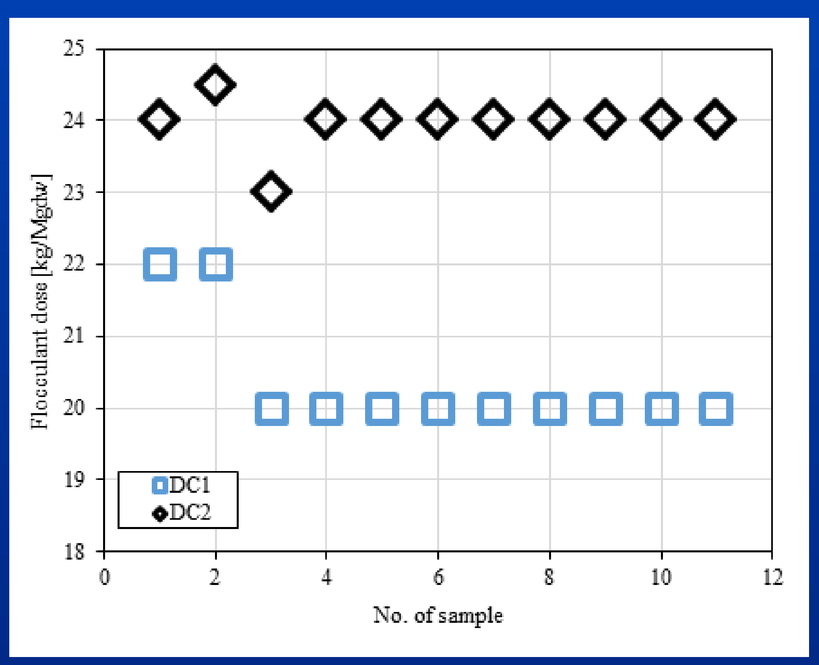


Figure 1. Process diagram.

Results & Discussion

The extension of the contact path of the polyelectrolyte with the sludge resulted in a decrease in the separation efficiency. In order to maintain the quality of the effluent, it was necessary to increase the polyelectrolyte dose (Fig. 2a). The contact time did not significantly affect the degree of sludge dewatering. The average degree of dehydration for DC1 was 23.3±0.9%dw, and for DC2 23.1±0.9%dw. Figure 2b below shows the obtained cake dry weight for both decanter centrifuges.



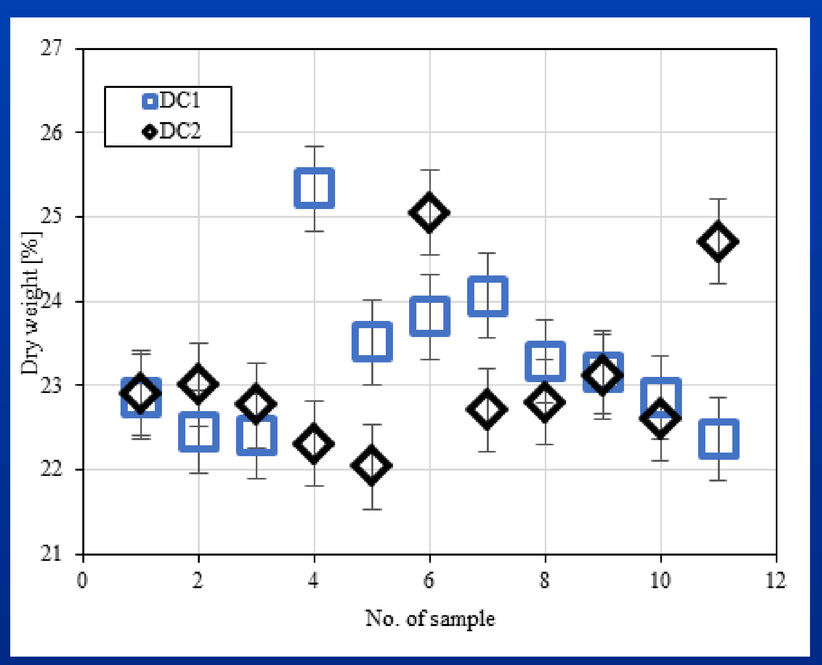


Figure 2. Exemplary results: a) flocculant demand, b) dry weight of cake.

Conclusions

Based on the research results, it was found that the place of polyelectrolyte dosing has a significant impact on the efficiency of sludge dewatering in decanter centrifuges. It has been shown that the use of preflocculation increases the required dose of flocculant by approximately 20%. There was no relationship between preflocculation and the degree of sludge dewatering. When designing the installation, the polyelectrolyte dosing point should be located as close as possible to the inlet to the decanter centrifuge.

In practical terms, these research insights hold significant implications for the design and operation of sludge dewatering installations. Engineers and designers should prioritize the positioning of the polyelectrolyte dosing point in close proximity to the inlet of decanter centrifuges when planning installations. By doing so, they can capitalize on the effective mixing of the flocculant with the sludge at an early stage, thereby maximizing the efficiency of the dewatering process.

In conclusion, the study's findings underscore the critical significance of the placement of polyelectrolyte dosing in enhancing the efficiency of sludge dewatering in decanter centrifuges. This insight should be integrated into the design and operational considerations of such installations to optimize the dewatering process and achieve improved overall performance.

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