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MAGNETIC AND CHEMICAL CONDITIONING OF SEWAGE SLUDGE

The influence of magnetic conditioning of sewage sludge on the final hydration, sewage sludge resistivity and capillary suction time was described. Sewage sludge samples were exposed to a variable electromagnetic field of varying values of the magnetic induction (0.01 and 0.03 T) and the exposure time (0–10, 0–20, 0–30, 0–40 s), and treated with polyelectrolytes (Renfloc 27484 and Praestol 624 BC). The results obtained reveal that magnetic conditioning of sewage sludge facilitates the process of dehydration of sewage sludge. The lowest value of a final hydration was achieved when the magnetic induction of 0.03 T at the exposure time of 10–20 s was applied.

1. INTRODUCTION

An increasing quantities of treated wastewater and implementation of more efficient treatment methods in wastewater treatment plants result in an increase in the quantities of sewage sludge. The methods of chemical conditioning used most frequently do not fulfil the obligatory requirements for maintaining the biological balance of the environment [1]. Therefore there is a strong need for implementation of reasonable methods and strategies for sewage sludge utilization and management [2].

The influence of magnetic phenomena on aqueous solutions has been investigated and explained in the literature. The impact of the magnetic field on such parameters as surface tension, viscosity or the effect of removal of salt crystals from aqueous solutions has been scientifically proved [3].

Due to a high degree of hydration sewage sludge exposed to magnetic field shows similar properties to water. The proposed method of magnetic conditioning of sewage sludge is currently in the stage of laboratory experiments and theoretical grounds for conditioning sewage sludge with the application of magnetic field are being established.

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This study of sewage sludge conditioning is one of the research projects adopted in order to apply unconventional methods in sewage sludge conditioning. Such conditioning has been carried out in the Institute of Environmental Engineering at Częstochowa University of Technology [4].

2. MATERIALS AND METHODS

The samples of digested sewage sludge taken from mechanical and biological wastewater treatment plants in Tarnowskie Góry and Częstochowa were investigated (the table).

Table

The parameters and properties of the sewage sludge investigated

Parameter	Unit	Tarnowskie Góry	Częstochowa
Colour/Odour	–	Grey-brown/Putrid	
pH	–	7.50	7.70
Dry matter	g/dm^3	22.0	18.0
Organic matter	g/dm^3	6.64	5.70
Mineral matter	g/dm^3	15.36	12.30
Initial hydration	%	97.80	98.20
Final hydration	%	82.92	87.33
Capillary suction time	s	1315	982
Resisitivity	m/kg	$1.7 \cdot 10^{14}$	$2.5 \cdot 10^{14}$
Electrokinetic potential	mV	–13.8	–24.9

The sewage sludge samples were exposed to a variable magnetic field in fixed time intervals (0–10, 0–20, 0–30, 0–40 s) and to magnetic induction (0.01; 0.03 T). Then, the samples were treated with the selected polyelectrolytes. The dosage of the polyelectrolytes was determined based on the test of capillary suction time. The following polyelectrolytes were used: Renfloc 27484 (5.4 mg/g dry matter) and Praestol 624 BC (2.2 mg/g dry matter). After physical and chemical conditioning the samples were dehydrated with a vacuum filter and a final hydration, the capillary suction time, resistivity, filtration velocity and efficiency were determined. The electrokinetic potential was determined in the supernatant liquor for each of sewage sludge sample in order to verify the conditions of free sedimentation. The pH of the supernatant liquor was also measured.

3. DISCUSSION

Due to an extensive range of experiments the paper presents the most significant diagrams illustrating the influence of a variable electromagnetic field on the resistivity, the final hydration and the capillary suction time.

Based on the changes in the parameters investigated (figure 1) we can conclude that 0–20 s time of the sludge exposure to magnetic field is considered the most advantageous. At the exposure time of 20 s all the values of the parameters investigated are lower than initial ones. Taking account of the initial values of the parameters of sewage sludge subjected to chemical conditioning only (Renfloc 27484 – dosage of 5.4 mg/g dry matter), it could be stated that magnetic field in the entire range of exposure time proved to be beneficial.

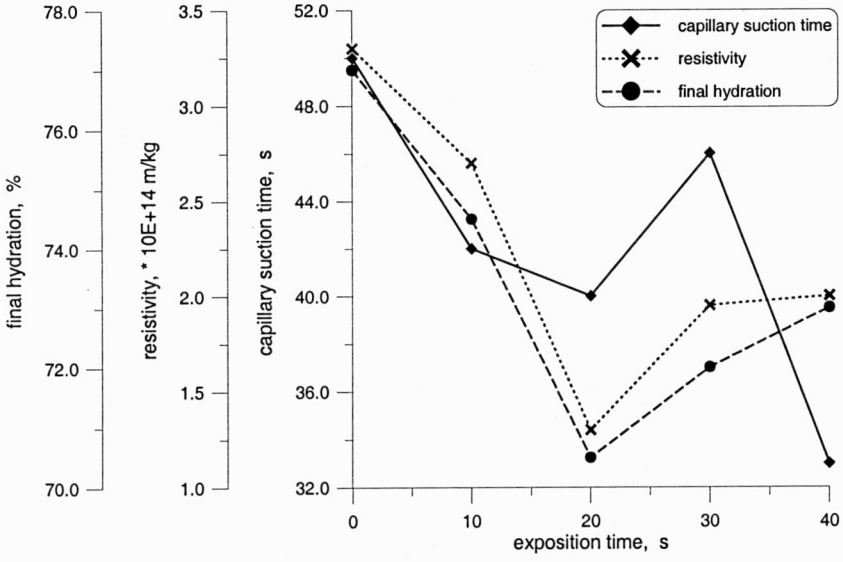

Fig. 1. Changes in the parameters of sewage sludge conditioned by exposing it to variable electromagnetic field with magnetic induction of 0.01 T and by treating it with polyelectrolyte Renfloc 27484 (dosage of 5.4 mg/g of dry matter)

In order to assess the efficiency of the magnetic field, only the value of magnetic induction was increased to 0.03 T. Figure 2 shows the changes in the investigated parameters of sewage sludge exposed to a variable electromagnetic field with the magnetic induction of 0.03 T. At the exposure time as short as 10 s all the values of the parameters investigated declined. At the exposure time of 10–20 s a final hydration as well as the resistivity reached their minima. The time of capillary suction also declined and its lowest values were observed at the exposure time of 30–40 s. The final dehydration was 8%.

For further experiments the samples of sewage sludge from the wastewater treatment plant in Tarnowskie Góry were taken. The Renfloc 27484 polyelectrolyte was replaced by Praestol 624 BC (dosage of 2.2 mg/g of dry matter). The selected results of the experiments are presented in figure 3. Except for the time of capillary suction, both the final hydration and the resisitivity values decreased during the exposure time of 10 s. However, with more significant decrease in the resistivity values sewage sludge dehydrated to a lesser extent.

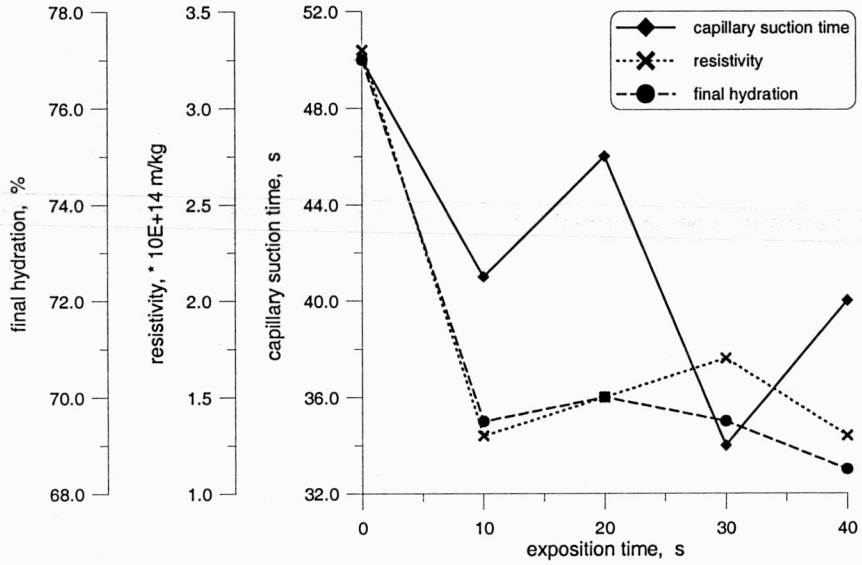

Fig. 2. Changes in the parameters of sewage sludge conditioned by exposing it to variable electromagnetic field with magnetic induction of 0.03 T and by treating it with polyelectrolyte Renfloc 27484 (dosage of 5.4 mg/g of dry matter)

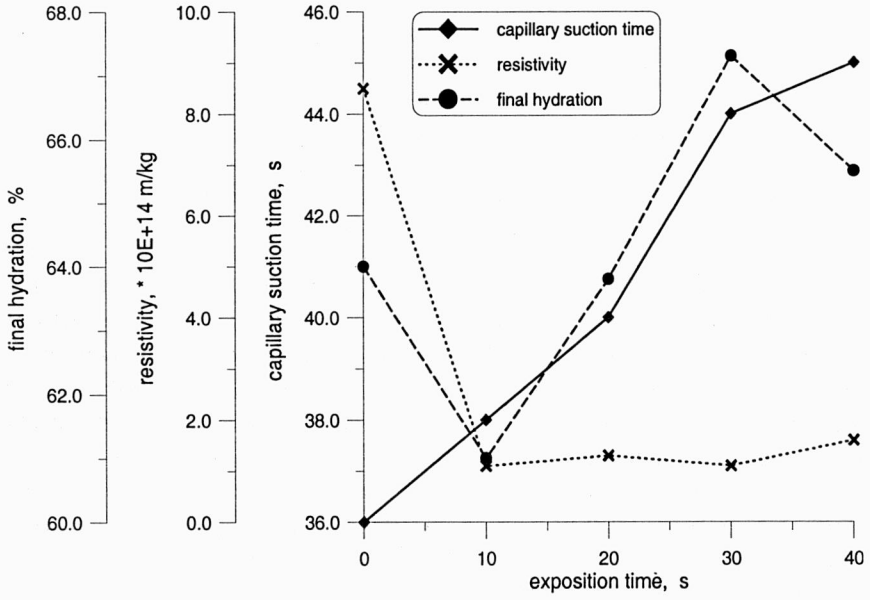

Fig. 3. Changes in the parameters of sewage sludge conditioned by exposing it to variable electromagnetic field with magnetic induction of 0.03 T and by treating it with polyelectrolyte Praestil 624 BC (dosage of 2.2 mg/g of dry matter)

4. CONCLUSIONS

Based on the results obtained the following conclusions can be drawn:

1. Magnetic field facilitated chemical conditioning of sewage sludge by reducing the dosage of the polyelectrolytes.

2. The time of exposure of sewage sludge to magnetic field influenced final hydration time, resistivity and capillary suction time. However, the optimal value of the exposure time is difficult to determine due to diverse values of sewage sludge parameters.

3. The final hydration of sewage sludge depended on the type of the flocculants applied and the exposure time with its most advantageous range of 10–20 s. The final hydration at the magnetic induction of 0.03 T was 8% and 3% for sewage sludge sampled from the wastewater treatment plants in Częstochowa and Tarnowskie Góry, respectively.

4. A higher value of the magnetic induction resulted in a shorter time of physical conditioning of sewage sludge.

5. The efficiency of magnetic and chemical conditioning of sewage sludge depends on its properties, in particular on its dehydration susceptibility.

LITERATURE

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MAGNETYCZNO-CHEMICZNA METODA KONDYCJONOWANIA OSADÓW ŚCIEKOWYCH

Badano wpływ magnetycznej metody kondycjonowania osadów ściekowych na ich uwodnienie końcowe, opór właściwy i czas ssania kapilarnego. Osady kondycjonowano zmiennym polem elektromagnetycznym o różnych wartościach indukcji magnetycznej (0,01 i 0,03 T) i różnych czasach ekspozycji (0–10, 0–20, 0–30, 0–40 s) oraz takimi polielektrolitami jak Renfloc 27484 oraz Praestol 624 BC. Z przeprowadzonych badań wynika, że zastosowanie magnetycznej metody kondycjonowania korzystnie wpływa na zmniejszenie uwodnienia badanych osadów. Wyższe wartości indukcji magnetycznej (0,03 T) oraz czas ekspozycji z przedziału 10–20 s powodowały ich najmniejsze uwodnienie końcowe.