The efficiency of the anaerobic hydrolysis process of thickened excess sludge

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Keywords: anaerobic hydrolysis, hydrodynamic disintegration, thickened excess sludge
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INTRODUCTION

The disintegration process involves the destruction of the flocculent structure of the activated sludge by the application of additional energy. As a result, the cell membrane is ruptured and compounds constituting the building blocks of activated sludge flocs, including dissolved organic compounds, are released into the sludge liquid Zielewicz, 2008.
Studies on the influence of sewage sludge pre-treatment on the improvement of anaerobic digestion effects have shown that the hydrolysis phase, due to the complex structure of the flocs and the hard cell wall, is the limiting and rate-limiting phase of the subsequent phases of the process, i.e. acidogenesis, acetogenesis and methanogenesis, and consequently the whole anaerobic digestion process Zhen et al, 2014. By intensifying the hydrolysis phase, it is possible to prolong the methanogenic phase of the process and thus significantly increase biogas production.
The aim of the experiment was to evaluate the efficiency of the anaerobic hydrolysis process of thickened excess sludge. In addition, it was examined whether it was possible to replace the process of anaerobic hydrolysis of sludge with the process of hydrodynamic disintegration.

MATERIALS AND METHODS

Characteristics of the substrate and disintegration apparatus
Thickened excess sludge (TES) (TS: 4.79÷5.44%) disintegration was conducted in a lab device containing a multi-use rotor driven by a motor with a power of P = 2.2 kW, motor speed: n = 2,800 rpm (patent no.214335), installed in a 10 L tank as described in detail in Zubrowska-Sudol & Walczak 2014. The experiment included the launch of 3 repetitions (R1, R2, R3), each with a different batch of thickened excess sludge. The disintegration process was conducted at five levels of energy density, namely 140, 280, 420, 560, and 700 kJ/L. The amount of energy used in the disintegration process is expressed as energy density (E_L) represented in kJ per 1 L of disintegrated sludge.

Anaerobic hydrolysis test
In order to determine the susceptibility of disintegrated sludge to hydrolysis and acidification processes, batch tests were conducted. The tests were carried out in continuously stirred reactors of 1 L volume for 7 days at a constant temperature of 20 °C. Both the disintegrated sludge, at every energy density level, and the sludge not subjected to the process of disintegration, underwent hydrolysis.

RESULTS

Table 1 Changes in the concentration of SCOD of the sludge depending on the energy density used in the hydrodynamic disintegration process

Repetition	Indicator	Raw Sludge	Energy density [kJ/L]				
			140	280	420	560	700
R1	SCOD [mg/O_2/L]	294	1605	6288	11 560	13 290	14 940
R2		422	1362	7085	11 952	17 220	19 320
R3		345	1756	5970	13 750	16 980	18 330

Table 2 Changes in the concentration of SCOD during the process of anaerobic hydrolysis of sludge not subjected to the process of hydrodynamic disintegration

Repetition	Indicator	Raw Sludge	Anaerobic hydrolysis time [h]						
			24	48	72	96	120	144	168
R1	SCOD [mgO_2//L]	294	1592	3496	3672	2724	2336	2436	2110
R2		422	2016	3852	2460	2178	2055	1530	1360
R3		345	393	373	466	434	610	1395	1254

The analysis showed that considerably higher SCOD concentration values were obtained after 48h of the process of anaerobic hydrolysis of raw sludge. For R1, the concentration value of dissolved COD was 2.2 times (SCOD=3496 mgO_2//L), and for R2 2.8 times (SCOD=3852 mgO_2//L) higher than the SCOD concentration values obtained at E_L equal to 140kJ/L in the repetitions. In comparison to energy density of 280kJ/L, however, values obtained after 48h of anaerobic hydrolysis of raw sludge were 1.8 times lower for R1 and R2, and as much as 16 times lower for R3. Moreover, in all the repetitions, SCOD concentration values obtained for E_L higher or equal to 280kJ/L were considerably higher than the SCOD concentration values obtained during the entire process of anaerobic hydrolysis of raw sludge. This suggests that the process of anaerobic hydrolysis of raw sludge should be conducted for a maximum of 48h.

CONCLUSIONS

1. The obtained results provide that it is possible to replace the process of anaerobic hydrolysis of sludge with the process of hydrodynamic disintegration.
2. The process of anaerobic hydrolysis of raw sludge should be conducted for a maximum of 48h.
3. Hydrodynamic disintegration can be an effective method of increasing the solubilisation and bioavailability of thickened excess sludge.

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