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RAPID ASSESSMENT OF ORGANIC LOADING RATE FOR A SEMI-CONTINUOUS ANAEROBIC DIGESTER

Abstract. This paper presents a mathematical model for analysis of biogas yield in a semi-continuous anaerobic digester. The main criteria for monitoring and evaluating the effectiveness of anaerobic digestion of different substrates in a semi-continuous anaerobic digester are the cumulative biogas yield and biogas production rate in a batch reactor. Different organic loading rates (OLR) for mono-substrates and their mixtures were analyzed for obtaining the maximum specific biogas yield in a semi-continuous digester.

Keywords: biomass energy; semi-continuous digester, organic loading rate, mathematical model, modified Gompertz model.

Introduction. Organic Loading Rate (OLR) is an important operational parameter which represents the biological conversion capacity of an anaerobic digestion system [1]. It is indeed a control parameter in semi-continuous systems. It has been established that the anaerobic digester runs inefficiently with low OLR, while with high OLR, there exists a risk of system failure due to overloading [2]. Researches in this area indicate that the methanogenic processes can be intensified by increasing the OLR and decreasing the hydraulic retention time (HRT) [3, 4, 5]. In [6] OLR increased 6 times during the digestion of olive mill solid residue. This led to an increase in the biogas productivity of more than 400%. According to literature data, the optimum OLR depends on the type of the substrate being digested, and on the total solids concentration of the substrate [3, 5, 7 - 12].

Even in modern anaerobic processes the OLR value greatly affects the performance of the digester [13-16].

Determination of the optimal OLR value for effective anaerobic digestion process in a semi-continuous digester is always based on long-term experimental studies [9, 17]. For example, in the PhD thesis of Hassan, the experimental study lasted 150 days in order to determine the yield of biogas from co-substrates with an OLR in the range from 1 to 5 kg $VS \cdot m^{-3} \cdot day^{-1}$ [3]. In study [18] two different concentrations of OLR (0.7 and 1.4 kg $VS \cdot m^{-3} \cdot day^{-1}$) were investigated to examine the effect of the change in the organic loading rate on the efficiency of the biogas production from grass and cattle slurry. The experimental study lasted 26 week. The feasibility of spent mushroom compost as a co-substrate in anaerobic digestion was investigated for 90 days [19]. 140 days of continuous experiment were required to assess the impact of OLR in the range of 1.0-5.0 kg $VS \cdot m^{-1}$ day^{-1} on the biogas yield [1].