Research of polystyrene floating material application parameters for wastewater treatment

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Abstract. The article reveals researches aimed to estimate if it is possible to intensify wastewater treatment processes by means of floating feed. There was a lab-scale experiment carried out in conditions of artificial wastewater treatment. Laboratory model to perform conventional treatment process was assembled and included aeration reactor and secondary clarifier. It is stated that optimal amount of floating material inside the reactors has to be no less 10% of volume; otherwise, it may not provide positive result. However, if this amount is higher than 30% of volume it may require higher costs. Three ratios were chosen for current lab-scale experiment: 10%, 20% and 30% of reactor volume. In this viewpoint there were four laboratory models in operation with three different amount of floating material inside. The fourth model has no floating media to compare the parameters of operation. The material in use is made of polystyrene to provide its floating ability and accumulation of sludge biomass. The samples of wastewater were investigated to according to the requirements of standard methods. Model with floating material provided 95% efficiency for BOD_5 removal and 83% efficiency of nitrogen removal, comparing to efficiency of 92% and 55% correspondingly in the model with no floating material.

Introduction

Strict regulation requires applied for pollutants concentration in treated wastewater requires the implementation of efficient sloutions. Moreover, in most cases provision of treatment quality has to be achieved under limited spaces and/or investments. That means in fact that every wastewater treatment plant may have certain possibilities for enhancement. Floating feed that may be inserted into the aeration tanks may be one of this possibilities. The research has an overall aim to assess if there is a positive impact of floating feed implementation for treatment of wastewater. The next step was to go deeper into the treatment process to describe how the removal of organic pollutions and nitrogen compounds goes in conventional treatment system. The research also had a slight touch over a possible economic efficiency that considered the amount of floating feed to be inserted and some operation parameters [1,2].

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Materials and methods

The research of floating feed application was performed in lab-scale conditions. There was a model of conventional treatment process (fig.1) applied that include aeration reactor and secondary clarifier. The aeration reactor was of a cylindrical shape with the following dimensions: inner diameter – 100 mm, height – 1000 mm; volume – 8 litres. The clarifier also had inner diameter of 100 mm and 2 volume of 2 litres. The described dimensions of lab-scale model were previously investigated to estimate the hydraulic similarity to real treatment tanks. The research was made on the artificial wastewater that was similar to domestic wastewater if main pollutants (BOD, NH4, and PO4) are considered. As the research was under preparation the optimal amount of floating feed inside the aeration reactor have to be determined, The minimum amount that might have positive effect is considered to be 10% to reactors' volume [3]. Maximum value is considered of 30%, otherwise application of floating feed may demand large costs [4].

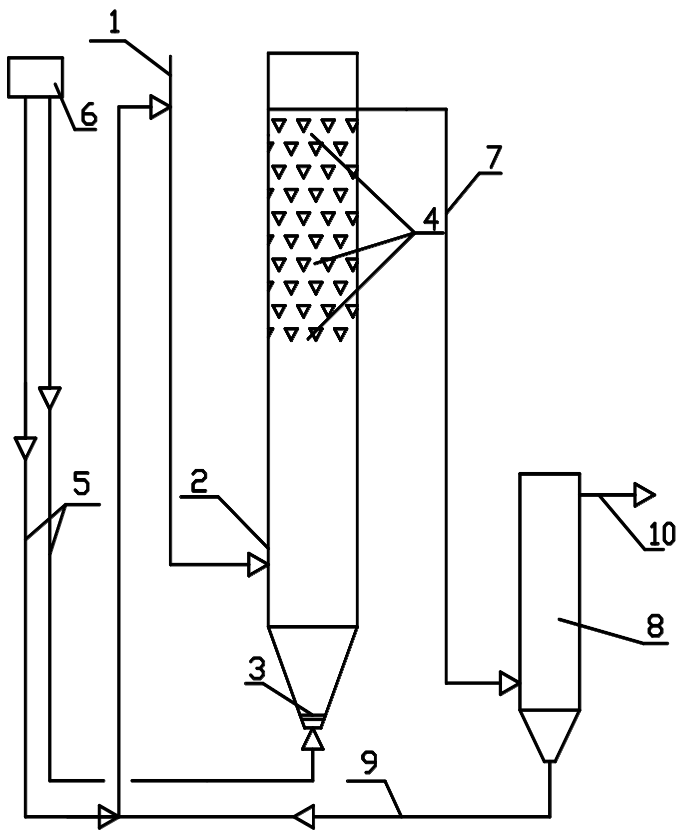

Fig. 1. Laboratory model: 1 – inlet; 2 – aeration tank; 3 – aerator; 4 – floating bed; 5 – air inlet; 6 – compressor; 7 – inlet of sludge mixture to secondary clarifier; 8 – secondary clarifier; 9 – recirculation of active sludge; 10 – discharge of treated water.

As literature review shows, the implementation of floating media for wastewater treatment is not fully investigated yet [5-8]. The research was aimed to define if any positive impact happen in case of floating feed application for wastewater treatment. In order to provide verified and comparative results there were several models launched with and without floating feed [9-10].

Within the research there were four lab-scale models launched – three models with correspondingly 10%, 20% and 30% amount of floating feed inside the aeration reactor and the fourth – with no floating media. Each of the model was working under the same operation mode: flow – 25 litres per day, hydraulic retention time – 8 hours; sedimentation time in clarifier – 2,5 hours.

A floating feed made of polysterene was chosen for the research, obtaining thr following characteristics: porous strips LxBxH 30x6x4 mm with unit weight of 22 kg per cubic meter and specific surface of 420 m^2/m^3 (fig.2).

Fig. 2. Polystyrene pieces

Results

The samples of wastewater to be analyzed within the research were taken manually. Investigation of samples was done according to standard instructions for the following parameters: BOD_5, suspended solids (MLSS), $P\text{-}PO_4$, $N\text{-}NH_4$, $N\text{-}NO_2$, $N\text{-}NO_3$ and dissolved oxygen. MLSS had an average value throughout the research of 1 g/l, dissolved oxygen concentration was kept around 2 mg/l. Average results for BOD_5, $N\text{-}NH_4$ and $P\text{-}PO_4$ are shown in the table 1.

Change of BOD_5, $N\text{-}NH_4$, $N\text{-}NO_2$ and $N\text{-}NO_3$ concentrations are shown on the diagrams on the fig.3-6.

Table 1. Average results

Amount of floating feed	Average values [mg/l]								
	BOD_5			$N\text{-}NH_4$			$P\text{-}PO_4$		
	In	Out	E [%]	In	Out	E [%]	In	Out	E [%]
10%	155	8	95	22,1	3,1	86	7,8	6,3	20
20%	161	8	96	21,2	3	86	7,8	5,8	26
30%	152	7,4	95	21,9	4,9	78	8,4	7,7	10
Control	154	12,9	92	22,7	10,1	55	8,6	7,6	12

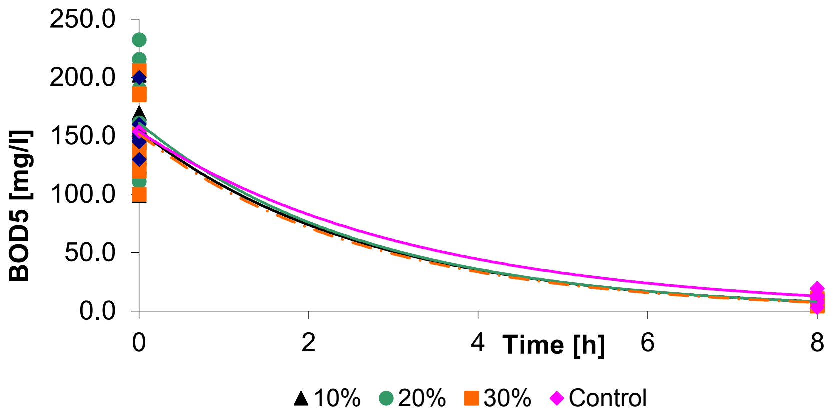

Fig. 3. BOD_5 concentration change

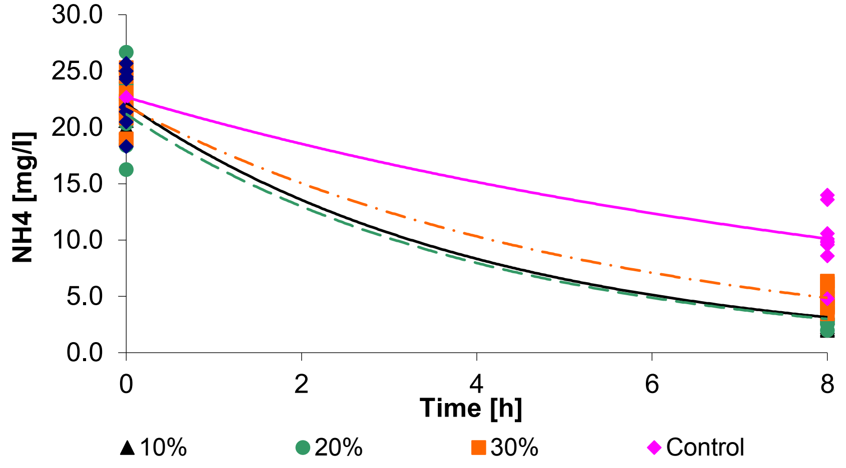

Fig. 4. NH_4 concentration change

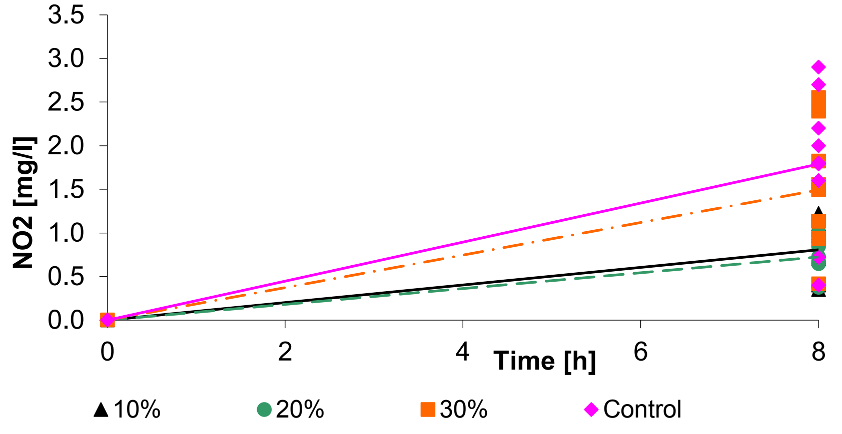

Fig. 5. NO_2 concentration change

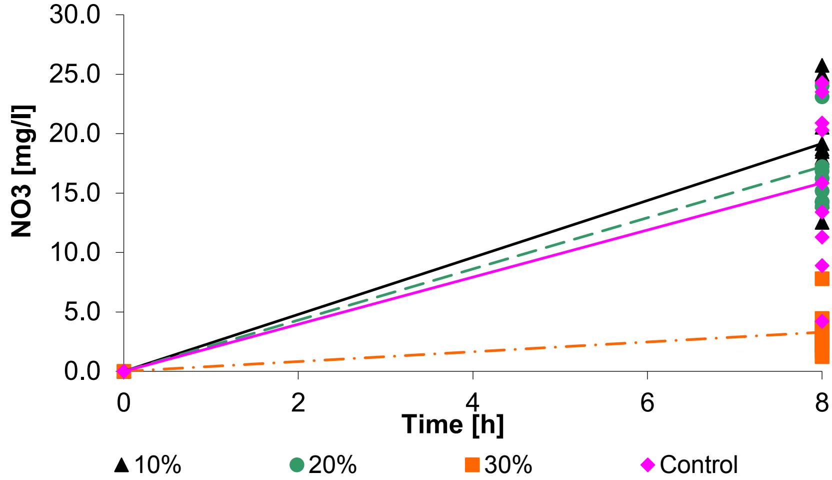

Fig. 6. NO_3 concentration change

Conclusions

1. All four lab-scale models showed equal results for organic compounds removal (BOD5) – 90-95%, however control model had poor results if ammonium removal is meant. That fact witnesses that floating feed application intensifies treatment processes.
2. Models with 10 and 20% amount of floating feed gave similar results both for BOD_5 (95-96%) and NH_4 (86%) removal. Phosphates removal was equal to conventional treatment (30%).
3. Lab model with 30% amount of floating media showed slightly worse efficiency, which may appear by possible secondary contamination due to excessive amount of biomass.
4. If model with 10 and 20% show similar results, amount of floating feed of 10% may be considered as preferable.

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