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APPLICATION OF NANOTECHNOLOGY FOR INTENSIFICATION OF WASTEWATER TREATMENT PROCESSES

Abstract: nanotechnology offers several benefits, and due to the unique features its popularity is increasing. Nanomaterials are currently being applied in a large scale of industrial and commercial fields, including wastewater treatment processes intensification.

Fixed Bed Biofilm Bioreactor with nanofiber textile as biomass carrier was employed to treat actual industrial wastewater coming from chloramines production. Nanofiber biomass carrier was verified in lab-conditions, and subsequently implemented into wastewater treatment plant to stabilize and intensify treatment efficiency.

Keywords: nanofibers, biomass carriers, industrial wastewater, intensification.

1. Introduction

Due to very high surface area nanomaterials act differently than bulk materials [1]. Nowadays, nanomaterials are being successfully used in a lot of commercial and industrial applications [2], including intensification of wastewater treatment processes. There are two options using nanotechnology to enhance wastewater treatment plant capacity. One is using membranes possess such properties limiting growth of microorganisms on its surface. The second option is use of nanofibers as biomass carriers. It enables microorganism's fixation, notably slow-growing ones removing hardly biodegradable compounds [3]. If nanofibers are used as biomass carriers, fast fixation and stable attachment of microorganisms occurs. . Due to fibers structure, better access of substrate and oxygen in inner layers of biofilm is ensured, and thicker layers are also involved in biodegradation. Carriers can be fixed to the support, so called Fixed Bed Biofilm Reactor (FBBR) or in motion -- Moving Bed Biofilm Reactor (MBBR). Bio¬film-based reactors have been successfully employed to treat different industrial wastewaters with hazardous con¬taminants so far [4]. Different materials and shapes of carriers have been tested to meet requirements for optimal features (i.e. stability, good adhesiveness, very high surface area) and to achieve high removal efficiency. All of them offer nanofibers; in addition, other properties can be adjustable by material characteristics.

This paper summarizes experiences with nanofiber biomass carriers used in full-scale FBBR. After lab tests, carriers were applied into WWTP. Upgraded

WWTP treats actual industrial wastewater mainly from chlora-mines (antimicrobial agent e.g. in food processing) production.

2. Materials and methods

Polyethylene fibers were used as scaffold for fixation of polyurethane nanofibers. Nanofibers were pft. pared using free surface electrospinning device [5]. Photo of nanofibers as well as final textile that was implemented into the \‘'WIT is shown in Fig. I .

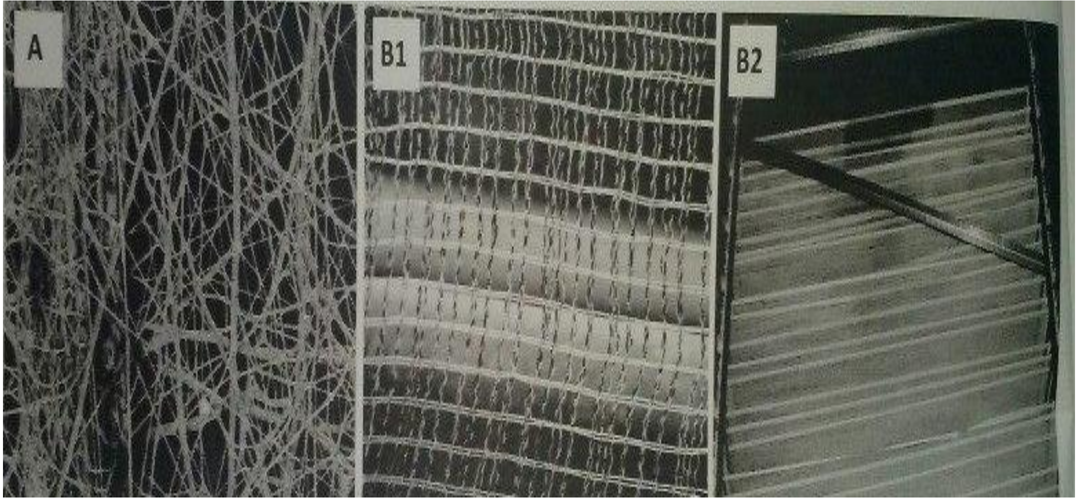

Figure I. Nanofibers biomass carriers: A) picture of nanofiber from scanning electron microscope; BI) final textile; B2) supporting construction with textile.

3. Results and discussion

3.1. COD removal and biomass concentration

Biomass concentration in suspension of tank with carriers was about 10-15% higher than in tank without carriers. In addition, biomass attached to carriers reached about 60 kg increasing total biomass storage in this tank significantly achieving about 40% higher value. When chloramine T was produced, biomass growth was inhibited, and it declined significantly in tank without carriers. While biomass in suspension of tank with carriers also decreased, biomass attached on carriersj remained almost stable proving stabilization of biomass balance.

3.2. Nitrogen removal

Prior to the implementation of carriers, removal of ammonia nitrogen was very low. However, shortly after implementation, elevated nitrate nitrogen was detected, simultaneously with sharp decline in ammonia nitrogen in effluent. When higher wastewater volume or changes in chloramine production (B vs. T) occurred, and previously resulting in sharp increase in ammonia nitrogen in effluent, transformation of ammonia to nitrate nitrogen remained almost stable and changes were only negligible after installation of carrier. It was enabled due to fixation of ammo-nia and nitrite oxidizing bacteria on carriers which were washed-out of system prior to carrier installation. It NO further observed that nitrite oxidizing bacteria were more sensitive to chloramines T at the beginning of WWTP operation, but later, this negative effect was not so pronounced due to their adaption. Afterwards, declines in nitrate nitrogen were not so significant compared to previous phases with chloramines T production.

3.3. New shape of biomass carrier

A new shape of biomass carrier (Fig. 3) has been developed at our institute to utilize specific features nanomaterials offered. This shape of biomass carrier made of polyurethane nanofibers is suitable notably for NIBBR; however, production technology can be easily applied for carriers used in FBBR. Its main advantage is very high flexibility in size, materials, structure and other characteristics, including final very high specific surface area. Currently, this biomass carrier is intensively tested in lab and pilot- plant installation.

4. Conclusions

Implementation of biomass carrier made of nanofibers into actual WWTP treating industrial wastewater from chloramines production led to system stabilization. Removal efficiency of chloramines (COD) and ammonia nitrogen increased, as well as biomass concentration and its fluctuations were stabilized after implementation of nanofibers carriers. Although sludge loading was low and fluctuated significantly, positive effect of biomass carriers was evident, namely already by using only 1/6 possible area. during the significant changes in wastewater composition related with production of chloramines.

References

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