DOI: http://doi.org/10.21698/simi.2018.ab03

COMPARATIVE EVALUATION OF CONTINUOUS AND SEQUENTIAL BATCH REACTOR WITH AEROBIC GRANULAR SLUDGE

Elena Elisabeta Manea, Costel Bumbac

National Research and Development Institute for Industrial Ecology - ECOIND, 71-73 Drumul Podul Dambovitei, district 6, 060652, Bucharest, elena.manea@incdecoind.ro, costel.bumbac@incdecoind.ro, Romania

Keywords*: efficiency, granular sludge, wastewater treatment*

Introduction

Increasing wastewater treatment efficiency is a common concern in the current context of environmental regulations and increased population density. Existing wastewater treatment plants, with biological processes based on conventional activated sludge are able to remove organics and nutrients to the legislative requirements, but have high space and energy needs. One of the currently studied solutions for increasing the biological processes efficiencies consists in replacing the conventional activated sludge with aerobic granular sludge, which has a series of benefits widely recognized (improved separation from the treated effluent, all the nitrification/denitrification take place in only one tank). The existing large scale aerobic granular sludge –based wastewater treatment plants have sequential batch reactors, and current studies focus on identifying configurations that provide the necessary conditions for the stability of granular structures in continuous flow reactors. The study focused on the efficiency evaluation of two lab-scale activated granular sludge bioreactors (sequential and continuous flow).

Materials and methods

The continuous flow bioreactor has a retention time of 8 hours. The synthetic wastewater is introduced at the bottom of the bioreactor and comes into contact with the granular sludge biomass. Air is introduced in the lower area with a flow that provides the aerobic conditions necessary for the metabolic processes involved in the waste water treatment, while also keeping the fluidized bed movement in the mixture mass. A pre-settling and granules recovery area is foreseen, and the granules with low settling velocities are directed towards a secondary settler.

The sequential batch reactor has cycle duration of 8 hours, the aeration step being of 7.5 hours,

Both bioreactors were fed with synthetic wastewater following a recipe proposed by Zhang et al (2007) modified, containing 0.9 g of L-1 sodium acetate; 0.2 g of L-1 NH4Cl; 0.08 g of L-1 K2HPO3 · 3H2O; 0.02 g of L-1CaCl2; 0.03 g of L-1 MgSO4 · 7H2O; 0.02 g of L-1FeSO4 · 7H2O; 1 ml L-1 microelement solution.

Wastewater treatment performances were assessed based on analytical determinations results of the organic load expressed both in the form of chemical oxygen demand (COD) and in the form of biochemical oxygen demand (BOD_5), total suspended matter (MTS), and concentrations of total Kjeldahl nitrogen (NTK), NH_4^+, NO_2^-, NO_3^- and PO_4^{3-}. The COD was volumetrically analyzed by the potassium dichromate

method according to the ISO standard (SR ISO 6060: 1996). BOD_5 was determined by calculation based on the amount of dissolved oxygen consumed within 5 days, under specific conditions according to SR EN 1899 / 1, 2-02 DIN 38409-87. The total suspended material was determined gravimetrically according to STAS 6953-81. Total Kjeldahl nitrogen was determined according to SR EN 25663-00. NH4 +, NO2-, NO3- and PO43- were determined according to SR EN ISO 14911: 2003 and SR EN ISO 10304/1: 2009 using the ICS-3000 ion chromatography system (Dionex, USA).

Results and conclusions

Organic load removal efficiency for continuous bioreactor is higher than 80%, ranging from 86 to 99% (Figure 1). For the sequential batch reactor, the efficiency values vary between 67 and 96%, the low values being recorded following a failure of the aeration system.

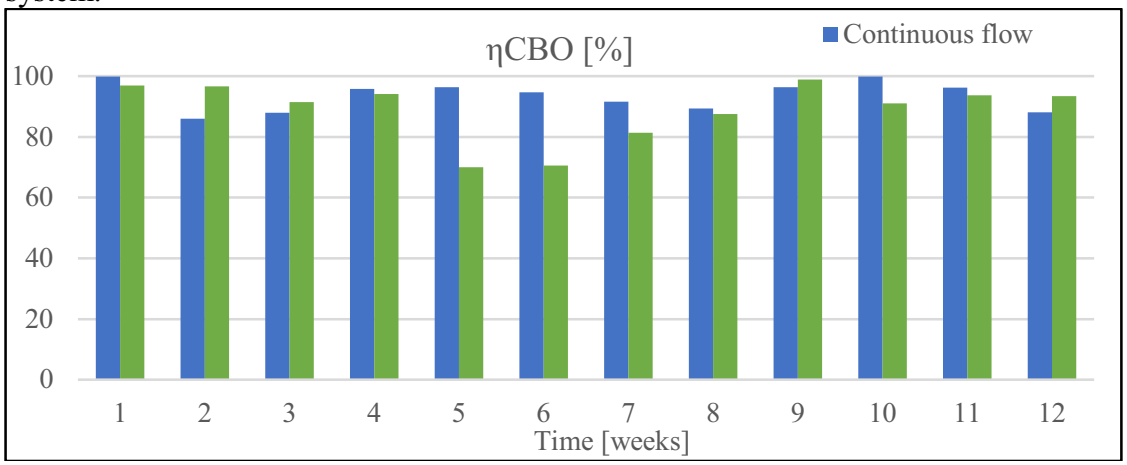

Figure 1. Organic load removal efficiency

The ammoniacal nitrogen removal efficiency is over 97% throughout the experiments for the continuous flow bioreactor ranging from 74 to 98%. The results obtained with sequential bioreactors showed efficiencies ranging from 43 and 99%.

The removal efficiency of PO_4^{3-} ions is between 7 and 99% for the continuous flow bioreactor. Lower efficiencies are obtained especially during the start of the experimental study, due to the transfer of the aerobic granular sludge from sequential operation to continuous system. Similar results were obtained for the sequential bioreactor, ranging between 3-77%. The biological anaerobic process has a reduced efficiency due to the reduced diameter of the sludge granules.

Acknowledgements

This work was supported by a grant of the Executive Agency for Higher Education, Research, Development and Innovation Funding – PN-III-P2-2.1-PED-2016-1766.