OPERATION OF AN INTEGRATED ANAEROBIC-AEROBIC-ANOXIC REACTOR FOR WASTEWATER TREATMENT

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Introduction. Global standards in terms of water quality and the land cost for the construction and implementation of wastewater treatment plants are becoming stricter and higher (1). Integrated reactors are considered as a viable alternative since they combine anaerobic, aerobic and anoxic processes in a single reactor, increasing the degradation efficiency of pollutants and reducing operation costs and space (2). There are several studies about the application of these kinds of reactors for the degradation of carbon and nitrogen compounds with degradations efficiencies greater than 95% for both compounds using synthetic wastewater (3). Nevertheless, reports about the implementation of this type of system in real wastewater treatment, is still limited. That is why the aim of this work was to design and operate an integrated reactor based on the optimization of the anaerobic module and the manipulation of aeration rates as well as the recycling ratios in the subsequent modules for the oxidation of organic matter, nitrification and denitrification in the treatment of municipal wastewater in low footprint plants.

Methods. The Integrated reactor is composed of three modules without physical separation between them. The first module consists in an UASB reactor, the second one in a membrane aerated biofilm reactor and the third one in a membrane anoxic biofilm reactor. The features of these are as follows: working volumes of 3, 1.35 and 1.95 L respectively. These last two modules have 24 tubular membranes with a superficial membrane area of 0.17 m^2. The oxygen dosage to the biofilm formed in the external wall in module 2 can be done through the membranes and an external saturation column. Modules 1 and 2 were inoculated with 1 L of the anaerobic granules (52.5 gVSS/L) and 0.2 L of WAS (15.6 gVSS/L). Module 3 was inoculated with 0.2 L of the anaerobic granules and adapted to denitrifying conditions. The DO control is conducted by changing the recirculation ratio of module 2 which also affected the oxygen transfer coefficients (K_La) of membranes and column.

Results..Table 1 shows the operational conditions of the integrated reactor.

Table 1. Operational conditions of the integrated reactor.

Time (d)	HRT_{an} (d)	OLR (gCOD/L·d)	DO (mg/L)
0-36	0.52	0.35	1.8
37-41	0.35	0.55	1.1
42-48		1.4	0.8
49-54	0.28	2.05	0.5
54-62	0.24		0.2

Figure 1 shows the COD degradation efficiency during the operation of the integrated reactor.

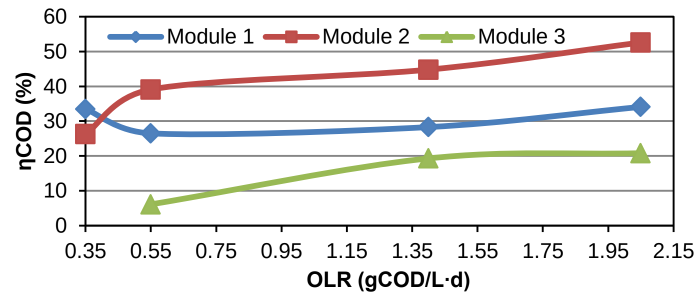

Fig.1 COD degradation efficiency during the reactor operation.

Regarding the oxidation of ammonium Nitrogen, the average influent concentration was 116.2±49.8 mgNH_4-N/L. During this operation period, the aerobic biomass has not yet high metabolic capacity to oxidize ammonium due to the concentrations lower than 8 mg NO_3-N/L and 1 mg NO_2-N/L that were detected in effluent 2. This may be due to the short time of reactor operation which has not allowed the colonization of the slow growing population of ammonium oxidizing microorganisms.

Conclusions. The operation of module 1 (UASB) presented a ηCOD of 34.1% while the ηCOD of module 2 was greater than 50% with an OLR of 2 gCOD/L·d. However, the ammonia oxidation is low. The data obtained during the operation of the reactor will be used to validate an integrated model (the anaerobic digestion model (AD1), the biofilm aerobic treatment model (4) and the biofilm nitrification model (5) combined with a hydrodynamic mixed cell model to characterize the complete reactor behavior) which will help in the reactor operation and control.

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