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Effect of high concentrations of nitrates on a permeable support biofilm reactor

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ABSTRACT

The aim of this research was to observe the effect of high concentrations of nitrates on removal of pollutants (organic carbon, ammonia nitrogen, nitrate) using a Permeable Support Biofilm Reactor (PSBR).

KEYWORDS

biofilm, permeable support, carbonaceous oxidation, nitrification, denitrification.

INTRODUCTION

A new technology for the removal of pollutants from wastewater, in the PSBR, described by Timberlake et al. (1988), and studied by other investigators (Abdel-Warith et al, 1990; Jácome, 1990; Eguía, 1991), allows all the reactions in the same biofilm (carbonaceous oxidation, nitrification and denitrification). The main point of interest of process is that the oxygen is provided by diffusion through a gas-permeable support. Providing oxygen in a quantity that can be exhausted in the biofilm, it's possible to obtain microenvironments for reactions described above. In this study, the PSBR was observed at a laboratory scale. It was conducted so as to maintain in every run: nitrification, heterotrophic oxidation, denitrification, and anaerobic fermentation. Important quantities of nitrates were supplied to the reactor to obtain high rates of denitrification.

EXPERIMENTAL PROCEDURES

The experiments were conducted with a 10 l laboratory scale PSBR, the biofilm support with a surface area of 710 cm^2, consists of a synthetic porous membrane of

polytetrafluoroethylene (PTFE) with 0,2 μm pores. The reactor was supplied with synthetic wastewater at a constant flow rate. This synthetic wastewater consisted of a solution of glucose, ammonium chloride, potassium nitrate, phosphatic neutralizers and oligoelements. Oxygen was supplied by supplying air at a pressure of 0,3 bar, and in low quantities to preserve the bulk liquid anoxic. Runs 8 and 10 were conducted without any pressure air (atmospheric pressure). The experiments started with a 3 months old biofilms. 10 runs of 5 days duration were done. The influent and effluent concentrations of TOC, COD, N-NO_3^- and N-NH_4^+ were measured twice a day.

RESULTS AND DISCUSSION

TABLE 1 Influent and effluent wastewater composition during the 10 runs

RUN	Sampling Point	Organic Load (gCOD/m^2/d)	CONCENTRATION (mg/l)				
			TOC	COD	N-NH_4^+	N-NO_2^-	N-NO_3^-
1	In	120	48	100	5	0,02	6
	Out		15	26	2,5	1,0	3
2	In	120	76	200	9,6	0,02	12
	Out		15	25	3,7	2,2	1,5
3	In	240	77	200	9,5	0,02	13
	Out		40	76	6,2	2,3	3
4	In	120	45	100	4,8	0,01	14
	Out		15	25	2,3	0,3	12
5	In	120	75	200	10	0,03	28
	Out		22	40	4,2	2,5	16
6	In	240	77	200	9,2	0,04	28
	Out		26	50	5,8	5,2	15
7	In	240	151	400	19	0,06	62
	Out		69	112	10,5	17	32
8	In	240	150	400	20	0,2	70
	Out		61	200	16	23	42
9	In	120	76	200	10	0,02	62
	Out		25	55	5,6	7,3	48
10	In	240	---	200	9,3	0,04	62
	Out		---	68	5,3	7	47

Throughout the experiments (Table 1), the denitrification remained independent of the nitrates load provided. For organic loads of 120 gCOD/m^2/d, ranges of nitrates loads from 4 to 6 gN-NO_3^-/m^2/d were removed, and for organic loads of 240 g COD/m^2.d, ranges from 8 to 10 gN-NO_3^-/m^2/d were removed. Effluent nitrite concentration has a wide range (from 1 to 23 mg/l). The increment of nitrate apportation caused a

production of nitrite. It was deduced from the nitrogen influent and effluent concentrations, that the nitrite resulted from a reduction of nitrate.

The removal of COD ranged from 50 to 87,5% (50% in the run without air pressure). A carbon balance was calculated from mass balance and stoichiometry. Part of carbon removed was eliminated in the denitrification, part by aerobic oxidation and part by fermentation. High organic loads, from 87 to 172 gCOD/m^2/d have been removed. Those ranges are about 10 times as wide as values obtained in RBCs.

CONCLUSIONS

Combined aerobic oxidation, nitrification, denitrification and fermentation can occur with high organic loads in a Permeable Support Biofilm Reactor. The process is able to perform each reaction described without air nor oxygen artificial supply.

The nitrate denitrification is limited by the organic carbon load. An increment of nitrate supplying caused a nitrite production resulting from a partial reduction of nitrate.

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