BIODEGRADATION OF AN ANTIOBIOTIC CEPHALEXIN USING AEROBIC BATCH REACTOR

BASAVARAJU MANU , KARTHIK M

Abstract: Potential environmental and indirect human impacts of pharmaceutical substances (Antibiotics) in the environment are an emerging concern. Many of these substances tend to persist in the environment and have toxic and carcinogenic effects. Biodegradation at varying dosages of CEPHALEXIN (CPH) and also at varying sludge concentration was studied with the aid of aerobic batch reactors . Study was carried out in five batches, all consisting of six reactors in each. To the first batch, all the six reactors were seeded with 1g/L MLSS and varying dosages (i,e 5mg/L, 10mg/L, 15mg/L, 20mg/L, 25mg/L) of synthetic waste water containing pollutant (CPH) was added to each reactors and the sixth reactor was maintained as control. Similarly batches 2 , 3 ,4 and 5 were conducted with increasing concentration of MLSS (i ,e. 2g/L, 3g/L, 4g/L, 5g/L) respectively. Maximum CPH biodegradation at 10 mg/L dosage was found to be about 79.8%, which gradually decreased with increase in the dosage and finally at a dosage of 25 mg/L the degradation efficiency dropped to almost 40%. Similarly, the COD removal efficiency at 10 mg/L dosage was almost 77%, which gradually decreased with increase in the dosage and finally at a dosage of 25mg/L the COD removal efficiency reduced to almost 39%. Hence it seems that aerobic treatment may be efficient and economical in treatment of antibiotics in water at lower concentrations

Keywords: Antibiotics, Cephalexin, Aerobic, Biodegradation, COD.

Introduction: Antibiotics are used extensively in human and veterinary medicine for disease control. Inevitably, they are discharged into aquatic environments via domestic wastewater with concentrations of ng/L range. Pharmaceutical residues are potential pollutants, that they often have similar physico-chemical behaviour like other harmful xenobiotics (Fakhri Ali and Adami Seideh, 2014). Antibiotic chosen for the study is Cephalaxin (CPH). Cephalexin is one of the most widely used antibiotics. It belongs to the cephalosporin family and beta (β) -lactam category. Some of the physico-chemical properties of Cephalexin include, molecular weight of 347.39 g/mol, pKa (acid dissociation constants) of 4.5 and Log KOW (octanol/water partition coefficient) of 0.65.

CPH is used for the treatment of a number of bacterial infection including middle ear infections, strep throat, bone and joint infections, pneumonia, skin infections, and urinary tract infections (Alaa Kamal Jabbar Alhamd, 2014). Also CPH is active against gram positive and some gram negative bacteria. Exposure to β-lactam antibacterials proved to induce allergic and toxic reactions in hypersensitive individuals and promote the spread of bacterial resistance which is posing a potential threat to public health (Lee et al, 2012).

The most common effects include diarrhea, burning stomach, vomiting, severe indigestion, infection due to the Candida Fungus, stomach cramps, dizzy, feeling restless, genital itching, numbness and tingling. Severe effects include abnormal liver function, allergic reaction causing serum sickness, decrease in the blood-clotting, protein prothrombing, hemolytic anemia, hemorrhage, hepatitis, hives, interstitial nephritis, kidney Failure, etc. Antibiotic abuse has become a serious worldwide issue due to the overuse in aquaculture and livestock. The major Objective of the study is to evaluate Aerobic Batch reactors as a treatment option for the biodegradation of selected antibiotic Cephalaxin.

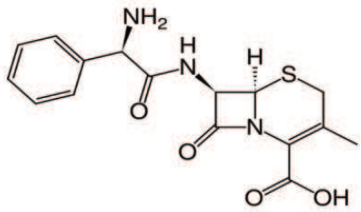

Figure 1. Chemical Structure of Cephalaxin used in the present study Experimental Methodology

Figure 2. Photograph of the experimental setup adopted in the present study

Sludge Conc. (MLVSS in g/L)	Cephalaxin Removal Efficiencies (%) at various influent CPH conc.					COD removal Efficiencies (%) at various influent CPH conc.				
	5	10	15	20	25	5	10	15	20	25
1	52	39	31	21	17	50	40	31	24	23
2	52	55	48	45	40	49	48	42	37	35
3	56	57	34	26	25	53	55	30	26	23
4	60	71	43	39	36	55	63	41	37	35
5	65	80	52	41	40	61	77	45	40	39

Six lab scale reactors were used for the experiments of which 5 were test reactors & 1 control reactor. Each reactor was of 2.0 liter capacity with a working volume of 1.0 liter. Aeration was done by submerged air diffusers. Feeding and Decanting was done manually. The whole set of experiments was done in five batches. The required amount of sludge concentration as MLSS (g/L) for each of the batches was determined by gravimetric method. After determining the sludge concentration the same was seeded to all the six reactors of a batch and the total volume of the reactor was made up to 1.0 liter with non-chlorinated water. COD tests were conducted to monitor the reduction in COD. Pollutant was added to all the five reactors in the concentration of 5mg/L, 10mg/L, 15mg/L, 20mg/L, 25mg/L respectively.

The same procedure was followed for the remaining batches (i ,e 2g/L ,3 g/L ,4g/L ,5g/L). The influents and effluents from each of the reactors were analyzed for pH, COD and cephalaxin concentration. Three samples were collected from each reactor after an HRT of 24hrs. All the samples were centrifuged at 10000 rpm and then filtered through micro filter paper before the analysis to prevent any possible occurrence of errors caused due to interference of suspended particles in the samples. The pollutant removal efficiencies were analyzed by using UV spectrophotometer and by COD. CPH concentration was analyzed at wavelength of 261 nm.

Results and discussion: Percentage quasi steady state removal of cephalexin and corresponding COD removal efficiencies observed during the present study is shown on table 1.

Table 1. CPH removal efficiencies and corresponding COD removal efficiencies observed during the study period

From the above table it can be observed that maximum cephalexin removal of up to 80% with corresponding COD removal efficiencies of up to 77% was observed when the MLVSS concentration in the reactor was 5 g/L and for influent concentration of 10 mg/L. It may be due to the fact that 10 mg/L of CPH was increasing the microbial activity. Higher concentration of CPH was causing microbial toxicity. Weilin Guo et.al. (2010) have reported that degradation of cephalexin using ultra sound technique follows pseudo first order kinetics and substantially increase BOD/COD ratio for subsequent treatment using biological treatment techniques. Bui et.al. (2016) have reported that advanced methods such as adsorption, oxidation and advanced oxidation processes (O_3 and O_3-based advanced oxidation processes, UV/H_2O_2), membrane processes, and membrane bioreactors, become an inevitable approach for treating micropollutants including antiobiotics contaminated water.

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Basavaraju Manu , Karthik M, Department of Civil Engineering, National Institute of Technology Karnataka, Surathkal, Mangalore, India