

Treatment of Pharmaceutical Waste with Special Emphasis to Treatment Processes - A Review

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Abstract

Recently, the major area of concern is the presence of the emerging pollutants in wastewaters, surface waters and ground waters. In most cases, the emerging contaminants refers to the unregulated pollutants, which can be included for future regulation depending upon research on their health effects and their occurrence. They generally includes surfactants, illicit drugs, endocrine disruptors, pharmaceuticals and personal care products (PPCPs), gasoline additives and many other groups of compounds. The presence of endocrine disruptors and pharmaceutical residues in the wastewater poses a great threat for the humans if not treated.

Pharmaceutical wastes are introduced into the environment through hospitals, veterinary clinics, pharmaceutical industry effluents, and household effluents. Among these pharmaceutical wastes antibiotics poses to be of great threat. So to eliminate these unwanted pollutants from environment that can potentially cause many deleterious effects to human health, many treatment processes are employed to make sure the water released is antibiotic free. The methods include activated sludge treatment, activated carbon columns, ion exchange columns, membrane processes are to mention a few.

This paper deals with few treatment processes that could effectively, in an environmental sustainable manner, could remediate the pollution load in the pharmaceutical waste water.

Keywords: antibiotics, contaminants, pharmaceutical wastewater, treatment process.

1. Introduction

The appearance of pharmaceuticals and personal care products (PPCPs) in the natural ecosystem poses a great threat for the human beings if not treated. The occurrence of these pharmaceutical effluents is generally prevalent in the aquatic environment and this pose a serious threat to public health, as we need water for every work, whether it is ground water or surface water. This leads to an increasing problem due to the probable environmental risks and the supply and transmission of antibacterial resistance amid microorganisms (Xiaosong et al., 2010).

Various types of PPCPs can be found in the effluents from sewage treatment plants, hospitals, livestock farms, pharmaceutical manufacturers, dairy industries, slaughterhouses, and households (Chang et al., 2010, Kosma et al., 2010 and Sim et al., 2011). Among these PPCPs, the antibiotic is of major concern, as it is used by both animals and human beings. The antibiotics which are transported in the aquatic environment from different sources may either lead to increased antibiotic resistant bacteria or some detrimental effects on water quality or both. The frequent use of antibiotics accelerates the development of the antibiotic resistant genes in bacteria which causes fatal health risks to animals and human beings (Saichang et al., 2013). The continuous exposure of the bacteria even in minimal concentration to antibiotics or active metabolites could lead to the development of resistant bacterial strains (Obst et al., 2006). Previous studies done by several scientists shows that most of the antibiotic compounds displayed direct toxic effects (Sendzik et al., 2005; Park and Choi, 2008) and sometimes detrimental effects in mixture were also observed (Pomati et al., 2006).

2. Removal Methods and their Efficiency

The primary source of antibiotics in the environment is the faeces which consists of incomplete metabolized antibiotics by both animals and human beings. Secondary sources may include the effluents released from the pharmaceutical manufacturing industries and the disposal of such unused or expired antibiotics. Residential facilities such as private residences, dormitories, hotels, and residential care facilities and commercial facilities such as hospitals are the contributors to the municipal wastewater. Other probable contributors of antibiotic are the effluents released from the wastewater treatment plants (WWTPs) to the surface and groundwater resources (Alder et al., 2003) and various industries including pharmaceutical plants and surface runoff from the cattle sheds (Hirsch et al., 1999).

For the treatment of these deadly antibiotics several methods have been employed. In these antibiotics there are a variety of classes present namely Macrolide, Quinolone, Sulfonamide, Tetracycline, Trimethoprim, Lincosamide, etc. The removal efficiency varies differently for different classes of antibiotics. The different removal percentages of the antibiotics are shown in the following table.

Table 1: Different removal rates for antibiotics.

Sl. No.	Methods	Percentage Removal	References
1.	Activated sludge in WWTP	60 – 100 %	Xiaosong et al., 2010
		78 %	Chang et al., (2010)
		92 %	Golet et al., (2003)
2.	Anaerobically digested sludge	77 – 87 %	Golet et al., (2002); Hong et al., (2008)
		95 %	Chelliapan et al., (2006)
3.	Photocatalysis + Ozonation	97 %	Deniz et al., (2012)
4.	Ozonation	4 – 50 %	Angela et al., (2013)
5.	Ozonation	90 %	Andreozzi et al., (2005)
6.	Ozonation and Adsorption	> 90 %	Sánchez-Polo et al., (2008)
7.	Nanofiltration	85- 95 %	Ivan et al., (2011)
8.	Membrane Bioreactors	20 – 70 %	
9.	Membrane Bioreactors + Reverse Osmosis + Nanofiltration + Ozonation	97 - 99 %	
10.	Chlorination	> 90 %	Adams et al., (2002)
11.	Photo - Fenton	100 %	Trovó et al. (2008); Elmolla and Chaudhuri (2009 a, b)
12.	Combination of Fenton oxidation with two-stage reverse osmosis	99.7 %	Zhang et al., (2006)
13.	Adsorption on granular activated carbon	95 %	Putra et al., (2009)
14.	Adsorption on bentonite	88 %	
15.	Reverse osmosis + Nanofiltration	> 90 %	Kosutic et al., (2007)
16.	Removal using metallic iron	100 %	Ghauch et al., (2009)
17.	Clarification + Chlorination + GAC filtration	47 %, 92%, 100 %	Stackelberg et al., (2007)
18.	Coagulation/Flocculation/ Sedimentation + Rapid sand filtration and Granular activated carbon filtration + Ozonation	30 %, ~ 10 %, 16 % = 56 %	Vieno et al., (2007)
19.	Adsorption on zeolite coupled with ozonation	80 %, 100 %	Ötker and Akmehmet-Balcioglu (2005)
20.	Ion exchange	~ 90 %	Choi et al., (2007)
21.	Electrochemical oxidation	99.5 %	Jara et al., (2007)

3. Conclusion

In the last couple of decades, the enormous production of antibiotics has aided in recovery of human from number of ailments from common cough and cold to cancer, but also has been an ever increasing source of pollutants in aquatic as well as terrestrial ecosystems. Even a very small quantity has shown severe harmful effects. These compounds are persistent and resistant to biodegradation and thus go on accumulating in the environment. Thus a variety of removal or degradation processes are employed to solve this problem.

From the above table it is quite obvious that all treatment processes have proved to be successful in removing the antibiotic from the aqueous matrices. If we can go for a combination of these treatment processes then we would get complete removal.

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