Samarra J. Eng. Sci. Res., 2023; 1 (1): 6-31

IRAQI Academic Scientific Journals

SAMARRA JOURNAL OF ENGINEERING SCIENCE AND RESEARCH

S.J.E.S.R

Pharmaceutical Wastewater Treatment - A review

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Article Information

Received: 17/07/2022
Accepted: 05/01/2023

Keywords:

Pharmaceutical wastewater, BOD, Up flow anaerobic filter, Membrane bioreactor, and COD.

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Abstract

The composition of pharmaceutical, which is high concentration of organic matter, microbial toxicity, high salt, and difficult to biodegrade(Y Guo et.al 2017). Pharmaceuticals are biologically active compounds which are used to impart therapeutic effects in humans and animals. These pharmaceuticals compounds are contaminants of emerging concern due to their heavy use and release into the environment. Their persistence in waterways and drinking water has gained attention across the globe and among lawmakers, regulators, and the public, because they are active and often escape from the wastewater treatment plants (WWTPs) undisturbed or in transformed states. Most of the biological treatment technologies are not specifically designed to remove the pharmaceuticals (SridharPilli et.al 2020). In This paper the methods of pharmaceutical wastewater will reviewed

Introduction:

The continued exponential growth in human population has created a corresponding increase in the demand for the Earth's limited supply of freshwater. Thus, protecting the integrity of our water resources is one of the most essential environmental issues of the 21st century. Recent decades have brought increasing concerns for potential adverse human and ecological health effects resulting from the production, use, and disposal of numerous chemicals that offer improvements in industry, agriculture, medical treatment, and even common house hold conveniences. (Kolpin, et.al 2002).

Researches has shown that many such compounds (pharmaceuticals) can enter the environment, disperse, and persist to a greater extent than first anticipated. Some compounds, such a pesticide is intentionally released in measured applications others, such as industrial byproducts are released through regulated and unregulated industrial discharges to water and air resources. House hold chemicals, pharmaceuticals, and other consumables as well as biogenic hormones are released directly to environment after passing through wastewater treatment processes (via wastewater treatment plants or domestic septic system) which often are not designed to remove them from the effluent. (Kolpin, et. al 2000).Surprisingly, little is known about the extent of environmental occurrence, transport, and ultimate fate of many synthetic organic chemicals after their intended use. Particularly hormonally active chemicals, personal care products and pharmaceuticals that are designed to stimulate a physiological response in human, plants and animals (Kolpin, 2000).In the enterprise of Jiangasu province, in the middle east coast of China, in the year of 2000 total volume of wastewater of the pharmaceutical industry was 761.9114 million tons or 37.72% of the whole province. Yearly discharged pollutant included 0.02ton stannum, 0.22ton chromium (VI), 51.51 tons arsenic, 52.23 tons volatile hydrobenzene, 30202.19 tons COD, 928.73 tons Petrolics, 31132.4 tons suspending substances and 205.66 tons sulfides (China 2000).

Literature review about Pharmaceutical wastewater Treatment

Jennett and Dennis (1975) used four laboratory filters fabricated of plexiglas column. Each has 0.14 m inside diameter and 0.915 m height. Sample ports were placed at 0.15m interval through the column height. Each column was filled with smooth quartz gravel (2.54–3.84) cm in diameter. A pharmaceutical wastewater having COD concentration ranged from1000–16000mg/l was applying to upflow anaerobic filters at 35 Co and with different HRTs ranging from 12 to 48 hours. This filter successfully treated pharmaceutical wastewater with (93.7- 96.8) % COD removal efficiency

Sachs, et.al (1982) used six laboratory upflow anaerobic filters for pharmaceutical wastewater treatment. Each filter was fabricated from a acrylic tubing 48 inch (121.9 cm) height, and 5.5 inch (14 cm) in inside diameter. Each filter was filled with inert stone passed a sieve with 3.84 cm opening and was retained on sieve with 2.54 cm opening the porosity of packed media was 0.43. The influent pharmaceutical wastewater of 2000mg/l. COD was subject to the filter and operated with temperature 35Co and HRT 36 hours. The anaerobic filter successfully treated wastewater with 70-80 % COD removal efficiency.

Hamdy, et.al (1992) studied the mesophilic and thermophilic upflow anaerobic filter for treatment of pharmaceutical waste resulted from pharmaceutical plant in Bombay- India. The average characteristics of untreated wastewater were: pH: 7.2. alkalinity: 750 mg/l, COD: 2500 mg/l, TSS: 40 mg/l, TVA: 750 mg/l, NH4-N: 750 mg/l, PO4-p: 16 mg/l SO4: 300 mg/l, chlorides: 900 mg/l, sulfide: 5.0 mg/l cobalt: 0.2 mg/l, Iron: 0.45 mg/l, potassium:18mg/l, manganese:0.2 mg/l, magnesium: 40mg/l, sodium: 200mg/l, lead: 0.35mg/l, silicon:25 mg/l, zinc: 0.09mg/l. Chromium: 0.3mg/l, mercury: 0.25mg/l, copper: 0.1mg/l, tin: 0.6mg/l, aluminum: 0.1mg/l barium: 0.16mg/l, arsenic: 0.25mg/l, cadmium: 0.1mg/l, bismuth 0.15mg/l, antimony: 1.4mg/l, and selenium 0.38mg/l.

They used two laboratory scale reactors which fabricated from P.V.C pipes having 15cm inside diameter and 200 cm length-each reactor contained 2754 porcelain balls the measophilic reactor was operated at temperature 30 Co on average while thermophilic was operated at 55 Co. The two reactors were operated at HRT of 4.7 days resulted in COD removal efficiency ranged from 82% to 88% for mesophilic reactor and 51-58 % for thermophilic reactor one.

Chen, et.al (1994) studied the upflow anaerobic filter for treatment of pharmaceutical wastewater. They used a cylindrical Plexiglas pipe within internal diameter of 0.14 m. Fire expanded clay pellets were used as packing medium filled to a depth of 2 m with an effective void volume of 15 L. The recycle stream was drawn from the top and recirculated through the bottom at 45 l/h using peristaltic pump. A sampling ports extending to central axis of the biofilter was used to withdraw a representative samples of liquior. The biogas was collected in a 30 L inverted plexiglas tank. The pharmaceutical wastewater with an organic concentration 20000 mg/l was applying with different HRT s. They concluded that when HRT decreased from 20 to 2 day organic loading rate from 1 to 10kg COD/m3.d. This anaerobic treatment achieved 93- 70% COD removal rate.

S. P. MAYABHATE, S. K. GUPTA , and S.G. JOSHI(1998) used the study of physicochemical and biological treatment of pharmaceutical wastewater by the activated sludge process was performed in an oxidation ditch. The physicochemical study using different coagulants revealed that all the coagulants used are not effective and their doses required were very high for COD reduction. In the biological oxidation study, it was found that the wastewater could be processed at all organic loadings and phenol concentrations encountered in wastewater. The yield coefficient and decay coefficient were 0.75 (COD basis) and 0.01 day- 1 (COD basis), respectively.

Nandy and kaul (2001) studied the upflow anaerobic fixed film reactor for treatment of herbal-based pharmaceutical wastewater which characteristics ranges were: pH (4.2-4.5), COD (5000-80000) mg/l, total solids (4300- 74000) mg/l, suspended solids (900-18800) mg/l, suspended volatile solids (580-12400) mg/l, ammonia nitrogen- NH3 (40- 320) mg/l, total nitrogen-N (135-1250) mg/l, total phosphorus -P (30-120) mg/l. The upflow reactor was fabricated from a PVC Column of 0.11m diameter and 2.25 m height having a total empty volume of 0.0124 m3. The column base was designed to disperse the wastewater flow uniformly. Sampling ports at 30cm intervals along the column height from the bottom. The column was packed randomly with 150 nylon scrubbers as a media within 2.1 m of the column. This media provided surface area 0.127 m2 per one scrubber. The reactor was operated at 35 Co and HRT ranged from 0.833 day to 6 days. The COD removal efficiencies ranging (76- 96)% were achieved for applying organic loading rate up to 10 kg COD/m3d, while increasing organic loading rate to 48 kg COD/m3.d led to COD removal efficiency ranging (46-50)%.

Ince et. al (2002) studied the upflow anaerobic filter of chemical synthesis - based pharmaceutical wastewater. They used Plexiglas column with 50 cm long by 10 cm diameter. The filter was packed with plastic pall rings which have void space of 90% and specific surface area 205 m2/m3. The temperature was maintained at 35±2C° for the filter. They concluded that a maximum of 70% COD removal efficiency was obtained with a raw pharmaceutical wastewater an organic loading rate OLR of approximately 7.5 kg COD/m3.d. with HRT of 2-3 days.

Morse, et. al (2002) studied the anaerobic/ aerobic sequence for treatment of pharmaceutical wastewater. They referred that the purpose of their research is to determine the overall transformation potential of candidate pharmaceutical in a biological wastewater treatment and recycle system. The pharmaceutical chosen for this investigation is amoxicillin that is an antibiotic used by (NASA).

The biological components of water recovery system (WRS) were an anaerobic packed-bed reactor and aerobic tubular reactor. The anaerobic packed-bed reactor reduced total organic carbon (TOC) concentration and denitrifies the wastewater by converting nitrate and or nitrite to nitrogen gas.

Buitron, et. al (2003)studied the performance of sequencing Anaerobic/ Aerobic treatment for pharmaceutical wastewater with biofilters. These biofilters are packed with porous volcanic stone (puzzolone). The reaction time varying for anaerobic stages from 8hr to 24hr and for aerobic one from 4hr to 12hr. The pharmaceutical wastewater that applying to the system has a characteristics of COD (28400- 72000) mg/l, N- NH4 (280-605) mg/l, and TSS (430- 650) mg/l. The system successfully treating pharmaceutical wastewater with COD removal efficiency ranging (95-97)% with maximum organic load 5.7 kg COD /m3.d.

Chia-Yuan Changa et.al. (2008) study the Pharmaceutical wastewater treatment by membrane bioreactor process – a case study in southern Taiwan in this study A pilot-scale study of pharmaceutical wastewater treatment by a membrane bioreactor (MBR) process in southern Taiwan is presented in this paper. A 10 m3 /day capacity MBR plant consisting of an aeration tank and a membrane bioreactor was installed to remove organic matter (measured in terms of chemical oxygen demand (COD)). The performance of the MBR was monitored for a period of 140 days. The removal of COD was on average over 95%. The effluent did not contain any suspended solids. During the 140 days of operation, manual cleaning was carried out twice and chemical cleaning was carried out once. A natural logarithmic evolution of the viscosity with TSS concentration was observed. The results of SEM and EDX demonstrated that the fouling on the membrane outer surface was mainly due to microorganisms and/or the sludge physiological properties. The results indicated that the MBR system has potential as a means of treating high-strength and fluctuating strength wastewater with consistent performance.

M.C. Collivignarelli et.al. (2014) used the treatment of high strength pharmaceutical wastewaters in a thermophilic Aerobic Membrane Reactor (TAMR) In the present work we studied the thermophilic biological treatability of high strength liquid wastes from a pharmaceutical industry (rich in organic matter - COD: Chemical Oxygen Demand, nutrients and salinity). Different mixtures (with concentrations of COD, phosphorus and chloride up to 57,000 mg/ L , 2000 mg/ L and 9000 mg/ L , respectively) were tested. The pilot plant used in this work was designed and built with dimensions comparable to a semi-industrial unit. The results are therefore representative for full-scale applications. During four months of experimentation, the pilot plant (TAMR e Thermophilic Aerobic Membrane Reactor) was operated at 49 ± 1 C and the organic loading rate was 1.5-5.5 kgCOD/ m3 .d with a hydraulic retention time of 5-10 days

Burcu Akcal Comoglua, , Cansu Filik Iscenb , and Semra Ilhan (2015) used the anaerobic treatment of pharmaceutical industry wastewater in an anaerobic batch and upflow packed-bed reactor. The first stage of this study statistically investigates the optimization of anaerobic treatment conditions of pharmaceutical industry wastewater in a batch study. In the second stage, continuous treatment processes were planned using data obtained as a result of the batch study. For processing, an upflow anaerobic packed-bed reactor was used for treating substrate mixtures containing 10–100% pharmaceutical industry wastewater. The effects of operating parameters on the chemical oxygen demand (COD) removal efficiency and the methane production rate were evaluated. COD removal efficiencies of 93–97% were obtained for the pharmaceutical industry wastewater using a 2.5–4 d hydraulic retention time and a 0.6–2.2 g COD d−1 organic loading rate. The overall results suggested that the mixed bacterial and archaeal biomass was able to efficiently treat pharmaceutical industry wastewater under determined anaerobic conditions.

Conclusion

Pharmaceutical wastewater is considered one of more complex industrial wastewater. Anaerobic treatment of pharmaceutical wastewater represented the best solution since it consists of high organic materials concentration as BOD and COD. Also the anaerobic treatment is used to overcome the issue of toxicity due to the acclimation of anaerobic bacteria to toxins and anti-bacterial that presence in pharmaceutical wastewater. Aerobic treatment may be used after anaerobic treatment as polishing of wastewater quality . Membrane bioreactors may be used to remove the pharmaceuticals that can exist in wastewater to prevent them to discharge to water bodies as well as removing of organic materials

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