Journal of Pharmaceutical Research International

33(55A): 167-172, 2021; Article no.JPRI.77621
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919,
NLM ID: 101631759)

A Short Communication on Wastewater Treatment Techniques Used in Pharmaceutical Plant

Simran [a*], Nishant Thakur [a] and Karishma Mahajan [a]

[a] University Institute of Pharma Sciences, Chandigarh University, Mohali, Punjab, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i55A33819
Editor(s):
(1) Dr. Juan Carlos Troiano, University of Buenos Aires, Argentina.
Reviewers:
(1) Noureddine Ouerfelli, University of Tunis El Manar, Tunisia.
(2) Pradeep Kumar Das, N. C. Autonomous College, India.
Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here:
https://www.sdiarticle5.com/review-history/77621

Short Communication

Received 15 September 2021
Accepted 24 November 2021
Published 13 December 2021

ABSTRACT

Toxic and difficult to biodegrade pharmaceutical wastewater is complex in composition with high concentrations of organic debris and microorganisms. There may still exit quantities of suspended particles and dissolved organic materials even after further treatment. Advanced treatment is required to improve the quality of pharmaceutical wastewater discharge. In this study, the pharmaceutical technology categorization has been established, and the features of pharmaceutical wastewater effluent quality have been summarized. On the other hand, The methods of advanced treatment of pharmaceutical wastewater have been incorporate, including coagulation and sedimentation, flotation, activated carbon adsorption, membrane separation, advanced oxidation processes, membrane separation, and biological treatment. In the meanwhile, each process's features were specified.

Keywords: Water treatment; techniques; characteristics; wastewater.

1. INTRODUCTION

"Water treatment describes those industrial-scale processes used to make water more acceptable for a desired end-use. These can be used for drinking water, industry, medical and many other uses. The goal of water treatment process is to eliminate existing contaminants in the water. The processes involved in treating water for drinking purpose may be solids separation using physical

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**Corresponding author: E-mail: simrankundal352@gmail.com;*

processes such as settling and filtration, and chemical processes such as disinfection and coagulation. Biological processes employed in the treatment of waste water and these processes may include, for example, aerated lagoons, activated sludge or sand filters [1]. However, with the development of pharmaceutical industry, the environmental pollution is becoming more and more hazardous. Manufacture of diverse pharmaceutical products and the difference in production scale and process leads to discharge of different kinds of pharmaceutical wastewater. Biopharmaceutical wastewater is mainly generated by high-concentrated antibiotic wastewater, which is characterized as strong fluctuation in quantity, low concentration, high sulfate concentration, complicated composition, biological toxicity and high chroma. The chemical pharmacy has a single composition with high concentration having certain salt content and is hard to biodegrade and toxic to microbiology [2]. The traditional treatment methods of pharmaceutical wastewater are difficult to come over the stringent government standard which demands advanced treatment for the purpose. The review aims to introduce the fundamental advanced treatment of pharmaceutical wastewater".

2. PHARMACEUTICAL WASTEWATER CHARACTERISTICS

General Pharmaceutical Wastewater is composed of Organic Matter, Microbiological Toxicity and high salt content [3]. Furthermore, the majority of pharmaceutical companies are batch processes, with diverse raw materials and manufacturing processes, resulting in a wide range of waste water. Distinct types of pharmaceutical wastewater, on the other hand, have different properties. It has high chroma, low concentration and sulphate concentrations, and a complex composition. Chemical pharmacy lacks nutrition, is difficult to biodegrade, is harmful to microorganisms, and has a high salt concentration. Chinese prescription medication wastewater contains glycosides, organic pigment, anthraquinone, sugar, tannins, cellulose, alkali content, lignin, and other organic materials [3].

3. ADVANCED PHARMACEUTICAL WASTEWATER TREATMENT METHODS

Science and engineering have switched their focus to improved treatment of pharmaceutical wastewater in recent years, using physiochemical technology as the major technique [4].

Sedimentation and coagulation, Activated carbon adsorption, Flotation, Advanced oxidation process, and Membrane Separation are examples of physical and chemical procedure used to treat waste water.

3.1 Coagulation and Sedimentation

Water is coagulated by adding chemical agents, spreading them by fast mixing, and then transforming stable contaminants into detectable ones. Coagulation has a complicated mechanism. Hydrophilic colloids are essential for improved pharmaceutical wastewater treatment. Because of this, the nature of the flocculent is critical to the coagulation process. As flocculants, Inorganic metal salts and polymers are commonly employed potential flocculants for removal of chromaticity, and harmful organic debris using this technique [5]. Biodegradable pharmaceutical wastewater is another benefit. Sedimentation is the second most frequent approach after coagulation, and it is the most common way after that. Pollutants, which have a higher density than wastewater, can be separated using gravity. These methods offer certain advantages, such as straightforward operation and established technology, but it is difficult to remove dissolved organic materials from the solution.

3.2 Flotation

Flotation can remove suspended particles from secondary effluent in addition to sedimentation. By injecting air into wastewater, this technique generates myriads of tiny bubbles which carry the suspended particulate matters on to the surface of water owing to its lower density as compared to the wastewater, which subsequently get removed from the waste water.

3.3 Activated Carbon Adsorption

Adsorbents like activated carbon have a lot to offer in terms of benefits. Because of its large specific surface area, multilayer porous structure, it has high adsorption capacity and chemical stability. To remove contaminants from the environment, it is extensively employed as an adsorbent or a catalyst carrier [6]. Activated carbon is utilized in the treatment of industrial effluents, which is hazardous and difficult to meet discharge standards. Another major form of improved wastewater treatment is aeration, which is a relatively new technology. There are two types of adsorption with activated carbon: physical and chemical adsorption. Because of its irreversibility, physical adsorption has no preference for the adsorbate. Desorbing activated carbon is simple when it is saturated with adsorbats. Chemical adsorption, on the other hand, depends on the nature of the adsorbates, which is irreversible and difficult to desorb. The efficacy of regeneration and reuse of activated carbon hinges on the efficiency of recovery of the material adsorbed, which in turn depends on its adsorption properties. For advanced therapy, this approach is frequently utilized since it can be recycled, has a greater therapeutic impact, and is broadly applicable. As a result of the poor regeneration efficiency and complexity of the system's operating system there are various drawbacks that limit its use.

3.4 Advanced Oxidation Processes

It is possible to create free radicals using advanced oxidation processes (AOPs), which are capable of oxidizing contaminants. They cannot be degraded by oxidizing agents commonly found in the environment. Wet air oxidation, supercritical water oxidation, Fenton reagent, photo catalytic oxidation, electrochemical oxidation, ultrasonic oxidation and ozonation are only a few of the numerous types of oxidation processes.

i) Wet Air Oxidation: F. J. Zimmermann proposed WAO in 1958 for the treatment of black liquid in papermaking. This technique decomposes organic materials into inorganic or tiny molecules by utilizing air or oxygen as the oxidant at high temperatures (150-350°C) and high pressures (0.5-20 Mpa). Generally, wet air oxidation is utilized in wastewater advanced treatment as a pretreatment method. When used properly, this technique offers a wide variety of applications, great efficacy in removing COD (up to 90 percent in some cases), and low energy usage with little secondary emissions.

ii) Supercritical Water Oxidation: A chemical interaction between dissolved oxygen and organic pollutants in supercritical water is called the SCWO (supercritical water organic pollutants) reaction. At a pressure of 24 Mpa and a temperature of 400°C, organic matter, air, and supercritical water were completely combined, forming a homogenous phase. Organic molecules spontaneously begin the oxidation process under these circumstances. Over time, 99.9% or more of the organic matter is swiftly converted into simple, non-toxic tiny molecules as a result of the increase in reaction temperature. As a result, SCWO's oxidation efficiency is great, and it will not produce secondary pollution. Although this approach has certain drawbacks, such as requiring high operating conditions and expense, there are some advantages [7].

3.5 Electro Dialysis Process [8]

Charged positively or negatively, membranes near steam inlet attract counter ions. Negative or positive charged ions can flow across these membranes, where the ions migrate from one water stream to another.

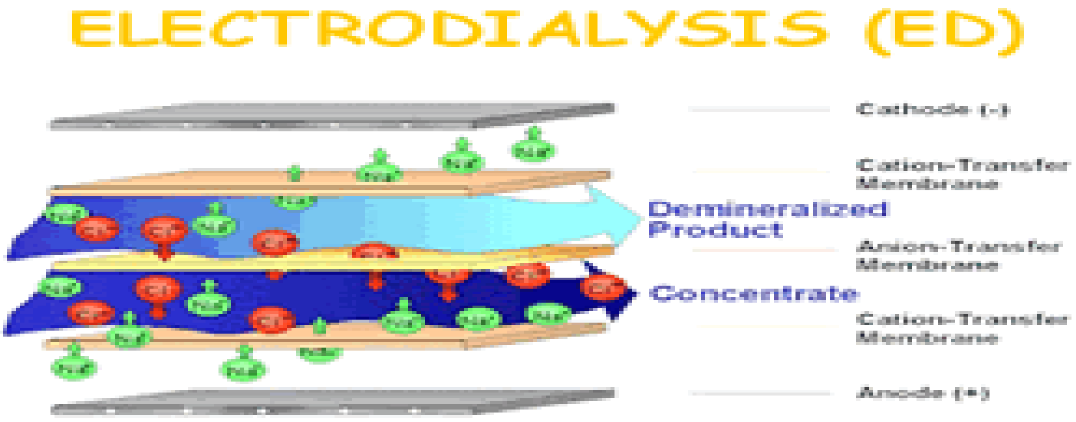

Fig. 1. Electro Dialysis

Table 1. Wastewater treatment technology based on chemical synthesis in pharmaceuticals

S.No	The characteristics of technology	Comment	Ref.
1	Sulfate anion radical oxidation (Fe and Co sulfate salts used with hydrogen peroxide and ozone)	Second-order kinetic degradation was followed by DCF and SMX, with an N-centered radical mechanism: a particularly effective approach, as sulphate radicals are more selective than hydroxyl radicals.	[10]
2	Dissolved air precipitation with solvent sublation	Because of variations in physical characteristics like Henry's constant and interfacial partitioning coefficient, removal efficiency for a combination of pollutants may differ from those for single contaminants. Toluene was shown to be removed at a greater rate.	[11]
3	Electro coagulation (EC) followed by heterogeneous photo catalysis (TiO2; iron electrodes were used as cathode and anode)	This resulted in a COD removal efficiency of 86 percent and a turbidity removal efficiency of 90 percent; the initial removal efficiency with EC is 70 percent, which is increased to 76 percent with the use of UV/ H_2O_2. For wastewater with a high concentration of refractory compounds, the combination works well.	[12]
4	Two-stage aerobic process, cyclic activated sludge system (CASS), and biologic contact oxidation tank + up-flow anaerobic sludge blanket (UASB) + micro aerobic hydrolysis acidification reactor (NHAR) + two-stage aerobic process, cyclic activated sludge system (CASS), and biologic contact oxidation tank (BCOT)	The integrated process results in a complete reduction in COD levels at every stage of the process and a COD removal efficiency of over 90%, making it ideal for wastewater effluents based on chemical synthesis.	[13]
5	The acidogenic and methanogenic phases of a two-phase anaerobic digestion (TPAD) system with a sub sequential membrane bioreactor (MBR) TPAD system with a continuous stirred tank reactor (CSTR) and an up-flow anaerobic sludge blanket-anaerobic filter (UASBAF)	Both the combined pilot plant and the MBR achieved 99 percent COD removal. To successfully treat chemically synthesized wastewater, TPAD-MBR can be combined with other technologies.	[14]

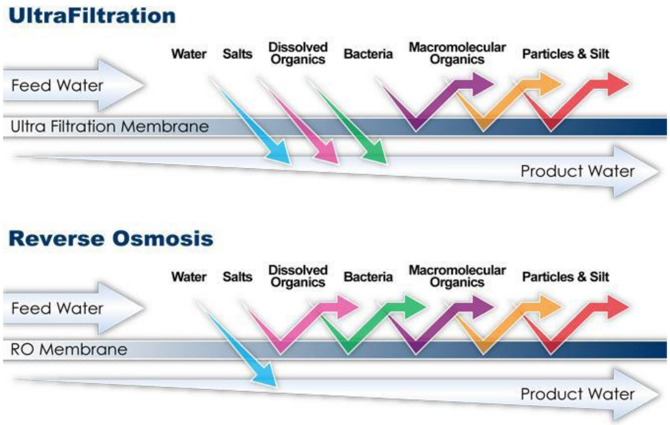

Fig. 2. Process of ultrafiltration

Electro Dialysis Equipment

The electro dialysis system is made up of three components:

1. A source of pressurized water
2. A source of direct current electricity
3. A pair of membranes that is selective

Electro dialysis has the following advantages:

1. It removes all contaminated ions as well as many dissolved non-ions.
2. It is insensitive to flow and TDS levels.
3. Low effluent concentrations are a possibility.

Electro dialysis' Limitations

1. High operating and capital expenses
2. A high level of pretreatment is necessary.
3. Approximately 20% to 90% of the input flow is rejected.
4. Electrode replacement is required after dialysis.

3.6 Ultra Filtration

Using the hydrostatic pressure, liquid is forced against a semi-permeable membrane in ultra filtration. Water and low molecular weight solutes pass through the membrane, while suspended solids and high molecular weight solutes are retained. Purifying and concentrating macromolecular (103-106Da) solutions, particularly protein solutions, is accomplished with this separation method in industry and research. Ultra filtration is a cross- flow separation technique, similar to reverse osmosis. Two streams are created when the liquid to be treated (feed) runs tangentially over the membrane surface. Permeate is the term used to describe the liquid that passes through the membrane. It will rely on the properties of the membrane, operating circumstances, and feed quality to determine what species will be left in the permeate. The other liquid stream is termed as concentrate, and it gradually concentrates those species eliminated by the membrane as it passes through [9].

4. CONCLUSION

At the end we conclude that the Pharmaceutical wastewater has several characteristics, such as low biodegradability and high concentration, due to the complexity of pharmaceutical operations. Advanced treatment of pharmaceutical wastewater is critical due to these features. There are many different types of advanced therapy, each with its unique set of characteristics. The quality of pharmaceutical wastewater effluent may be successfully improved via the logical application of diverse approaches.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/77621