Effluent Treatment and Wastewater in Pharmaceuticals

Anoop Sharma, Manish Kumar Mishra

School of Pharmaceutical Sciences, Shri Guru Ram Rai University,

Patel Nagar, Dehradun (Uttarakhand) 248001.

ABSTRACT: The composition of Pharmaceutical wastewater is complex, which is high concentration of organic matter, microbial toxicity, high salt, and difficult to biodegrade. After secondary treatment, there are still trace amounts of suspended solids and dissolved organic matter. To improve the quality of Pharmaceutical wastewater effluent, advanced treatment is necessary. In this paper, the classification of the Pharmaceutical technology was introduced, and the characteristics of Pharmaceutical wastewater effluent quality were summarized. The methods of advanced treatment of Pharmaceutical wastewater were reviewed afterwards, which included coagulation and sedimentation, flotation, activated carbon adsorption, membrane separation, advanced oxidation processes, membrane separation and biological treatment. Meanwhile, the characteristics of each process were described.

KEY WORDS: Effluent treatment, Chlorination, TDS, COD, BOD

INTRODUCTION:

Effluent Treatment Plants or (ETPs) are used by Dominant industries in the pharmaceuticals and chemicals to purify water and remove any toxic, non-toxic substances, solid particles, pathogenic microorganisms and chemicals from it. The ETP plants are mostly used in industrial sector, for example, pharmaceutical industry, to remove the effluents, many foreign substances from the bulk drugs. These plants are used by all companies for Environment safety and protection. The ETP plants use evaporation and drying methods, and other auxiliary techniques such as centrifuging, filtration, incineration for chemical processing and effluent treatment. The effluent liquids in any industry come from the different processes taking place in the industry it can be called as "process wastewater". Process wastewater can be defined as any water which during manufacturing or operations comes into direct contact with results from the production or use of incoming raw material, intermediate material, and finished product, by product or waste substance. The effluent contains high level of organic material, abundant nutrients and many other waste solids are separated and get change into fresh liquid.

Mechanisms and cure level of effluent Treatment plant in pharmaceuticals:

There are four level of treatment of ETP:

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Tertiary treatment

Preliminary Treatment: In preliminary treatment of ETP, the Physical separation of large sized impurities like wood, logs, paper, cloth, plastics, solid materials etc.

Screening: A screen with openings of uniform size is used to remove large solids such as plastics, cloth etc. Generally maximum 10mm is used in preliminary cure. **Sedimentation:** in which Physical water treatment process using gravity to remove suspended solids from water. **Clarification:** It is used for separation of solids from fluids in preliminary level of treatment.

Primary Treatment: In which Removal of floating materials such as organic matter and suspended solids is done by primary cure. **Methods:** Both physical and chemical methods are used in this treatment of ETP. **Chemical unit processes:** Chemical unit processes are always used with physical operations and may also be used with biological treatment processes. Chemical processes are use the addition of chemicals to the wastewater to bring about changes in its quality.

Secondary treatment: There are Biological and chemical processes are involved in this treatment. Biological unit process is to remove, or reduce the concentration of organic and inorganic compounds. Biological treatment process can take many forms but all are based around microorganisms, mainly bacteria.

Anaerobic Processes the anaerobic treatment processes take place in the absence of air (oxygen).

Aerobic Processes Aerobic treatment processes take place in the presence of air (oxygen). Utilizes those microorganisms (aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass.

Tertiary Treatment: In this treatment Final cleaning process that improves wastewater quality before it is reused, recycled or discharged to the environment.

Mechanism: Removes remaining inorganic compounds, and substances, such as Bacteria, viruses and parasites, nitrogen and phosphorus which are harmful to public health, are also removed at this treatment.

Methods: Alum: This method is used to help remove additional phosphorus particles and group the remaining solids together for easy removal in the filters. Remaining chlorine is removed by adding sodium bisulphate just before it's discharged.

IMPORTANCE AND BENEFITS:

Nowadays there are a number of pharmaceutical industries throughout the country and their waste water is discharged into the environment. A number of them are situated beside rivers, streams lakes or other water bodies and some are situated beside residential areas. Some of the pharmaceutical industries use ETP for treatment of their effluent before disposal whereas the others do not which is creating a threatening condition to the environment. The main purpose of effluent treatment plant is to reuse water for various functions.

It can be used for testing, laboratory scale, Production scale etc. ETP is beneficial for each Pharmaceutical, chemicals and many other industries to control the Environmental hazards.

MATERIAL AND METHODS:

Characteristics of pharmaceutical wastewater:

In Pharmaceutical industries, waste water contains high concentration of organic matter, microbial toxicity, microorganisms, high salts and solid particles and it is very hard to biodegrade.

There are many stages of cause's waste water from batch process, raw material and production process in every pharmaceutical industry.

Table 1.The following table shows the characteristics of pharmaceutical waste water:

COD (mg/L)	BOD (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Suspended Solids (mg/L)	Chromaticity (times) (mg/L)	Temp. (˚C)	PH
1000-10000	500-2500	500-1500	50-250	200-500	500-1000	25-80	1-8

Treatment of pharmaceutical waste water: (Methodology):

1. **Coagulation and Sedimentation:** Coagulation is a method by adding chemical substance to wastewater, dispersing by rapid mixing, then creating stable impurities into unstable and perceptible matters. The mechanism of coagulating treatment is complex. The important is how to squeeze and remove bound water round hydrophilic colloid. So the atmosphere of flocculent is important, which related to the effect of coagulation. Inorganic metal salts and polymers are frequently used as flocculent. This method is used for removing the suspended solids. sedimentation is a method after coagulation in which separation of solid particles can be done.

2. **Flotation:** flotation is method of removing the suspended solids from secondary effluent. The technology representative is producing a large number of tiny bubbles by injecting air into wastewater, forming floating with smaller density than wastewater. It can float to the surface of wastewater to separate.
3. **Activated carbon adsorption:** Activated carbon is a type of adsorbent has many advantages in this treatment. It is widely used as adsorbent or catalyst carrier to eliminate contaminants. It is an important method of advanced treatment of pharmaceutical wastewater. Activated carbon adsorption can be classified as physical adsorption and chemical adsorption. It has large specific surface area, multilevel pore structure, high adsorption capacity and stable chemical property. In industrial effluents treatment, activated carbon is used for effluent, which is toxic and hard to achieve discharge standard. This method is widely used for advanced treatment, because it can be recycled, its better treatment effect and wide suitability.
4. **Advance oxidation process:** There are many types of AOPs, such as supercritical water oxidation, wet air oxidation, Fenton reagent, photocatalytic oxidation, ultrasound oxidation, electrochemical oxidation. In this treatment oxidize the toxins by forming free radicals. Those types of toxins cannot be degraded by common oxidizing agent.

4.1. **Wet air oxidation (WAO):** This method has wide range of applications, high efficiency of COD removal, which can reaches more than 90 % under appropriate conditions, low energy consumption, less secondary pollution, and it is easy management. This method decomposes organic matter into inorganic or small molecules at high temperature (150-350 °C) and high pressure (0.5-20 Mpa). WAO is mainly used in pretreatment of wastewater advanced treatment.

4.2. **Supercritical water oxidation (SCWO):** SCWO is chemical reaction between dissolved oxygen and organic pollutants in supercritical water. Under these conditions, organic compounds instinctively initiate the oxidation reaction. With the increase of the reaction temperature, 99.9 % or more of the organic matter is quickly oxidized into simple non-toxic small molecules in a period of time, attaining the purpose of eliminating pollutants.

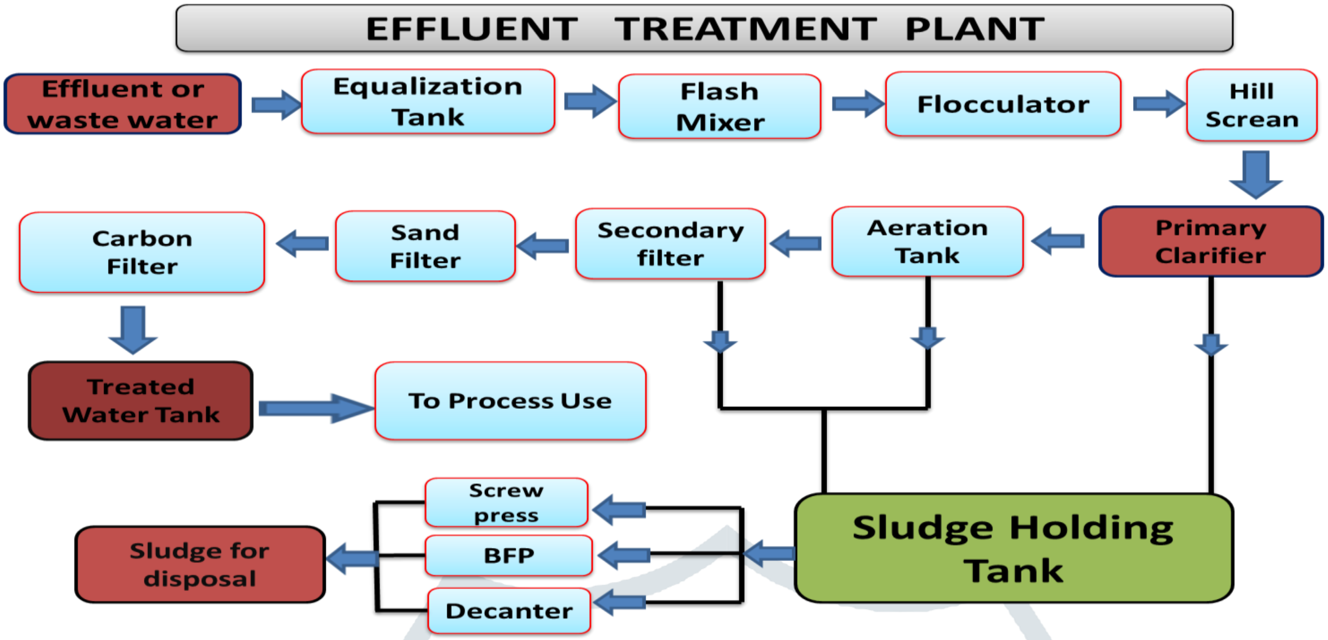
4.3 **Fenton reagent:** Fenton system was originally used in organic synthesis. The system was regularly applied to industrial wastewat

er treatment. Fenton reaction can be carried out under normal temperature and pressure, and less damage to the environment and one of the best treatment. Fenton is a progressive oxidation method, which is simple, high oxidation efficiency and mild reaction conditions. However, the inadequacy of the Fenton reaction cannot be ignored

4.4. **Ultrasound oxidation:** Ultrasonic degradation of organic matter in wastewater is a physical and chemical degradation process, mainly based on ultrasonic cavitation effect and the resulting physical and chemical changes. It includes the three methods: free radical oxidation, pyrolysis and supercritical water oxidation

Chlorination: Chlorination is widely used method in the wastewater treatment process by eliminating pathogens and other physical and chemical impurities. Chlorine can be used in wastewater treatment as also elemental chlorine (gas) or as a chlorinated compound such as liquid sodium hypochlorite solution or solid calcium hypochlorite. Elemental chlorine is usually the greatest cost-effective option, but other factors must also be considered.

Filtration: Filtration is also physical and chemical process of waste water treatment which is used for the separation of solids from fluids (liquids or gases) by interrupting a medium through which only the fluid can pass. The fluid that passes through is called a filtrate. Two types of sand filters are in use: slow and rapid. Slow filters require much more surface area than rapid filters and are difficult to clean. Most modern water-treatment plants now use rapid dual-media filters following coagulation and sedimentation.



EXPERIMENTAL:

pH test: Calibrate the instrument with 4,7and 9.2 buffer solutions. Ensure the calibration is done.100ml of sample into a cleaned beaker place the electrode.Note the reading of pH.

COD (Chemical Oxygen Demand) :_ A sample is refluxed in strong acid solution with a known spare of potassium dichromate.After digestion the remaining unreduced K2Cr2O7 is titrated with FAS.To determine the amount of K2Cr2O7consumed and the oxidized matter is calculated in terms of oxygen equivalent.

TDS (Total Dissolved Solids): Sample is filtered through filter paper and the filtrate is evaporated to dryness in a weighted dish and dried to constant weight at 180oC.

SS (Suspended Solids): Dry paper for 1hr at 105 0C and keep it in silica gel for 30min and measure its weight. Add 50ml sample on the paper, apply vacuum and dry the paper in oven at 105 0C and ool the paper by charge it in silica gel and measure its weight.

Ammonical nitrogen : The sample is buffered at pH 9.5 with a borate buffer to decrease hydrolysis of cyanates and organic nitrogen compounds. It is distilled into a boric acid solution and determines ammonia in distillate titrimetric ally with std. H2SO4 and mixed indicator.

RESULT AND DISCUSSION:

Waste water is treated by different methods and it is based upon the different parameter followed by different pharmaceutical industries. The above review of waste water treatment consider the treatment plant. In pharmaceutical industries this treatment is followed as per industries guidelines and removing process of liquid and solid matter.This review conclude that various treatment followed by pharmaceutical industries for waste liquids. The problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to catch such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources.The following results are obtained by wastewater treatment:

pH: It was observed that all the samples pH is acidic in nature and varied between 2.9 to 5.26 before treatment pH values generally depend on nature of chemicals used in synthesis and other compounds and their reaction mechanism. Some drugs release neutral or highly alkaline effluents. The pH was fixed at 6.5 for all the samples to reach 98% efficiency of treatment.

Oil & Grease: The source of oil and grease in effluents is due to fatty acids and esters. Oil and Grease varied from 1080mg/L to 1650mg/L before treatment. After the treatment the O & G values varied from 6mg/L to 10mg/l.

TDS: Total Dissolved Solids are very high and varied from 17250mg/L to 21900mg/L.TDS before treatment. After treatment the TDS values varied from 190mg/L to 135mg/l. There is enough scope to increase or to decrease the TDS values by operating bypass valve of R.O. Process.

TSS: Total suspended solids (TSS) were more prominent in all the samples. TSS varied between 1560mg/L to 2170 mg/L before treatment. After treatment the TSS values are less than 10mg/L. This is due to R.O. Process in tertiary treatment.

COD: Chemical oxygen demand is mainly due to organic matter present in the effluent. Organic matter is two types, one is bio-degradable and the other is non bio-degradable. In pharmaceutical industry the effluent contains nonbiodegradable chemical oxygen demand. COD values varied from 13800mg/L to 16860 mg/L before treatment. After treatment the COD values varied from 130mg/L to 240 mg/L.

CONCLUSION:

This review contributes to enhancing our knowledge of wastewater management issues and about solid waste from the pharmaceutical industry. The overall performance of the effluent treatment plant was satisfactory. This treatment plant is high potential for BOD, TSS and TDS removal. Thus this treatment Technology can be considered as a potential plant for industrial wastewater treatment.

Due to the complication of pharmaceutical processes, pharmaceutical wastewater has some characteristics, such as poor biodegradability and high concentration. From these characteristics, advanced treatment of pharmaceutical wastewater is very necessary. There are many kinds of advanced treatment, each method has its own features. Through rational utilization of various methods, can effectively improve the quality of pharmaceutical wastewater effluent.

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