



# The Journal of Multidisciplinary Research (TJMDR)

Content Available at [www.saap.org.in](http://www.saap.org.in)

ISSN: 2583-0317



## WASTEWATER MANAGEMENT TECHNIQUES: A REVIEW

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Received: 05 Mar 2023 Revised: 14 Mar 2023 Accepted: 14 May 2023

### Abstract

The wastewater treatment research is based on industrial processes and agricultural wastewater treatment methods. Most of the river basins are closed to severe water storages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. In these research the aerobic, anaerobic or the combination of methods used. Other than that an adsorption and coagulation have been applied to remove the pollution. The research on chemical industrial wastewater treatment was first studied on organic removal efficiency of lab scale system using aerobic and anaerobic reactors. The aerobic wastewater treatment as a reductive medium is receiving increased interest due to its low operation and maintenance costs and aerobic wastewater treatment is easy to obtain. The primary goal of the wastewater treatment process is to eliminate various pollutants such as solids, organic carbon, nutrients, inorganic salts, metals, pathogens and so on effective wastewater treatment and disposal are critical for both environmental and public health reasons. The aim of wastewater treatment is to protect the environment and wastewater management. The many research papers on wastewater pollution control studies, but very few research works is carried out for treatment of wastewater. The beneficial aspect of this paper is recycling, reuse of water. The industrial wastewater is divided into four categories: Chemical, Physical, Biological and mathematical approaches. In this main focused on the Biological methods viz. Aerobic and anaerobic.

**Keywords:** Aerobic, Anaerobic, Dissolved Oxygen (DO), Industrial Water, Wastewater, Biological.

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DOI: <https://doi.org/10.37022/tjmdr.v3i2.443>

### Produced and Published by

South Asian Academic Publications

### Introduction

A supply of clean water is an essential requirement for the establishment and maintenance of diverse human activities. Water resources provide valuable food through aquatic life and irrigation for agriculture production. However, liquid and solid wastes produced by human settlements and industrial activities pollute most of the water sources throughout the world.

The World Water Development Report, released in March 2018, states that global water demand is increasing at an annual rate of 1% due to factors such as population growth, changes in economic development patterns, and diversification of consumption patterns (UNESCO). In India population of 1.3 billion people, 91 million people (6% of the population) lack access to safe water and 746 million people (54%) lack access to safely managed household sanitation facilities. Current challenges include extreme water stress, contaminated

surface water and lack of access to piped water supply. The effects from climate change like droughts and rising sea levels also affect access to safe water and sanitation for families in India (<https://water.org/our-impact/where-we-work/india/>). In the table 1. Shows different countries adopted different methods for the wastewater treatment [1].

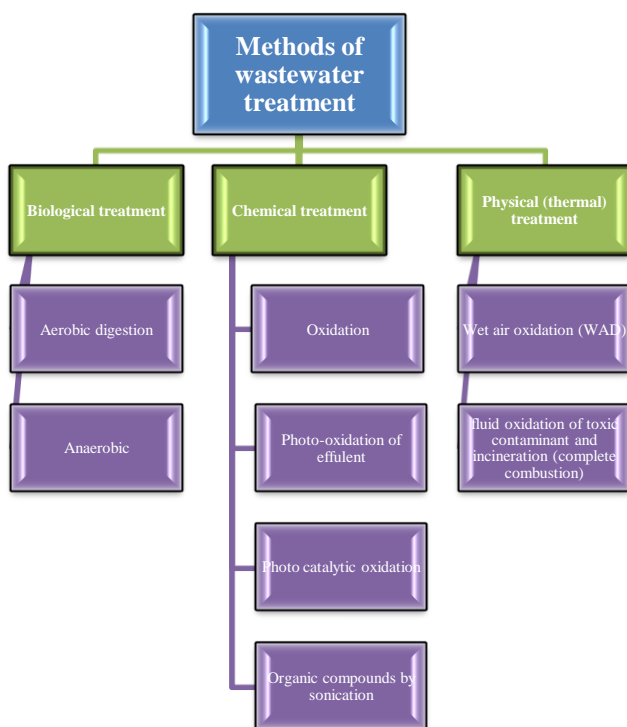
**Table. 1. Overview of the wastewater treatment technology types in the selected countries [1]**

Country	Treatment type
Jordan	Activated sludge Biofiltration Stabilization ponds Extended aeration
Turkey	Activated sludge/extended aerated Trickling filter Stabilization ponds
Lebanon	Grit and scum removal
Palestine	Extended aeration Stabilization ponds Oxidation ditches Anaerobic Rock filter Imhoff tank and trickling filter Anaerobic sludge stabilization

<b>China</b>	Municipal WWTPs
<b>India</b>	Microfiltration (MF) or ultra filtration (UF)
	MBR sewage treatment technique
	<ul style="list-style-type: none"> <li>Activated sludge plant (ASP)</li> </ul>
	Rotating disc system
	<ul style="list-style-type: none"> <li>Submerged aerated filter (SAF)</li> <li>Suspended Media Filters (SMF)</li> <li>Sequencing batch reactor (SBR)                             <ul style="list-style-type: none"> <li>Non-electric filter</li> <li>Trickling filter [2]</li> </ul> </li> </ul>

**Types of wastewater treatment**

The classification of techniques for the removal or the reduction of the contaminants based on the need and the available technology is as follows:

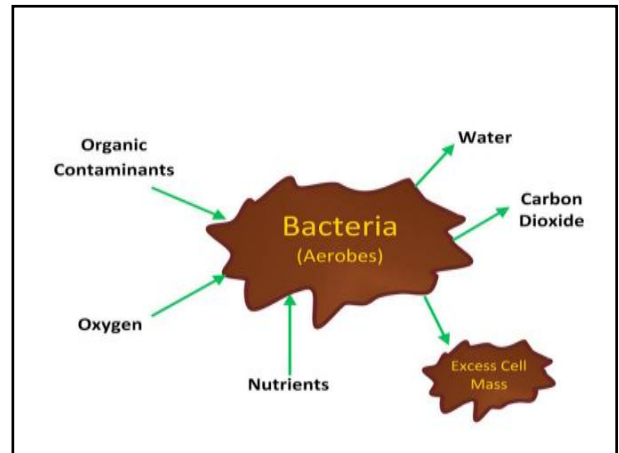


**Fig 01: Shows Methods of waste water treatment**

**Aerobic and Anaerobic Wastewater Treatment:**

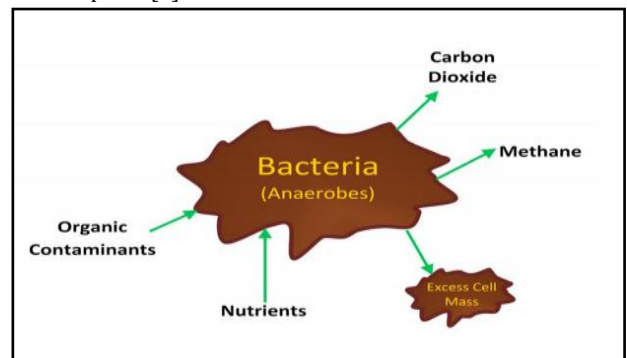
Aerobic, as the title suggests, means in the presence of air (oxygen); while anaerobic means in the absence of air (oxygen). These two terms are directly related to the type of bacteria or microorganisms that are involved in the degradation of organic impurities in a given wastewater and the operating conditions of the bioreactor. Therefore, aerobic treatment processes take place in the presence of air and utilize those microorganisms (also called aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass. The anaerobic treatment processes, on other hand take place in the absence of air (and thus molecular/free oxygen) by those microorganisms (also called anaerobes) which do not require air

(molecular/free oxygen) to assimilate organic impurities. The final products of organic assimilation in anaerobic treatment are methane and carbon dioxide gas and biomass [2].



**Fig 02: Aerobic Process [3]**

Aerobic treatment systems such as the conventional activated sludge (CAS) process are widely adopted for treating low strength wastewater (< 1000 mg COD/L) like municipal wastewater. CAS process is energy intensive due to the high aeration requirement and it also produces large quantity of sludge (about 0.4 g dry weight/g COD removed) that has to be treated and disposed off. As a result, the operation and maintenance cost of a CAS system is considerably high. Anaerobic processes for domestic wastewater treatment are an alternative that is potentially more cost-effective, particularly in the sub-tropical and tropical regions where the climate is warm consistently throughout the year. Anaerobic wastewater purification processes have been increasingly used in the last few decades. These processes are important because they have positive effects: removal of higher organic loading, low sludge production and high pathogen removal, methane gas production and low energy consumption [4].



**Fig 03: Anaerobic Process**

In the figure shows clearer visualization of some of the advantages of anaerobic digestion in relation to aerobic treatment, notably regarding the production of methane gas and the very low production of solids. In aerobic systems, only about 40-50% of biological stabilization occurs, with its consequent conversion into CO<sub>2</sub>. A very large incorporation of organic matter as microbial biomass

(about 50-60%) is verified, constituting the excess sludge of the system. The organic material, not converted into carbon dioxide or into biomass, leaves the reactor as non degraded material (5-10%).

In an aerobic systems, most of the biodegradable organic matter present in the waste is converted into biogas (About 70-90%), which is removed from the liquid phase and leaves the reactor in a gaseous form. Only a small portion of the organic material is converted into microbial biomass (about 5-15%), which then constitutes the excess sludge of the system. Besides the small amount produced, the excess sludge is usually more concentrated, with better dewatering characteristics. The material not converted into biogas or into biomass leaves the reactor as non-degraded material (10-30%) [5].

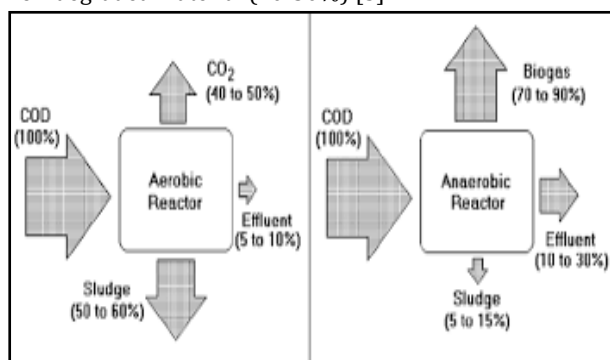


Fig 04: Biological conversion in Aerobic and anaerobic systems

### 1. Techniques of wastewater treatment:

In this paper literature investigate the thorough analysis of the wastewater and in this literature also discussed some previous researches towards it. The qualitative part of research consists of analysis of wastewater and its requirement, multiple techniques enhancements and future scopes. The literature review is basically used to identify the major factor which is being involved in wastewater treatment. The following such researches are being mentioned below of the different authors to give wastewater treatment technology a balance review.

### Review of Literature

❖ **Mahdi, et al., 2007** reported on management an associate anaerobic and aerobic system for the wastewater treatment. Water is used extensively in textile production process water is mainly used in the work of dyeing and finishing fabrics of establishments. Both the amount generated and the composition of the sewage considering the factors, wastewater from the textile industry is the most polluting of all industrial areas is rated. In this study, compounds for processing textile wastewater anaerobic-aerobic reactors were operated continuously. Effects of pH, dissolved oxygen and nitrification and organic changes in the denitrification process were investigated. The results indicated that over 84.62% is high ammonia nitrogen and about

98.9% volatile suspended solid (vss) extractions efficiency can be obtained. Dissolved oxygen (DO) has been shown to have only a slight effect on pH Nitrification process and for every 10% nitrogen removed, only 3% of the pH changes achieved.

### ➤ Instrumentation:

A laboratory scale integrated anaerobic and aerobic reactor was set up for testing effectiveness of the system for processing textile wastewater during the period of nitrogen removal.

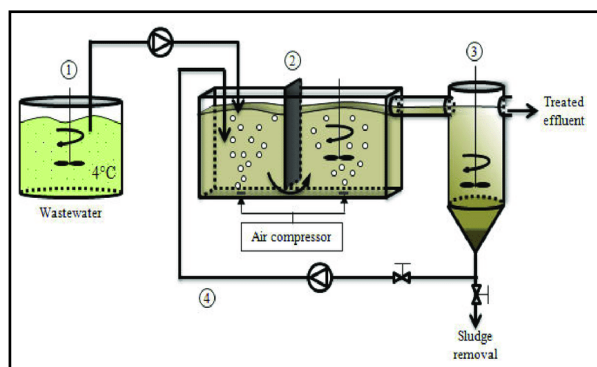
### ➤ Anaerobic reactor:

The diameter of the anaerobic reactor made of transparent PVC is 30 cm, height 30 cm and total working volume 18 liters. The reactor was filled with auxiliary particles to stabilize microorganism in the system and a total of 2-liters of active sludge the palm oil mill was collected from Hulu Langat in Malaysia and filled in the reactor.

### ➤ Aerobic reactor:

The aerobic reactor is made of transparent PVC, has a diameter of 20 cm, height of 48 cm, and total working volume of 9 liter. A total of 1 liter sewage sludge from Indah Water consortium was collected and fed into the aerobic reactor. Acclimatization of the aerobic sludge was not as critical as compared to anaerobic reactor due to primary function of the aerobic reactor was meant for polishing only. Air was supplied by a fine bubble diffuser; flow was regulated at 6 mg/lit/min by a flow meter. They concluded that the combined anaerobic and aerobic system was able to treat high strength textile wastewater. The maximum removal of ammonia nitrogen, BOD, COD, VSS were 84.62%, 63.64%, 60% and 98.9% respectively.

❖ **Fayza et. al., 2004** conducted a research on chemical industrial wastewater treatment. There was a building and construction chemical factories and factory for making plastic has investigated both factories discharge their wastewater into the public sewage network. The results showed sewage discharged from the building and construction chemicals factory organic compounds are highly contaminated. The average values of chemical oxygen demand (COD) and Biological oxygen demand (BOD) were by 2912 and were 150mgO<sub>2</sub>/lit phenol concentrations up to 0.3 mg/lit were found. Lime with ferric chloride chemical treatment using proved to be effective and Egyptian permissible created of fluid property by adhering to limits. In the context of other factories, organic industrial wastewater was mixed with domestic wastewater to reduce the load. Mix after COD, BOD values reached 5239 and 2615 mg O<sub>2</sub>/lit Average concentration phenol content was 0.5 mg/lit.



**Fig 05: Conventional Activated sludge process system**

Aerobic biological treatment is performed using activated sludge and rotating biological contacts passed. From their survey, they concluded that characteristics of chemical industrial wastewater determine the adequate treatment system, more specifically, concentration, molecular size, solubility, toxicity and biodegradability of the pollutants. Dilution of chemical industrial pollutants using domestic sewage in the factory effectively decreases the concentration and toxicity of the pollutants and subsequently increases the efficiency of the biological treatment. Also dilution with sewage is cost effective since no chemical salts are required to provide nutrients [6].

- ❖ **Florante et. al., 2009** conducted a preliminary study on nitrogen and organic removal efficiency of a lab-scale system using aerobic and anaerobic reactors. A simulated wastewater containing elevated levels of nitrogen was used. This paper aims to compare the efficiency of aerobic and anaerobic reactors in achieving nitrogen and chemical oxygen demand (COD) removal of nutrient rich wastewater. It also presents the start-up experimentation conducted on simulated wastewater using two different reactors configured as aerobic and anaerobic. Start-up experiments were carried out using a 5-liter acrylic aerobic reactor and a 4-liter flask anaerobic reactor containing activated sludge taken from De La Salle University (DLSU) wastewater treatment plant as a source of inoculums. Simulated wastewater was continuously fed to the two reactors and the time course of biomass growth was monitored by measuring the biomass concentration represented by mixed liquor volatile solids (MLVS). The time course of organic pollutant reduction by measuring the chemical oxygen demand (COD) was conducted until steady state condition was reached. On the other hand, COD and nitrogen tests such as Ammonia nitrogen ( $\text{NH}_3\text{-N}$ ), Nitrite nitrogen ( $\text{NO}_2\text{-N}$ ), Nitrate nitrogen ( $\text{NO}_3\text{-N}$ ) were also performed using 5 batch aerobic reactors containing different concentrations of wastewater and a single batch anaerobic reactor to see the effect of different feed concentrations in the removal of nitrogen. Preliminary results showed that 98% reduction in COD was obtained in aerobic reactor, as supported by increasing concentration of MLVS, with a hydraulic retention time (HRT) of 5 hours after 11 days while 34% reduction in COD was obtained in anaerobic reactor with the same HRT after 14 days.

### ➤ Instrumentation

Experiments were carried out using aerobic and anaerobic reactors. A continuous aerobic reactor was made up of acrylic board with a working volume of 5 liters where an air pump was used for aerobic zone. On the other hand, a continuous anaerobic reactor was made up of a 4 liter Erlenmeyer flask equipped with magnetic stirrer and stir bar to facilitate continuous stirring within the reactor. A photograph of the reactors used in this study is shown below. Batch reactors as shown in the picture below were made up of five 1 liter imhoff cones supported by iron stand and iron ring with different concentrations of wastewater. Air pumps were also used for each reactor for aeration. From the experimental results obtained, the following conclusions were drawn:



**Fig 06: Aerobic and anaerobic reactors**

Aerobic process requires longer aeration time and produces large amount of sludge but they can remove ammonium nitrogen. Anaerobic treatment methods usually offer advantages such as higher organic loading rates and production of usable biogas; however a relatively higher effluent concentration and incapability to remove ammonium nitrogen are some of its disadvantages.



**Fig 07: Batch Reactor**

At the same HRT, 98% reduction in COD was obtained in aerobic reactor against 34 % reduction in anaerobic reactor; therefore, anaerobic bacteria have a slower capability to degrade organics. Nitrite accumulation and low nitrate build up in aerobic reactor was observed because of the low activity of NOB maybe due to the presence of inhibitors or un-controlled pH. In the reactor nitrification is occurred. Therefore, based on the above findings, it is more attractive to use combined anaerobic and aerobic systems for simultaneous removal of nitrogen and COD [7].

❖ **Rakesh Singh Asiwai, 2016** was concluded the water is the essential natural resources for all life on Earth. The availability and quality of water always not only also where people can live, but their quality of life. The Commercial water use includes Fresh water for motels, hotels, restaurants, office, buildings other commercial Facilities, and civilian and military institutions. Domestic water use is probably the most important daily use of water for most people. Industrial water use is a valuable resource to the nations. Industries for such purposes as Processing, cleaning, transportation. Dilution and Cooling in manufacturing Facilities major waste using industries. Include steel, chemical, paper and petroleum refining Industries often reuse the same water over and over for more than one purpose. Public Supply water use refers to water withdrawn by public and private water suppliers, such as country and municipal water work and industrial purposes. In 1995, the majority of the nations delivered from public water suppliers.

Treatment Levels & Mechanisms of ETP -  
- Treatment levels:

- 1) Preliminary
- 2) Primary
- 3) Secondary
- 4) Tertiary

### 1) Preliminary Treatment level Purpose

Physical Separation of big sized impurities like cloth, plastics, wood logs, paper, etc. Common physical unit operations at Preliminary level are: Screening: A screen with openings of uniform size is used to Remove large solids such as plastics, cloth etc. Generally maximum 10 mm is used. Sedimentation: Physical water treatment process using gravity removes suspended solids from water is used for separation of solids from fluids.

### 2) Primary Treatment Level Purpose

Removal of floating and settle able materials such as suspended solids and organic matter.

• **Methods:** Both physical and chemical methods are used in this treatment level. Chemical unit processes: Chemical unit processes are always used with physical operations and may also be used with biological treatment processes. Chemical processes use the addition of chemicals to the wastewater to bring about changes in its quality.

### 3) Secondary Treatment Level Methods

Biological and chemical processes are involved in this level. Biological unit process 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. Aerobic Processes takes 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. Anaerobic Processes takes place in the absence of air (oxygen). Utilizes microorganisms (anaerobes) which do not require air (molecular/free oxygen) to assimilate organic impurities. The final products are methane and biomass.

### 4) Tertiary / Advanced Treatment Purpose

A 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 the nitrogen and phosphorus. Bacteria, viruses and parasites, which are harmful to public health, are also removed at this stage. Methods: Alum: Used to help remove additional phosphorus particles and groups the remaining solids together for easy removal in the filters. Chlorine contact tank disinfects the tertiary treated wastewater by removing microorganisms in treated wastewater including bacteria, viruses and parasites. Remaining chlorine is removed by adding sodium bisulphate just before its discharge.

❖ **Niraj S. Topare et al., (2011)** demonstrated about an overview of the wastewater treatment. Sewage treatment techniques, design of wastewater systems and factors influencing selection are briefly mentioned in this article. Furthermore, the author thoroughly discussed the main persistence of the wastewater treatment process, which is to eliminate the various elements of the polluting load, such as inorganic salts, solids, nutrients, organic carbon, metals, pathogens and so on. In the last segment the author provided a conclusion to give a balance view. After researching about the above mentioned research paper, it can be said that the research has been done keeping various means of wastewater treatment but the balance view has not been provided as some of the research papers are missing the factors affecting the wastewater objectives of it and the biological treatment techniques that are being required for wastewater treatment. So basically, it does not conclude a balance view. So, our research paper overcome all such limitations and all these factors are thoroughly analyzed and mentioned in such a manner that it is easily understood and most importantly all the wastewater treatment techniques including biological treatment are clearly mentioned and analyzed to give it a balance view. This study is useful for those interested in learning more about studies in the field of wastewater treatment techniques.

## **Conclusion**

The various options used for wastewater treatment recovery and reuse. The anaerobic system is an excellent technology for many regions of the world has been proven. Post treatment still requires an aerobic system example pond, trickling filter or there may be active sludge plants. The large plant the more economical it energy combine these technologies. Anaerobic biological treatment are well understood and primary and secondary wastewater as anaerobic designer for treatment of complex organic solids such as sludge are used frequently .The low energy organic wastewater from industrial and domestic use not much has been used in the past to process. Treatment of these effluent streams aerobic procedure were preferred because they are easy to operate and process can withstand, installation is more expensive and longer for startup. Problems related to wastewater recycling arise due to its lack of treatment. Thus, reduced the challenge is to find cost effective, low technology, user friendly methods that, on the one hand, avoid endangering the lives of those who depend on our wastewater, and on the other, protect us from the loss of our precious natural resources. The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment. Compared to traditional treatment methods, constructed moist soils require less material and energy, they run smoothly, there is no problem of sludge disposal and they can be maintained by untrained staff. Further the maintenance and operation costs of these systems are low as they are powered by the natural energy of sun wind, soil.

## **Funding**

No Funding

## **Acknowledgement**

NA

## **Conflict of Interest**

Authors are declared that no Conflict of Interest

## **Informed Consent**

Not Applicable

## **Ethical Statement**

Not Applicable

## **Author Contribution**

First author collect the information and prepare manuscript, corresponding author finalize manuscript, third and fourth author assistance for manuscript preparation

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