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REVIEW ARTICLE **OPEN ACCESS**

Wastewater Treatment in India: An Update Review

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ABSTRACT

Growth of big cities and industrial set-up along the rivers has posed serious pollution problems. Huge sewer discharge and discharge of industrial wastes into the river systems have, at times polluted the water to the extent that dead fishes were seen floating on the water surface. During ancient times human wastes were simply discharged into the nearest body of water, such as lake, stream, river or ocean. In rural areas of many developing countries, this practice still continues. As the human population size grew these water bodies became degraded, affecting aquatic wildlife due to depleting levels of oxygen. Moreover waterborne diseases began to threaten human lives also. Human activities create vast amounts of various solid and liquid wastes. The release of these materials into the environment causes serious health problems as they make undesirable changes in our land and water resources making them unfit for use. Disease like cholera, jaundice, typhoid, dysentry and tuberculosis became very common. So the proper treatment of such wastes is necessary, using microbial biodegradation/ detoxification etc.

Key words: *Pollution, environment, biodegradation and detoxification*

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INTRODUCTION

"Nature's plentifulness is a heritage not to be squandered with impunity, it must be conserved for future generations or its bank-ruptcy will extinguish us all" [1]. Man made pollutants not only damage environment, health, vegetation and materials but also interfere with climate. Water is extremely essential for life; this common fact is known to all. It is required to meet our basic needs in day today life viz., cooking, drinking, and bathing, disposal of sewage, irrigation, generating electricity in power plants, cooling and manufacturing different products in industrial wastes [2]. During all these process undesirable substances are added to the water resources to a great extent. This alters the basic chemistry of water resources to a great extent [3]. Inorganic nitrates and phosphates promote growth of oxygen consuming algae, which result in the death of fishes and other aquatic animals. Presence of cadmium damages kidneys and liver. Waste minimization in the production process in chemical industry is the first and most important step to avoid waste formation during the production [4, 5]. Because of the fluctuation in the strength and flow rate, Bury applied dynamic simulation to chemical-industry wastewater treatment to manage and control the treatment plant [6, 7].

A recent 2016 survey made by C.S.E. Delhi has shown that on the basis of strategies for solid waste management used by different urban areas, Indian cities could be grouped into three categories:

1. Those that collect segregate and process waste, indicating a holistic way to process (rank 1 to 4).
2. Those that collect, but have partial segregation and treatment facilities (rank 5 to 8)
3. Those that collect but do not segregate and process waste (rank 9 to 14)

Kerala, Goa, Karnataka and Andra Pradesh are India's top four cities as they give priority to segregation of waste at the house hold level and its reuse. Sunita Narain and Swati Singh Sambyal of CSE, Delhi put their views that the real challenge for waste processing in India is to integrate the technology with a system of house hold-level segregation, collection and transportation of waste and all this in ways that both are affordable and manageable by invariably weak and financially stretched city local bodies [8].

Wastewater must be treated before it reaches the receiving environments to maintain minimum pollutant standards. Wastewater treatment is a process in which the solids in wastewater are partially removed and partially changed by decomposition from highly complex, putrescible, organic solids to mineral or relatively stable organic solids [9]. Effective wastewater treatment methods should remove the pollutants, nutrients, organic load, fat, oil crease, blood and pathogens from the wastewater to ensure the low level of toxicants in the final discharge effluent. Wastewater treatment involves various methods

to treat the industrial effluents and to retain the bio-wealth of an ecosystem[10]. Wastewater treatments technology completely depends on quality and quantity of wastewater, and treatment systems can be applied exclusively or integrate all suitable methods to obtain minimum level of pollution.

WASTE AND WASTEWATER MINIMIZATION TECHNIQUES

Although the collection of wastewater dates back to ancient times, its treatment is a relatively recent development dating from the late 1800s and early 1900s [11]. Modern knowledge of the need for sanitation and treatment of polluted waters however, started with the frequently cited case of John Snow in 1855, in which he proved that a cholera outbreak in London was due to sewage contaminated water obtained from the Thames River [12, 13]. In developed nations, treatment and discharge systems can sharply differ between countries and between rural and urban users, with respect to urban high income and urban low-income users [14]. The most common wastewater treatment methods in developed countries are centralized aerobic wastewater treatment plants and lagoons for both domestic and industrial wastewater.

Some key techniques help to manage the quality of waste, and quantity of water use and wastewater generation. The application of good wastewater minimization techniques will keep the volume of wastewater and potential pollutants to a very minimum.

The following are some of the waste and wastewater reduction technologies:

- Recover as much as organic waste without wash down
- Don't allow solid into water system/streams
- Avoid generating unnecessary wastewater
- Minimize the strength of contaminants
- Minimize the amount of water used
- Treat and water reuse/recycle
- Use evaporation pond
- Dispose of the wastewater to the sewerage system
- Treat wastewater before it reaches to the receiving to the end

Wastewater is primarily a combination of human fecal matter, urine and grey water. Gray water result from washing, bathing and meal preparation. Water from various industries and business establishments may also enter the system. Major organic and inorganic constituents of untreated domestic sewage are suspended solids volatile, settable solids, BOD, organic carbon, nitrogen (free NH_3, Nitrites and Nitrates) and phosphorus (organic and inorganic) etc. pathogenic microorganism are invariably present in domestic wastewater like *Enterococci, Salmonella, Clostridium sp, Helminthes* ova, Enteric virus etc. their chief source appears to be the excreted matter from infected persons.

Sewage is the used water supply containing domestic waste together with human excrement and wash water and industrial waste, vegetable matter and storm waters[15]. Basic principle of sewage treatment is that water is separated from the waste while the solid organic matter is biodegraded by microorganisms to simple compounds like nitrates, sulphates, carbonates, CO2, methane etc. Knowledge of microbiology of sewage is central to maintenance of quality of environment. Sewage treatment is done both at small as well as large scale. The amount of organic matter in domestic wastes determines the degree of biological treatment required.

The primary objective of sewage treatment is the removal and degradation of organic matter under controlled conditions. Municipal plants are equipped for a mechanized sewage treatment that handles massive amounts of daily generated waste and garbage. All wastewater reduction technologies go through three stage treatment technologies (primary, secondary, tertiary/advanced/nutrient removal) that can be used to treat the abattoir wastewater[16].

The primary or first stage of treatment removes the floating materials and large size items, while the next stage helps to reduce the settling solids and reduces the organic matter content and stabilizes through biological treatment.

Pre-treatment and primary treatments: Pre-treatments include screening, catch basins, floatation, equalization and settlers. A primary treatment includes screening, dissolved air floatation (DAF) and flow equalization. Pre-treatments are processes which remove gross solids; coarse suspended floating matter and primary treatments remove readily settle able solids, most commonly by sedimentation.

Secondary treatments: To achieve an acceptable reduction in the BOD, secondary treatment by a variety of means is necessary. The pollutants that remain after primary treatments can be removed by secondary treatment methods, including fine suspended solids, colloidal and dissolved and dissolved organic matter by biological / chemical treatments by aerobic or anaerobic process. By now the original sewage BOD is reduced to 80-90%. Secondary treatment relies on microbial activity which may be

aerobic and anaerobic, and is conducted in large variety of devices. Various device like oxidation ponds, trickling filter, biodisc system, conventional and non conventional activated sludge.

Tertiary treatments / biological treatments: Nutrients removal is an important treatment process in wastewater treatment and is the final or tertiary stage treatment. Nutrients such as N and P are introduced to the receiving area if industries fail to adopt nutrients removal before discharge into sites. This conventional treatment is designed to remove pollutants and minerals nutrients, especially N2 and P salts by chemical process. Activated carbon filters are normally used in their removal from secondary-treated effluents. To prevent eutrophication, phosphate is removed from sewage by precipitation as calcium, aluminum or iron phosphate. Breakpoint chlorination is a process to remove NH3. In big cities, a highly advanced tertiary water treatment system integrates several of the tertiary treatment processes. Modern large scale sewage treatment, however involves additional processing of sewage after tertiary treatment. This includes removal of pathogens, sludge processing and land farming.

STATUS OF WASTEWATER TREATMENTS IN INDIA

The process of wastewater treatment must be monitored to ensure that water released into the environment and health risks. The real objective of wastewater treatment is removal of carbon and its compounds. The successful implementation of wastewater reuse options in a water resources management programme requires careful planning, economic and financial analyses, and the effective design, operation, and management of wastewater reclamation, storage, and distribution facilities. Technologies for wastewater reclamation and purification have developed to the point where it is technically feasible to produce water of almost any quality, and advances continue to be made. Current water reclamation strategies incorporate multiple measures to minimize the health and environmental risks associated with various reuse applications.

Some of the challenges still faced in India are:

- Lack of awareness
- Lack of public-private partnership on wastewater management
- Apathy by some governments
- Lack of a cohesive nationwide campaign
- Imbalance in the amount of wastewater and treatment plants

India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population [17]. Wastewater treatment plants in India have become an important part of the landscape -Vital in maintaining the health of our people and the land. If wastewater is not properly treated, then the environment and human health can be negatively impacted [18,19 &20]. Microbiology is affected by wastewater, filtration substrate, type of the wetland, vegetation. Floating wetlands are still lacking the design and operational parameters [21]. These impacts can include harm to fish and wildlife populations, oxygen depletion, beach closures and other restrictions on recreational water use, restrictions on fish and shellfish harvesting and contamination of drinking water.

According to the 2015 report of the Central Pollution Control Board currently, India has the capacity to treat approximately 37% of its wastewater, or 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD. Only one-third of India's wastewater is currently treated, leading to the high burden of water-borne diseases. While urban water access is high on average, significant gaps remain across the country, and wastewater treatment remains stuck at the national average of around 33%. Large waste water generators-Punjab, Maharashtra, Gujarat, and U. P. can potentially treat 65-100% of their urban wastewater. Despite this, many populous states, such as Madhya Pradesh, Bihar, Andhra Pradesh, have only enough installed capacity to treat less than half of their wastewater. Further, several North-Eastern and Himalayan states have low or no capacity for treatment. Mohammadreza Kamali and Zahra Khodaparast study indicated that adopting the integrated methods, alongside a combination of biological (e.g., anaerobic digestion) and physicochemical (e.g., novel Fenton reactions) treatment methods, can be environmentally and economically preferable to minimize environmental contaminants and energy recycling [22].

In cities, industries and commercial sectors pay higher tariffs for water but they don't have supply assurance. Fernandes & Krishna reported that, "Water shortages threaten coal company revenues", nearly 7 billion units (kWh) of coal power, with an estimated potential revenue of INR 24 billion were lost in the first five months of 2016 due to lack of water for cooling in thermal power plants. In addition to water supply augmentation, wastewater treatment offers new economic opportunities for energy and fertilizer recovery [23].

The Hindu News Paper report on dated May 20, 2019 in Ahmadabad J.P. Gupta, Principal Secretary on water supply for the State said that "As of today, our total sewage water generation is 4,000 MLD (million

liters per day), while our treatment capacity is 3,500 MLD. In the next 2-3 years, new capacity of 1,500 MLD will be added, with the setting up of new STPs and expanding the existing ones.

In the last few years, there have been four new wastewater treatment technologies that have emerged and are helping to improve the health of river and streams [23].

1. **Thermal hydrolysis:** Thermal hydrolysis has three applications are wastewater treatment, by product reaction and energy production. It is a smart technology that is utilizing thermal energy to separate different types of metals. This is a good technology to reduce pollution that is created from the production of metals.
2. **Cells for microbial fuel:** Microbial fuel cells (MFC) technology, which uses bacteria to clean wastewater, is another technological innovation that can help clean up water. MFCs are a thin membrane that allows bacteria to attach and consume carbon dioxide and hydrogen, which generates electricity. This process can be used to generate electricity, but it can also be used to turn sewage into drinking water. The MFC can also be used to create bio-films that produce fuels such as methane and hydrogen.
3. **Treatment of wastewater by solar photo catalysis:** One of the most difficult challenges in wastewater treatment is the treatment of wastewater by solar photo catalysis. The chemical reactions are very efficient and can be done without any energy input from the sun, which makes it a sustainable option for wastewater treatment. In order to create solar photo catalysis, two chemicals are needed: one oxidant and one reductant. The oxidant reacts with the organic matter in the wastewater to create oxygen and hydrogen peroxide, while the reductant then breaks down the hydrogen peroxide into water and oxygen. These reactions occur simultaneously, creating a process that is highly efficient and sustainable.
4. **Natural wastewater treatment technologies:** The natural wastewater treatment technologies that are available to us are very important to our health. There are two significant sources of these technologies: roofs and streets. The roofs of homes, businesses, and schools help capture the precipitation that falls on them. This water is then treated to remove pollutants before it can flow into our streams, rivers, and oceans. The streets in cities are also a source of natural wastewater treatment technologies. When water from the storm drains flows into the sewers and then into the waterways, it is filtered through the soil and plants that make up the streets. This filtration process helps reduce the amount of pollutants in our waterways.

Table 1. Summary of some important different wastes: their character and treatments

S.No	Industries producing wastes	Major characteristics	Treatments and methods
1	Dairy	Dissolved organic matter, protein fat and lactose	Biological treatments by trickling filtration, activated sludge
2	Meat and poultry	Dissolved suspended organic matter, blood, other protein and fats	Screening, settling and or flotation, trickling filtration
3	Leather goods	Solids, hardness, salt, sulfides, Chromimum, pH lime and BOD	Equalization, sedimentation and biological treatments
4	Beet sugar	Dissolved and suspended organic matter sugar and protein	Reuse of water, coagulation and lagooning
5	Pharmaceutical products	Dissolved and suspended organic matter, vitamins	Evaporation and drying feed
6	Coffee	High BOD and suspended solids	Screening, settling and trickling filtration
7	Fish	Very high BOD, total organic solids and odour	Evaporation of total waste, large remainder to sea
8	Water pollution	Minerals and suspended solids	Direct discharge to streams or indirectly through hold lagoons
9	Bakeries	High BOD, grease floor washings, sugar, flour and detergents	Amenable to biological oxidation
10	Paper industry	Colour, high suspended colloidal and dissolved solids inorganic filters	Settling, lagooning, biological treatment, aeration, recovery of

			products
11	Steel	Low pH, acids, cyanogens, phenols and ore, cokes, lime stones, alkali, oils mill and fine suspended solids	Neutralization, recovery reuse, chemical coagulation
12	Iron foundry	High suspended solids, mainly sand, clay and coal	Selective screening, drying of reclaimed sand
13	Oil refineries	High dissolved salts from high BOD, odour, phenols and sulphur compounds	Diversion, recovery, acidification and burning of alkaline sludge. Leak and spill prevention, flotation
14	Rubber	High BOD and odour, high suspended solids, variable pH and chlorides	Aeration, chlorination, sulfonation, biological treatments
15	Glass	Red colour, alkaline non settleable suspended solids	Calcium chloride precipitation
16	Glue manufacturing	High COD, BOD, chromium	Amenable to aerobic treatments and floatation
17	Detergents	High BOD and saponified soaps	Floatation and skimming, precipitation with $CaCl_3$
18	Pesticides	High organic matter, benzene ring, toxic to bacteria and fish, acid	Dilution storage, activated carbon absorption, alkaline chlorination
19	Plastics and resins	Acids, organic matter like phenols, formaldehyde etc.	Discharge to municipal sewers, reuse, controlled discharge
20	Coal	High suspended solids, mainly coal, low pH, high H_2SO_4 and D_2SO_4	Waste settling, froth floatation, drainage control and sealing of mines
21	Nuclear power and radioactives	Radioactive elements	Concentration and containing of dilution and dispersion.
22	Explosives	TNT, coloured acids, organic acids, metals acids, oils and soaps	Floatation, chemical precipitation, biological treatments, aeration, chlorination, neutralization, adsorption
23	Rice	High BOD, total and suspended solids solids	Lime coagulation and dilution
24	Pickles	Variable pH, high suspended solids, colour, organic matter	Good housekeeping, screening equalization
25	Laundry trades	High turbidity, alkalinity and organic solids	Screening, chemical precipitation, floatation and absorption

CONCLUSION

It is clear from the above discussion that wastewater treatment is one of the most important issues for our country as well as for other countries. The biggest problem for developing countries like India is that it lacks knowledge for wastewater treatment and also does not have any technical solution for its proper recycling. India is not just the country of great ancient culture and rich heritage, but also has a lot of natural resources that can be exploited. One of these resources is water, which is often considered a scarce resource. In a country where people drink contaminated water, it is important to find ways to make sure that the water is clean and safe. The treatment of wastewater in India has been an ongoing process that has seen a lot of advancement over the years. Indian wastewater treatment plants are now capable of treating a large amount of wastewater and turning it into usable water. This has been made possible with the help of innovative technologies. If wastewater is not properly treated, then the environment and human health can be negatively impacted. These impacts can include harm to fish and wildlife populations, oxygen depletion, beach closures and other restrictions on recreational water use, restrictions on fish and shellfish harvesting and contamination of drinking water. So it is important to all of us that it is a time to aware of our environment and along with the government we should also take a decision that we will not pollute our environment in any way.

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