Critical Review on The Development in Waste Water Treatment Technologies

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Abstract

Presently, anthropogenic compounds like domestic and agricultural waste and industrial wastewater are contaminating numerous water resources. Nowadays, more concern is rising about how wastewater contamination affects the environment and health. The contamination has been removed using a number of standard wastewater treatment procedures, such as chemical coagulation, adsorption, and activated sludge, but there are still significant drawbacks, particularly the high operating costs. Due to its inexpensive operation and upkeep, aerobic wastewater treatment is becoming more popular as a reductive medium. Additionally, it is simple to obtain, efficient and capable of pollutant degradation. The principal pollutants in wastewater, such as halogenated hydrocarbon compounds, heavy metals, dyes, pesticides and herbicides are removed from wastewater using wastewater treatment technologies which are reviewed in this paper.

Keywords: *Anthropogenic compounds, Aerobic, Waste water Treatment, Waste Water Treatment Technologies.*

Introduction

The establishment and maintenance of a variety of human activities depend on a steady supply of clean water. Aquatic life and agricultural irrigation are two ways that water resources provide useful food. The majority of the world's water sources are, however, contaminated by the liquid and solid wastes that are produced by industry and human activity. Water will become one of the most in-demand resources in the 21st century as a result of rapid growth in the global population (Day D., 1996). A large portion of the world's population will reside in cities by the year 2013. (UN, 1997). There will be 23 megacities with populations of over 10 million by the year 2000, with 18 of them located in the developing world (Black, 1994). The issues with delivering municipal services and water sector infrastructure, including the provision of both freshwater resources and sanitation services are at the heart of the urbanization phenomenon. At this time, it is extremely difficult for engineers, planners and politicians to provide housing, healthcare, social services and access to basic human requirements infrastructure including clean water and effluent disposal (Black, 1994; Giles and Brown, 1997). As the population of humans grows, more demands will be made on the resources already available, posing a larger threat to environmental resources. According to a report by the Secretary-General of the United Nations Commission on Sustainable Development (UNCSD, 1997), neither developing nor developed countries are currently using fresh water sustainably and global water usage has been increasing at a rate of more than three times that of global population growth, which has a negative impact on a variety of social, economic and environmental issues.

Despite just making up 3.29 million km2 (2.4 percent of the world's land area), India is home to more than 15% of the world's population. Additionally, India is home to 500 million animals or nearly 20 percent of all livestock worldwide. However, the nation's entire annual utilizable water resources are only 1086 km^3 or 4% of the world's total water resources (Kumar et al., 2005). Groundwater and surface water combined have annual utilizable resources of 690 and 396 km3, respectively (Ministry of Water Resources, 1999). India's water resources are under increasing stress as a result of the country's rapid population increase and rising water consumption and the amount of water available per person is steadily declining. Surface water availability per person in India was 2300 m^3 (6.3 m^3/day) in 1991 and 1980 m3 (5.7 m^3/day) in 2001; however, it is predicted that this will drop to 1401 and 1191 m^3 by the years 2025 and 2050, respectively (Kumar et al., 2005). The country's predicted total water use in 2050 is 1450 km^3, which is more than the 1086 km^3 that is currently available.

The discharge of waterborne waste from the home, industrial and non-point sources transporting undesirable and unrecovered compounds is a major way that civilization's wastes end up in water bodies (Welch, 1992). Despite the fact that wastewater has been collected since the beginning of time, its treatment is a relatively new invention that dates to the late 1800s and early 1900s (Chow et al., 1972). However, the well-recognized instance of John Snow in 1855 in which he established that a cholera outbreak in London was caused by sewage-contaminated water supplied from the Thames River, is where modern knowledge of the necessity for sanitation and treatment of polluted waters began (Cooper, 2001). Treatment and discharge policies may differ dramatically across developed nations, between consumers in rural and urban areas and between users in high- and low-income metropolitan areas (Doorn et al., 2006). The most widely used wastewater treatment methods in industrialized countries are lagoons and centralized aerobic wastewater treatment plants for both residential and commercial wastewater.

In the majority of developing nations, the levels of wastewater treatment vary. Domestic wastewater can be processed in closed or open sewers, pit latrines, septic systems or centralized facilities before being dumped into uncontrolled lagoons or waterways (UNEP, 2002). While major industrial facilities may have thorough in-plant treatment, there are occasions where industrial effluent is released directly into bodies of water (Carter et al., 1999; Doorn et al., 2006). The majority of domestic and industrial wastewater is released untreated or merely after initial treatment in many developing nations. Around 15% of the collected wastewater in Latin America is treated there (with varying levels of actual treatment). In Venezuela, 97% of the sewage is released directly into the environment (Caribbean Environment Programme, Technical Report, 1998). Even in a highly industrialized nation like China, sewage is discharged without treatment in roughly 55% of cases (The People's Daily, Friday, November 30, 2001). The bulk of Tehran's population, which lives in a Middle Eastern nation that is comparatively developed, has completely untreated sewage poured into the city's groundwater (Tajrishy and Abrishamchi, 2005). Momba et al. (2006) reported that in South Africa, where some level of wastewater treatment is observed, the poor operational state and inadequate maintenance of most of the municipalities' sewage treatment works have resulted in the pollution of various water bodies, posing very serious health and socioeconomic threats to the dependents of such water bodies. The vast majority of sub-Saharan Africa lacks wastewater treatment (Sci-Tech. Encyclopaedia, 2007).

Given its rapid technological advancement and expanding economic system, modern civilization is increasingly threatened by its own actions that pollute the environment (Singh et al. 1989). With a total territory of 3.29 million square kilometers and a population of over One billion, 29 percent of whom reside in metropolitan areas scattered among 5162 towns, India is the seventh-largest country in the world. India has the second-largest population of technical and scientific professionals in the world, thanks to its abundant natural resources and expanding economy. Indian regulators are faced with a difficult choice between economic development and environmental sustainability due to pollution by small-size businesses. Urban regions' unchecked population development has made designing and expanding sewage and water systems increasingly challenging and expensive (Looker, 1998).

On a small scale, bio-scrubbers called aerobic-activated sludge reactors have been utilized to remove odorous air (Bowker, 2000). Little information is known on the actual performance of these systems, with a wide range of worries about lowering settling efficiency due to changes in filamentous organisms and bacterial flocks, despite multiple good reports from full-scale installations in North America (Burgess et al. 2001). These worries are allayed in MBRs, where physical filtration takes the place of the microbial solution's gravitational settling. Additionally, contact time, bubble size and reactor design all affect how odorous gases diffuse and bio-convert (Burgess et al. 2001). Submerged MBRs use gas and liquid scouring to clean the membrane surface and embed the membrane unit within the bioreactor. Booster fans can be added to modern livestock farms that already have ventilation and blowing systems to raise the outflow pressure. When biofilter beds (compost and wood chips) were examined for their ability to remove odors, this idea was investigated in earlier studies (Mann et al. 2002).

Status of wastewater technology in India

16,652.5 MLD of wastewater were produced by 299 class-1 cities. About 59 percent of this is produced by 23 metro areas. Roughly 23 percent of the wastewater produced in class-1 cities is contributed by the state of Maharashtra alone and about 31 percent comes from the Ganga river basin. Only 72% of the generated treated wastewater is collected. Out of 299 class-1 cities, 160 have sewerage systems that cover more than 75% of the population and 92 have systems that cover more than 50% of the population. Sewage facilities are available to 70 percent of class-1 cities' total population, up from 48 percent in 1988. Open, closed or piped sewer systems are the three different types. Only 4037.2 MLD (or 24 percent) of the 16,662.5 MLD of wastewater generated is treated before release; the remaining 12,626.30 MLD is disposed of in an untreated manner. Only forty-nine cities have primary and secondary treatment facilities, compared to twenty-seven that only have primary treatment facilities.

Why is there a need for sewage treatment?

In order to clean wastewater, complex organic molecules must be broken down into simpler, stable and odorless substances using either physical, chemical or biological methods (biological treatment). The following are the negative environmental effects of discharging untreated wastewater into groundwater, surface water bodies, and/or lands:

1. A significant amount of foul gases may be produced as a result of the organic compounds in wastewater decomposing.

2. If untreated wastewater (sewage) with a lot of organic matter is dumped into a river or stream, the stream's dissolved oxygen will be used up to meet the waste-water'sBiochemical Oxygen Demand (BOD), which will lead to fish deaths and other unpleasant impacts.

3. Nutrients found in wastewater may also encourage the development of aquatic plants and algal blooms, eutrophicating lakes and streams.

4. Many pathogenic or disease-causing microorganisms and poisonous substances that live in the human digestive tract or may be present in some industrial waste are typically present in untreated wastewater. Where such sewage is disposed off, it could contaminate the land or the aquatic body.

Domestic, industrial and municipal wastewater reuse

The irrigation of road plantings, parks, playgrounds, golf courses and other municipal applications of treated wastewater are only a few examples (Bouwer, 1993). Cooling systems, agricultural uses (irrigation and aquaculture), the food processing industry and other high-rate water uses are examples of industrial wastewater reuse (Bouwer, 1993b; Khouri et al. 1994; Asano and Levine, 1996). Dual distribution systems will soon supply high-quality, treated effluents for toilet flushing to hotels, commercial buildings etc. in Middle Eastern nations where water is scarce (Shelef and Azov, 1996).

Wastewater is being used in India for flushing, air conditioning system cooling, irrigation, gardening, boiler feed and process water for businesses (Chawathe and Kantawala, 1987). The development of water-efficient technology is encouraged in China and recovered urban wastewater is encouraged to be used first in agriculture before being used for industrial and municipal purposes (Zhongxiang and Yi, 1991). In order to generate "urban amenities" like green space, reclaimed wastewater is used in Japan for toilet flushing, industry, stream restorationand flow augmentation(Asano, Maeda, Takaki, 1996).

Starting at the household level, a practical and long-lasting wastewater management plan is mostly based on the "software" or the human element (Khouri et al., 1994). Planning and execution won't be successful until the neighborhood/user level has absorbed the perception of need and perhaps even anticipation for a wastewater reuse system (Khouri et al., 1994). Assistance for a treatment and recovery program at the local level might spur proactive institutions and governmental vertical support. The future of wastewater reuse depends on public acceptance of reuse initiatives and the effects of a negative public image could jeopardize future wastewater reuse programs (Asano and Levine, 1996). For the treatment of wastewater contaminated with organic materials, a number of traditional treatment procedures have been taken into consideration. For reducing the organic load, commercial activated carbon is thought to be the most effective material. Unconventional adsorbents, such as fly ash, peat, lignite, wood and sawdust, have been used for the removal of refractory materials, although with different degrees of effectiveness due to their high cost and around 10-15 % loss during regeneration. Ionic liquids have the potential to be a more advantageous substitute for hazardous solvents (Sheldon et al., 2001)

Many researchers, including Nelson et al. (1969); Eye et al. (1970); Johnson et al. (1965); Deb et al. (1966); Gupta et al. (1978,1990); Mott et al. (1992); and Viraraghavan et al., have recently developed an interest in the removal of organic waste by adsorption (1994). They have looked into using fly ash as an adsorbent to treat wastewater and get rid of harmful substances and colors. By using fly ash as an adsorbent, Pandey et al. (1985) suggested a method for removing copper from wastewater. The removal of phosphorus from home wastewater has been proposed by Johansson et al. (1998) and Drizo et al. (2006) using active filtration via alkaline media. Given that it is more unstable than chlorine (1.36 V) and has a higher reduction potential (2.07 V), ozone is a particularly effective oxidizing agent (1.78V). Since the early 1970s, it has been employed in wastewater treatment and has the capacity to degrade a variety of contaminants, including phenols, pesticides and aromatic hydrocarbons (Robinson et al. 2001, zbelge et al. 2002, Pera-Titus et al. 2004). Ozone has a limited half-life and decomposes in 20 minutes, making constant ozonation necessary, which makes this process expensive to implement (Slokar et al., 1998, Robinson et al., 2001).

Without the use of air or pure oxygen, anaerobic wastewater treatment is a biological wastewater treatment method. Applications are focused on the elimination of organic contaminants from sludge, slurries and wastewater. Because the effluent quality of anaerobic treatment systems is subpar, a complete transition from aerobic to anaerobic technology is not yet feasible. In Colombia, Brazil, and India, the anaerobic treatment method has been used in place of the more expensive activated sludge procedures. It is regarded as a pretreatment approach. Different digesters are available; some have been tried and true over time, while others are still being studied. The UASB is one of the best digesters for tropical climates (Up-flow Anaerobic Sludge Blanket).

A self-sustaining sewage treatment system using a UASB as a pretreatment unit and an aerobic reactor Down flow Hanging Sponge (DHS) reactor as a post-treatment unit has been proposed by Harada et al. (2007, 2006, 2005, and 2002). Due to their low cost, ease of operation, and overall sustainability, the suggested anaerobic-aerobic bio conenoses of UASB and DHS satisfy the demand for a simplified treatment system for poor countries.

Conclusion

In this paper, a variety of approaches for the treatment, recovery and reuse of wastewater are reviewed. It is clear that many solutions are practical for usage in underdeveloped countries. It is even more apparent that several low-tech options can be combined to achieve extremely high efficiency. Environmental managers are showing a lot of interest in natural treatment technologies. Natural treatment methods are viable because they have minimal initial costs are simple to maintain, may have longer life spans and can recover a wide range of resources, such as treated effluent for irrigation, organic humus for soil improvement and biogas for energy. The size of the collection and treatment systems was the subject of this report's analysis of new problems and technological possibilities. The idea that recycling loops should be reduced from the point of generation (such as the household) to the point of treatment and reuse is gaining favor.

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