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Evaluation of India's Waste Water Treatment System

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ABSTRACT

These days, anthropogenic sources such as industrial operations and garbage from homes and farms contaminate a large number of water resources. Concern among the public over wastewater pollution's negative effects on the environment has grown. Many traditional wastewater treatment methods, such as chemical coagulation, adsorption, and activated sludge, have been used to eliminate the pollutants; however, there are still certain drawbacks, chief among them being the high cost of operation. Because aerobic waste water treatment has minimal operating and maintenance costs, there is growing interest in using it as a reductive media. It is also easily obtained and has an excellent efficacy and degradation capacity for pollutants. The primary pollutants in wastewater are halogenated hydrocarbon compounds, heavy metals, dyes, pesticides, and herbicides. This study examines the utilization of waste water treatment technology to remove these contaminants from wastewater

Key Words: industrialization, coagulation, adsorption, and activated sludge, pollutants, heavy metals, nonrenewable energy sources,volatile compounds, biofertilizer, pesticides, and herbicides

Introduction:

The security of food, water, and energy is becoming a more pressing concern for India and the rest of the globe. The combined effects of urbanization, industrialization, and agricultural growth are causing moderate to severe water shortages in most river basins in India and around the world, causing many to shut or close completely. Improving water use efficiency and demand management could help meet the demand for fresh water in the present and the future.

After necessary treatment, wastewater and low-quality water are becoming more and more viable sources for demand control. Major Indian cities create an estimated 38453 million liters of sewage per day (MLD), but the capacity of sewage treatment facilities is only 11785 MLD. Likewise, just 60% of wastewater from industrial sources—mostly large-scale industriesare treated. Performance of state-owned sewage treatment plants, for treating municipal waste water, and common effluent treatment plants, for treating effluent from small scale industries, is also not complying with prescribed standards. Wastewater- irrigated fields generate great employment opportunity for female and male agricultural laborers to cultivate crops, vegetables, flowers, fodders that can be sold in nearby markets or for use by their livestock. However, there are higher risk associated to human health

1- Water Availability and Use: India has 15.5% of the world's population but only 2.46% of the world's land area and 4.1% of its water resources. Only 28.3% of the water in the nation comes from precipitation; the total estimated utilizable water resource is 1123 billion cubic meters (BCM) (690 BCM from surface and 433 BCM from ground). Irrigation accounts for around 85% (688 BCM) of water demand (Figure 1), and by 2050, that number might rise to 1072 BCM. Groundwater is a major source of irrigation water. About 433 BCM of groundwater are recharged annually; of this, 212.6 BCM are used for irrigation and 18.2 BCM are used for residential and commercial purposes (Central Ground Water Board (CGWB) 2011). The demand for water for residential and commercial use could reach 29.3 billion cubic meters by 2025. As a result, it is anticipated that water availability for irrigation will drop to 162.3 BCM. By 2050, the population is predicted to surpass 1.5 billion at the current 1.91% annual population growth rate. From 1951 to 2001 and 2010, the per capita average yearly freshwater availability decreased from 5177 m3 to 1869 m3 due to the country's overall development and growing population. It is anticipated to drop even more, reaching 1341 m3 in 2025 and 1140 m3 in 2050. Thus, improved water use efficiency and waste water recycling are crucial for effective management of water resources.

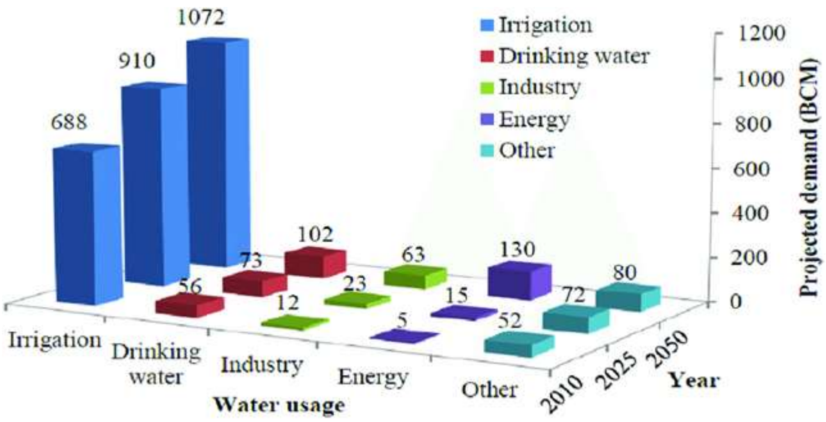

Fig1: Projected water demand by different sectors (CWC, 2010)

1.1 - Wastewater Production: As cities and home water supplies grow at a rapid rate, so does the amount of gray and wastewater produced. According to Central Public Health and Environmental Engineering Organisation(CPHEEO) estimates, wastewater is produced from 70–80% of the total water supplied for residential consumption. 72% of India's urban population lives in class I and class II cities, which generate approximately 98 litre per capita per day(LPCD) of wastewater per capita, compared to over 220 LPCD from the National Capital Territory of Delhi alone, which discharges 3,663 Millions of litre per day(MLD) of wastewater per year, of which 61% is treated (Central Pollution Control Board(CPCB), 1999). According to CPCB estimates, the nation's Class I cities (499) and Class II towns (410) generate a combined total of about 35,557 and 2,6967MLD of wastewater, respectively. Even though the installed sewage treatment capacity is only 11,553 and 233 MLD, respectively, an overall analysis of water resources shows that dealing with the dual issues of decreased fresh water availability and increased wastewater generation as a result of growing populations and industrialization will be difficult in the years to come. There are 234 sewage water treatment facilities (STPs) in India. Oxidation ponds, also known as activated sludge processes, account for 59.5% of installed capacity in class-I cities, making them the most widely used technology. Although their total capacity is only 5.6%, 28% of the plants additionally use the Series of Waste Stabilization Ponds technology.

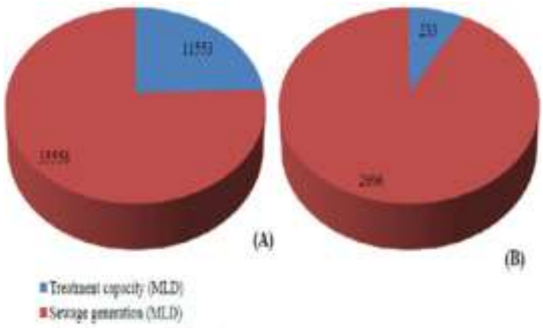

Fig: Sewage generation and treatment capacity in 499 Class I cities and 410 class II towns in India. (CPCB, 2009

2. Conventional waste water treatment techniques:

The CPCB has investigated how water treatment facilities operate nationwide, as well as the quality of raw water and water treatment technologies that are currently in use. Based on their findings, these plants have been treating waste water using the following procedure:

(i) Aeration: This process of dissolving beneficial gases into the water and converting volatile compounds from a liquid to a gaseous state requires bringing air or other gases into contact with water.

Fig: Aeration

(ii) Coagulation and flocculation: The chemical and physical processes of blending or mixing a coagulating chemical into a stream and then gently swirling the blended liquid can be generically characterized as coagulation and flocculation.

Coagulation: In this process, the charge of the particles is neutralized by extensively mixing a coagulant, such as alum, with raw water. When coagulant chemicals—which can be either organic or inorganic—are introduced to water at the right concentration, which is typically between 1 and 100 mg/l, instability results. Following coagulation, the water is flocculated, or gently agitated to improve the contact of destabilized particles and create floc particles with the ideal size, density, and strength that can be filtered or settled later.

(iii) Sedimentation and filtration: After the flocculated water is sent to clarifiers or sedimentation tanks to remove the flocs, the residual turbidity is removed in filters.

(iv) Backwashing filters: Bed porosity reduces as sediments are held in a filter for longer periods of time. Cleaning the bed necessitates backwashing before they begin to escape the filter.

(v) Disinfection: The specialized treatment for eliminating or destroying organisms in water that can spread disease is known as disinfection of potable water systems. Chlorine has been the chemical most frequently employed for this kind of treatment. The six distinct subsystems that make up this chlorination system are: the diffusion, mixing, and supply of chlorine; storage and handling; safety measures; and chlorine feed and application.

2.1. Treating waste water with biotechnologies

The CPCB states that using biological approaches instead of traditional treatment systems can result in a more economical solution for treating waste water. Biotechnology is less costly, simpler to use, and doesn't create any secondary pollutants. Below is a brief description of a few biotechnologies that have been utilized to treat waste:

i) Anaerobic technology: This method eliminates the need for large machinery and requires less space for the waste water treatment facility. The complex macromolecules of organic matter found in waste water are converted into biogas by the anaerobic process, which uses acclimated bacteria. Furthermore, the anaerobic process' stabilized sludge might not smell strongly or unpleasant. Its byproducts, biogas and digester sludge, can be used as fertilizer and as an alternative energy source, respectively.

ii) Duckweed-based waste water treatment: This method aims to establish an inexpensive waste water treatment system that makes use of the nutrients found in waste water. It is quite effective at removing bacteria, other pathogens, and suspended particulates from waste water. Based on its results, this technique can be applied in small towns or in rural or semi-rural locations where there is land available and duckweed can be harvested for a variety of commercial purposes.

iii) Enzymatic treatment: Toxic organic compounds and resistant substances are eliminated from drinking water sources and industrial effluents using oxidative enzymes like peroxides.

iv) Bio-filters: This technology, which is both economically and environmentally feasible, breaks down organic waste in waste water by using earthworms and helpful microbes. It also transforms energy, carbon, and other waste elements into bio nutritional products like humus and biofertilizer.

USEOFWASTEWATER

The disposal of waste water is a major concern due to inadequate capacity for treating wastewater and rising sewage generation. Because of this, a sizable amount of waste water is currently bypassed in sewage treatment plants(STPs) and sold to surrounding farmers by the Water and Sewerage Board on a fee basis, or the majority of the untreated waste water ends up in river basins and is used for irrigation inadvertently. One of the most lucrative ways for the lower classes to make money in places like Vadodara, Gujarat, where there are no other water sources, is by selling wastewater and charging for pumps to raise it (Bhamoriya, 2004). According to reports, irrigation using sewage or sewage combined with industrial effluents saves 25–50% of N and P fertilizer and increases crop output by 15–27% when compared to normal waters (Anonymous, 2004). Wastewater irrigation is thought to be used on

73,000 hectares of per-urban agriculture in India (Strauss and Blumenthal, 1990). Farmers in periurban locations typically use year-round, intense systems for producing vegetables (300–400% cropping intensity) or other perishable goods like fodder. These systems can yield up to four times the income per unit of land area than freshwater farming (Minhas and Samra, 2004). The following are the main crops that are irrigated with waste water:

cereals: 2100 hectares of land are irrigated with waste water to grow paddy along a 10-kilometer length of the Musi River (Hyderabad, Andhra Pradesh) where effluent from Hyderabad is disposed of. In Kanpur and Ahmedabad, waste water is used to irrigate wheat. **Vegetables**: In the vicinity of the Keshopur and Okhla STPs, 1700 hectares of land are irrigated with wastewater to grow a variety of vegetables.These locations are used to grow vegetables such as cucumbers, eggplant, okra, and coriander in the summer and spinach, mustard, cauliflower, and cabbage in the winter. Spinach, amaranths, mint, coriander, and other vegetables are all year-round crops grown in Hyderabad's Musi River Basin.

Flowers: Kanpur farmers use wastewater to cultivate marigold and roses. Farmers in Hyderabad are using wastewater to cultivate jasmine.

Avenue trees and parks: Public parks and avenue trees in Hyderabad are irrigated with secondary processed effluent.

Fodder crops: Para grass, a type of fodder grass, is grown on roughly 10,000 hectares of land in Hyderabad that are irrigated with wastewater along the Musi River.

Aquaculture: The world's largest single wastewater usage system for aquaculture is the East Kolkata sewage fisheries.

Agroforestry: Waste water is used to irrigate plantation trees such as sapota, guava, coconut, mango, arecanut, teak, neem, banana, ramphal, curry leaf, pomegranate, lemon, galimara, mulberry, etc. in the villages close to Hubli-Dharwad in Karnataka. Higher investment allowance is permitted for systems and devices included in the depreciation allowance list

3-Institutional framework and policies for wastewater management:

Apart from constructing treatment plants, the Central, State, and Board governments have provided financial incentives to investors and enterprises to motivate them to allocate funds towards pollution prevention. The available incentives and concessions are as follows: Higher depreciation allowance is permitted for systems and devices installed to minimize pollution or conserve natural resources;

Industries are urged to relocate out of cities in order to lessen pollution and clear up traffic. If the money is used to buy land or build a building with the intention of moving the business to a new location, any capital gains from the transfer of buildings or land utilized for the business are free from taxation. A decrease in the central excise tax for buying pollution control machinery. Financial support to businesses that must install pollution control equipment. Rebate on charges payable on water used by companies, if the industry installs an effluent treatment plant successfully and it continues to operate efficiently. The awarding of industries according to their efforts in pollution control.

4- Using artificial wetlands to treat municipal wastewater

Numerous research have been done on the effectiveness of constructed wetlands (CWs) in municipal water treatment, demonstrating its viability as a treatment alternative for wastewater from municipalities. Given that they have an impact on the wetland's treatment effectiveness, a well-designed constructed wetland should be able to retain its hydraulic properties, namely its hydraulic loading rates (HLR) and hydraulic retention time (HRT) (Kadlec and Wallace, 2009). The majority of India's experience with artificial wetland systems has been in the form of experiments treating various wastewater types (Juwarkar et al., 1995; Billore et al., 1999, 2001, 2002; Jayakumar and Dandig, 2002). In developing nations such as India, one of the main obstacles to field-scale artificial wetland systems is the need for a relatively big land area, which is not easily accessible. Therefore, subsurface (horizontal/vertical) flow systems are thought to be a better option for developing nations than surface flow systems, which have about 9.3 days of HRT. These systems are typically associated with about a 100 times smaller size range and three times smaller HRTs (generally 2.9 days) (Kadlec, 2009). In general, shorter HRTs correspond to reduced land requirements. Batch flow systems have been linked to lower treatment areas and greater pollutant removal efficiencies when they have shorter detention times (Kaur et al., 2012).

5. ADVANTAGES

In addition to producing clean, reusable water, the water treatment process may also result in a number of other advantages. It has the ability to decrease the amount of waste produced in a nation, to harvest methane for energy, and to turn the waste that is gathered during the process into natural fertilizer. A more thorough discussion of these advantages can be found below:

5.1. Waste Reduction:

The amount of waste that is typically released into the environment is decreased through the treatment of wastewater, increasing the health of the ecosystem. By doing this, the government also lowers the threats to public health posed by environmental contamination and the amount of water lost as a result of water pollution.

Additionally, wastewater treatment lowers the amount of money a nation must spend on environmental rehabilitation initiatives in order to combat pollution.

5.2. Generation of Energy:

The sludge collected during the treatment process is itself treated because it contains a large amount of biodegradable material. It is treated with anaerobic bacteria in special fully enclosed digesters heated to 35 degrees Celsius, an area where these anaerobic microorganisms thrive without any oxygen. The gas produced during this anaerobic process contains a large amount of methane, which is harvested and then burned to generate electricityThe wastewater treatment plants can become self-sufficient by using this energy to power them. If additional energy is generated, it can also be fed into the national grid of the nation.

This lessens a nation's dependency on nonrenewable energy sources like fossil fuels, lowering its carbon footprint and energy production costs. An instance of this technology in operation in the Middle East can be observed in Jordan's al-Samra wastewater treatment plants. Government representatives claim that the facility burns the methane created during the treatment process to provide 42% of the electricity it needs.

5.3. Fertilizer Production:

Any leftover biodegradable material is sun-dried in "drying lagoons" to create organic fertilizer. The agriculture industry uses the generated natural fertilizer to boost crop production. This reduces the amount of chemical fertilizers used, which contaminate the surface and marine environments nearby.

6. SUMMARY

The issue of wastewater reuse in poor nations such as India is primarily related to inadequate treatment. Thus, the task is to develop low-tech, affordable, and user-friendly solutions that, while protecting our priceless natural resources, also avoid endangering our heavily dependent livelihoods on wastewater. Constructed wetlands are becoming acknowledged as an effective wastewater treatment technology.Constructed wetlands need less energy and material than conventional treatment systems, are simpler to operate, don't require sludge disposal, and can be maintained by inexperienced workers.

Furthermore, because these systems are powered by the sun, wind, soil, microbes, plants, and animals, they are less expensive to build, maintain, and run.

Therefore, it would seem that policy decisions and well-thought-out programs are required for the planned, strategic, safe, and sustainable use of wastewaters. These programs should include low-cost decentralized waste water treatment technologies, bio-filters, effective microbial strains, and organic and inorganic amendments, as well as appropriate crops and cropping systems, the cultivation of profitable non-edible crops, and contemporary sewage water application methods.

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