Waste Water Management and Treatment

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ABSTRACT

The paper describes the type of wastewater from domestic usage and reflects on the quantity generated. Depending upon the use, the wastewater has to be treated at different levels with increasing order of the treatment. These levels are explained. As regards application of treated sludge on land, the major problem is the economical marketing of the product, but agricultural reuse has been established in many countries. The natural ecosystem, external inputs to primary food production, recycling of nutrients, system of wastewater utilization and project evaluation are explained. The environmental and health aspects are extremely important in the soil and crop system of any land application of treated wastewater. The potential for infection to human, animal and plants from land application can be mainly attributed to the presence of pathogenic organisms. We have reviewed available data on wastewater and agriculture in India. India is rich in water resources and endowed with a network of rivers and alluvial basins to hold ground water. However natural variability is of much importance. The demand for water for domestic use, irrigation, energy, industry and others has been calculated. Municipal sewage is the main source of water pollution in India especially in and around urban areas. The total wastewater generated at present from 299 class 1 cities, comprising of 63% of total population, is around 17000 MLD. Out of this 60% is generated from 23 metro cities. Around 11 municipal corporations and 10 municipalities have sewage farms organized through public authorities. It is, however, observed that not much data is available, and a lot more work is needed. It is felt that the use of treated municipal wastewater for Agriculture in India will gain many direct benefits in the country. Suggestions for further Investigations in India are made.

I INTRODUCTION

Wastewater can be divided into two categories - industrial wastewater and domestic (municipal) wastewater. The industrial wastewater results from various industrial operations and processes, and generally undergoes in-plant pretreatment and reuse before being discharged into a public water body or the natural hydrologic cycle, in many metro cities the industrial waste water is also used for cultivation in small farms. The domestic wastewater consists of human waste, ablution water, kitchen wastewater and other wastes of household activities in urban areas. In rural or suburban areas, the wastewater may be collected and disposed through the use of septic tanks.

II WASTEWATER QUALITY AND EFFECTS

Most of the wastewater contains organic compounds, ammonia, iron or other oxidizable compounds and is a significant source of biological oxygen demand. The discharge of industrial and domestic wastewater with oxygen demand interferes with desirable water uses. The impact of low dissolved oxygen concentrations or anaerobic conditions is reflected in an unbalanced ecosystem, fish mortality, odour and other nuisances. Some types of industrial wastewater may be toxic and pose substantial health hazard to biological lives in the environment. Some organic chemicals discharged into the aquatic environment result in aquatic effects of mortality and / or chronic effects on ecosystem. In extreme cases, heavy metals such as mercury, cadmium, lead etc. and organic chemicals which are bio accumulated in the aqueous food chain, may cause odour and nuisance problems. A large amount of nutrients such as nitrogen and phosphorous compounds present in domestic wastewater and certain industrial wastewater may cause eutrophication of receiving water bodies.

III WASTEWATER TREATMENT

The wastewater treatment generally consists of a number of unit operations and processes to achieve the desired level of treatment. According to the degree of treatment, the unit operations and processes are classified into three treatment types. These are known as primary, secondary and tertiary treatment. The term secondary refers to chemical and biological unit processes. The biological treatment is employed to remove colloidal and soluble organic material in the wastewater through metabolism. The biological treatment is also useful to remove nitrogen compounds in wastewater in some cases. The tertiary treatment processes have been developed for the treatment of wastewater, which contains chemicals difficult to treat with biological treatment or toxic substances. Nitrogen, phosphorous and soluble organic and inorganic compounds are removed to meet stringent, water quality standards. The most commonly used tertiary treatment processes are activated carbon adsorption, ion exchange, reverse osmosis etc.

IV WASTEWATER REUSE

Increased water reuse is inevitable in the world today. Existing water supplies are simply incapable of meeting the future demands. Conservation via recycling will be one means to augment conventional sources. Municipal wastewater reclamation and reuse for beneficial community should be a viable planning alternative. The potentially applicable effluent reuse methods can be grouped into the following general categories.

(a) **Agricultural Irrigation:** This category includes irrigation for edible and non-edible crops, pasture irrigation and livestock watering.
(b) **Cooling Water:** Many industries, including power generating plants use large quantities of water for cooling purposes.
(c) **Landscape, Irrigation and Recreational Uses:** includes irrigation of turf and ornamental planting in golf courses, parks, storm water retention basins or other areas; also use of the reclaimed wastewater to fill artificial lakes for recreational or aesthetic purposes may also be included in this category.
(d) **Industrial Process Water:** Many industries use significant amount of water in their manufacturing process and thus can utilize recycled wastewater.
(e) **Non-Potable Water Reuse:** Includes uses of the reclaimed water for toilet flushing, fire protection and air conditioning.
(f) **Groundwater Recharge:** Wastewater is used to replenish groundwater supplies, either by infiltration through the ground surface or direct injection into aquifers.

The potential reuse alternatives described above have varying requirements regarding the quality of the wastewater effluent.

V METHODS AND MATERIAL FOR AGRICULTURAL USE

(a) **Linkages and project evaluation for agricultural system:** In natural ecosystem external inputs to primary food production are important. Natural ecosystem productivity is sustained through the recycling of nutrients from plants and made available again in the process of organic mineralization.

(b) **Environmental and health considerations:** Along with soil and crop considerations, in the case of land application of treated municipal wastewater, environmental and health considerations are of much importance. The land application of treated wastewater provides water and nutrients for crop growth and avoids nutrient overloading and eutrophication of natural water body. The land application of provides nutrients for crop growth and organic matter for soil conditioning, and avoids potential water pollution problems. The inorganic contaminants such as cadmium, zinc, nickel, molybdenum, etc. and their permissible levels in wastewater can be studied and good literature including manuals can be referred to. This is also the case for organic chemical contaminants. The potential infection to human, animal and plants from land application of treated wastewater is attributed to the presence of pathogenic organism in the wastewater

(c) **Indian scenario on wastewater and agriculture:** India is rich in water resources, being endowed with a network of rivers and vast alluvial basins to hold groundwater. However, its natural variability in the existence and availability are of much greater concern. Out of the total annual precipitation of about 400 M. ha m (million hectare metres) in India, 188 M. ha m flows as runoff. Of this, it is estimated that only about 70-75 M. ha m is usable after providing for requisite storage (and without major inter-basin transfer). Depending upon population projections, the projected demand for water in cu km is given in Table 1.

Table 1 Projected Demand for Water (cu km)

Purpose	Year2010	Year 2025
Domestic Use	33	52
Irrigation	630	770
Energy	27	71
Industry	30	120
Others	30	37
Total	750	1050

(d) **Quality of water:** Municipal sewage is the main source of water pollution in India, especially in and around large urban centres. Fertilizers and pesticide residues from agriculture run-off are said to be the potential threat to potable water quality. Nitrate level becomes a cause for concern when it exceeds the maximum limit permissible in the water.

(e) **Urbanization in India:** A study of the process of urbanization in India since the beginning of this century reveals a steady increase in the size of its urban population, number of urban centers, and level of urbanization since 1911 and a rapid rise after 1951. From a modest base of 25.8 million persons in 1901, the number of urban dwellers has risen to 217.6 million, signaling a phenomenal eightfold increase in urban population over the period 1901 - 1991.

(f) **Status of water supply in India:** About 88% of total municipal population of class - 1 cities have been covered under organised water supply. Out of 299 class - 1 cities, 77 cities have cent percent water supply coverage. In 158 cities, there is 75% and above, and in 43 cities 50% and above coverage. In 10 cities the water supply is below 50%. Per capita water supply ranges from 9 lpcd to 584 lpcd. National average per capita water supply for class- cities is 183 lpcd. As compared to 1988 status, the average per capita water supply has increased from 147 lpcd to 183 lpcd at national level.

Table 2

	Major river basins territ ories	**Numb er of class-1 cities**	**Number of Class-1 cities with various mode of disposal**				
Sr. No			Agr icul ture	River	Both river and agri cult ure	Agr icul ture and oth ers	Other (sea/lan d/drain etc.
1	Beah mani	1	-	1	-	-	-
2	Brahm aputra	7	-	3	-	-	4
3	Cauva ry	16	3	3	-	1	7
4	Ganga	103	29	16	23	8	25
5	Godav ari	25	3	1	4	4	13
6	Indus	15	6	2	-	1	6
7	Krishn a	27	4	3	2	3	15
8	Maha nadi	9	-	1	2	2	4
9	Mahi	3	-	1	2	3	4
10	Narma da	4	1	1	-	2	-
11	Prnnar	6	-	-	-	-	6
12	Sabar mati	7	-	2	2	-	-
13	Subar nrekha	2	-	-	2	1	-
14	Tapi	8	-	1	1	3	3

(g) **Status of wastewater in India:** The total wastewater generated by 299 class-1 cities is 16,652.5 MLD. Out of this, about 59% is generated by 23 metro cities. The state of Maharashtra alone contributes about 23%, while the Ganga river basin contributes about 31% of the total wastewater generated in class-1 cities. Only 72% of the total treated wastewater generated is collected. Out of 299 class-1 cities, 160 cities have sewerage system for more than 75 percent of population and 92 cities have more than 50 percent of population coverage. On the whole 70% of total population of class-1 cities is provided with sewerage facility, compared to 48% in 1988. The type of sewerage system is either open or closed or piped.

(h) **Wastewater treatment in India:** Out of 16,662.5 mld of wastewater generated, only 4037.2 mld (24 %) is treated before release, the rest (i.e. 12,626.30 mld) is disposed off untreated. Twenty-seven cities have only primary treatment facilities and only forty-nine have primary and secondary treatment facilities.

(i) **Mode of disposal of wastewater in India:** Treated or partially treated wastewater is disposed into natural drains joining rivers or lakes or sea or is used for irrigation / fodder cultivation or combination of these by the municipalities.

The basin-wise mode of disposal adopted by various class-1 cities is given in Table 3. The mode of disposal in 118 cities is indirectly into rivers / lakes / ponds / creeks, while in 63 cities on to agricultural land. On the other hand, in 41 cities it is dispersed directly into rivers, and in 44 cities it is discharged both into rivers and on to agriculture land.

(j) **Irrigation water utility in India:** The use of treated municipal wastewater for irrigated agriculture offers an opportunity to conserve water resources. Wastewater reclamation can also provide an alternative to disposal in areas where surface waters have limited capacity to assimilate the contaminants, such as the nitrogen and phosphorous that remains in most treated wastewater effluent discharges. Land application of municipal wastewater has been practised for its beneficial effects. Not surprisingly, public response to the practice has been mixed. Raw municipal wastewater contains human pathogens and toxic chemicals. When treated to acceptable levels, the wastewater is referred to as "reclaimed water" Reclaimed water contributes a very small amount of water to agricultural irrigation, mainly because the extent of the practice is limited both by regional demands and the proximity of suitable agricultural land to many municipal wastewater treatment plants. Irrigation of residential lawns and / or gardens with reclaimed water should become increasingly popular.

VI RECOMMENDATIONS AND CONCLUSIONS FOR INDIAN CONDITIONS

(a) Surface water, which is a source of drinking water is polluted. Therefore, an action plan to arrest the pollution of surface water should be prepared and implemented.

(b) Application of treated municipal wastewater for irrigation and fodder cultivation should be encouraged by the local authorities.

(c) Irrigation of food crops with treated municipal wastewater has been practised on a limited scale. The public needs to receive explanation about the concept of wastewater irrigationas a part of larger and more comprehensive water conservation programmes, and the use of reclaimed wastewater for a variety of non-potable uses.

(d) Municipal wastewater contains a variety of pathogenic (infectious) agents. When reclaimed water is used on fields producing food crops, public health must be protected.

(e) The methods of testing salmonella are of questionable sensitivity. Until more precise methods are developed and accepted, the present test for salmonella should not be used as substitute for fecalcoliform results. This test is less precise because of the relatively low numbers of salmonella present compared to fecal coliform.

(f) A comprehensive and consistent survey of municipal wastewater treatment plants is needed to show whether or not toxic organic compounds are present at concentrations that pose a risk to human and animal health and to the environment.

(g) Those who irrigate crops with treated municipal wastewater should be aware of the concentration of nutriments (nitrogen and phosphorous) in the reclaimed water and should adjust fertilizer practices accordingly, in order to avoid vegetable growth or potential contamination of ground water.

(h) While determining fertilizer application rates, an analysis of the rates of organic nitrogen mineralization should be performed in order to avoid build-up of excess nitrate-nitrogen. Nitrate-nitrogen that is not taken up by plants may contribute to excess fertilization and leach ate.

(i) The programmers designed to promote agricultural use of treated effluents or treated should be carefully structured to avoid the creation of incentives to apply reclaimed water at rates in excess of agronomic rates, and to avoid undermining farm management practices needed to protect public and occupational health and the Environment.

(j) Municipalities that wish to implement a beneficial-use program me need to address public concerns and provide assurance that the wastewater do not endanger health or the environment in application areas. The public and local officials should be involved in the decision-making process at an early stage.

(k) The operators of municipal wastewater treatment facilities and the parties using wastewater should implement management and self-regulation measures that are visible and stringent, including monitoring and reliable reporting by farmers, and should support vigilant enforcement of appropriate regulations by local or state agencies. Implementation of these measures will be a credible means of preventing nuisance risks and harm to people, property, and highly valued nearby resources.

(l) The municipal utility should carry out demonstration programmes for public education,and for verification of the effectiveness of management and self-regulatory systems. In addition, the utility should be prepared to indemnify farmers against potential liabilities when farmers' financing by banks or other lenders may hinge on this assurance.

(m) Regulators should clearly assign authority to local governments for responding to any reports of adverse consequences related to beneficial, such as ground water contamination, odour, attraction of vermin, or illnesses.

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