An Analysis upon Treatment and Process Management of Restaurant Wastewater: A Review

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Abstract* – *Water, food and energy securities are emerging as increasingly important and vital issues for India and the world. Most of the river basins in India and elsewhere are closing or closed and experiencing moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Current and future fresh water demand could be met by enhancing water use efficiency and demand management. Thus, wastewater/low quality water is emerging as potential source for demand management after essential treatment. An estimated 38354 million litres per day (MLD) sewage is generated in major cities of India, but the sewage treatment capacity is only of 11786 MLD. Similarly, only 60% of industrial waste water, mostly large scale industries, is 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.

The characteristics of restaurant wastewater were investigated. High oil and grease contents were detected. Electrocoagulation was used to treat this type of wastewater. Different electrode materials and operational conditions were examined. Aluminum was preferred to iron. Charge loading was found to be the only variable that affected the treatment efficiency significantly. The optimum charge loading and current density were 1.67–9.95 F:m3 wastewater and 30–80 A:m2 depending on the wastewater tested. The specific electrode is necessary for destruction of organic pollutant in restaurant wastewater by electrochemical oxidation.

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INTRODUCTION

The restaurant industry in India is growing at a faster rate with the diverse culinary habits, wide range of cuisines and the diverse cooking techniques being some of the main factors behind its growth. High standard of living and the change in the lifestyle of the people stimulate more and more consumers for flocking various restaurants. Recent surveys have shown that there has been a growing trend among the Indians to taste various types of gastronomical delights. This has also led to the growth of restaurants which serve regional and international delicacies. India's hotel, restaurant and institutional sectors have been benefiting from India's strong economic growth, foreign investment, rising incomes, a young population and changing consumer consumption patterns. While opportunities for foreign food exporters in the market are improving, the sector for imported food products is comparatively smaller, due in large part to ongoing import restrictions and strong competition from domestic foods.

India has a vast hotel sector, but only a small percentage of hotels are considered three stars and above. The overwhelming majority of hotels are small traditional outlets that provide inexpensive accommodations for travellers and source all of their food locally. Of the estimated 300,000 hotels in India, only 2,050 are considered the modern or "organized" hotel sector. Nevertheless, as foreign and domestic travel has increased manifold in recent years, the number of modern hotels that carry at least small amounts of imported foods on their menus has also multiplied. Now, Hotels can obtain a special license that enables them to purchase food items (and other items such as equipment and furniture) duty-free subject to their foreign exchange earnings. Hotels tend to use the duty-free licenses to purchase the items with the highest import tariffs and may not use the licenses to purchase food.

Traditionally, Indians used to eat at home and eat Indian food. Those who ate outside the home either ate street foods from the enormous number of street stalls or from the informal eateries that are common across India. Eating out in restaurants was reserved for special occasions. However, India appears to be in the early stages of a significant transformation in

Department of Environmental Engineering, Delhi Technological University, Bawana Road, Delhi the restaurant sector. Indian consumers are eating out more frequently and younger generations are shedding the prejudice of their elders against international franchises and foreign foods. With only an estimated 100,000 modern restaurants (20 or more seats, wait staff, menus) in India, there is plenty of room for growth in the industry. It i estimated that Indians spend 7 to 10 percent of their food expenditures outside their homes in restaurants, cafeterias and other food establishments.

Of the estimated 300,000 hotels and resorts in India, just 2,050 hotels constitute the "organized" or modern sector accounting for about 150,000 rooms. Most of these hotels are in the larger or metropolitan cities and major tourist or business destinations. India has various world class domestic hotel chains and several international chains have also established a presence through franchising or partnerships with Indian firms. These branded hotels are mostly placed in the premium segment (5 star and above) and mid-range segments (3-4 star), which cater to business and leisure travellers. With the growth of tourism sector and business travel in India, several international brands are exploring the possibility of entering or expanding in the country.

It is difficult to assess the number of restaurants in India as the sector is largely considered to be the "unorganized" sector where small restaurants and street side stalls are common. There are approximately 100,000 restaurants in the "organized" or modern sector, which are restaurants with more than twenty seats and a restaurant menu. Indians have traditionally preferred multi-cuisine restaurants where a family or group can order a range of different cuisines. A typical multi-cuisine restaurant might have Chinese, various regional Indian dishes and European style foods on the menu. That trend is changing as restaurants serving a single cuisine are becoming increasingly popular. The Indian "organized" or modern sector is expected to grow at 8-10 percent annually for next few years because of increasing urbanization and increasing disposable incomes. International fast food and local multi-unit restaurant groups are driving the expansion in the restaurant industry. South India is also emerging with the growth of multi-unit chains that supply reasonably-priced ethnic food with a quick-service concept.

After a slow start, Western-style fast food restaurants have grown rapidly at 15-17 percent annually in recent years. Most foreign and local chains are doing well in major cities, and are expanding into mid-sized Indian cities referred to as tier-two and tier-three cities. Most of these fast food chains have added a variety of Indian-styled products to suit local preferences. Although these chains procure most of their products locally, several products such as French fries, specialty cheeses, some meats and seafood, flavours, condiments, and other ingredients are often imported. Over the past few years, the "coffee shop" culture has spread via chains like Costa Coffee, Mocha, Barista and Café Coffee Day in major cities. These chains are currently sourcing syrups, nuts and some bakery ingredients from foreign origins.

India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. Total utilizable water resource in the country has been estimated to be about 1123 BCM (690 BCM from surface and 433 BCM from ground), which is just 28% of the water derived from precipitation. About 85% (688 BCM) of water usage is being diverted for irrigation (Figure 1), which may increase to 1072 BCM by 2050. Major source for irrigation is groundwater. Annual groundwater recharge is about 433 BCM of which 212.5 BCM used for irrigation and 18.1 BCM for domestic and industrial use (CGWB, 2011). By 2025, demand for domestic and industrial water usage may increase to 29.2 BCM. Thus water availability for irrigation is expected to reduce to 162.3 BCM. With the present population growth-rate (1.9% per year), the population is expected to cross the 1.5 billion mark by 2050. Due to increasing population and all round development in the country, the per capita average annual freshwater availability has been reducing since 1951 from 5177 m3 to 1869 m3, in 2001 and 1588 m3, in 2010. It is expected to further reduce to 1341 m3 in 2025 and 1140 m3 in 2050. Hence, there is an urgent need for efficient water resource management through enhanced water use efficiency and waste water recycling.

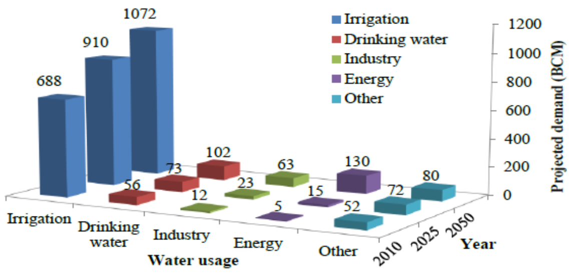

Figure 1: Projected water demand by different sectors.

With rapid expansion of cities and domestic water supply, quantity of gray/wastewater is increasing in the same proportion. As per CPHEEO estimates about 70-80% of total water supplied for domestic use gets generated as wastewater. The per capita wastewater generation by the class-I cities and class-II towns, representing 72% of urban population in India, has been estimated to be around 98 lpcd while that from the National Capital Territory-Delhi alone (discharging 3,663 mld of wastewaters, 61% of which is treated) is over 220 lpcd (CPCB, 1999). As per

CPCB estimates, the total wastewater generation from Class I cities (498) and Class II (410) towns in the country is around 35,558 and 2,696 MLD respectively. While, the installed sewage treatment capacity is just 11,553 and 233 MLD, respectively (Figure 2) thereby leading to a gap of 26,468 MLD in sewage treatment capacity. Maharashtra, Delhi, Uttar Pradesh, West Bengal and Gujarat are the major contributors of wastewater (63%; CPCB, 2007a). Further, as per the UNESCO and WWAP (2006) estimates (Van-Rooijen et al., 2008), the industrial water use productivity of India (IWP, in billion constant 1995 US$ per m3) is the lowest (i.e. just 3.42) and about 1/30th of that for Japan and Republic of Korea. It is projected that by 2050, about 48.2 BCM (132 billion litres per day) of wastewaters (with a potential to meet 4.5% of the total irrigation water demand) would be generated thereby further widening this gap (Bhardwaj, 2005). Thus, overall analysis of water resources indicates that in coming years, there will be a twin edged problem to deal with reduced fresh water availability and increased wastewater generation due to increased population and industrialization.

In India, there are 234-Sewage Water Treatment plants (STPs). Most of these were developed under various river action plans (from 1978-79 onwards) and are located in (just 5% of) cities/ towns along the banks of major rivers (CPCB, 2005a). In class-I cities, oxidation pond or Activated sludge process is the most commonly employed technology, covering 59.5% of total installed capacity. This is followed by Up-flow Anaerobic Sludge Blanket technology, covering 26% of total installed capacity. Series of Waste Stabilization Ponds technology is also employed in 28% of the plants, though its combined capacity is only 5.6%. A recent World Bank Report came out strongly in favour of stabilization ponds as the most suitable wastewater treatment system in developing countries, where land is often available at reasonable opportunity cost and skilled labour is in short supply.

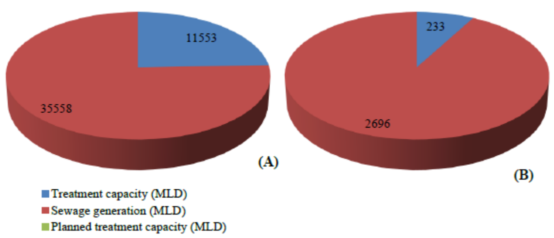

Figure 2: Sewage generation and treatment capacity in 498 Class I cities and 410 class II towns in India.

Apart from domestic sewage, about 13468 MLD of wastewater is generated by industries of which only 60% is treated. In case of small scale industries that may not afford cost of waste water treatment plant, Common Effluent Treatment Plants (CETP) has been set-up for cluster of small scale industries (CPCB, 2005b). The treatment methods adapted in these plants are dissolved air floatation, dual media filter, activated carbon filter, sand filtration and tank stabilization, flash mixer, clariflocculator, secondary clarifiers and Sludge drying beds, etc. Coarse material and settable solids are removed during primary treatments by screening, grit removal and sedimentation. Treated industrial waste water from CETPs mixed disposed in rivers. For example, 10 CETPs from Delhi with capacity of 133 MLD dispose their effluent in Yamuna River.

The conventional wastewater treatment processes are expensive and require complex operations and maintenance. It is estimated that the total cost for establishing treatment system for the entire domestic wastewater is around Rs. 7,560 crores (CPCB, 2005a), which is about 10 times the amount which the Indian government plans to spend (Kumar, 2003). Table 1 illustrates the economics of different levels of treatments through conventional measures. The sludge removal, treatment and handling have been observed to be the most neglected areas in the operation of the sewage treatment plants (STPs) in India. Due to improper design, poor maintenance, frequent electricity break downs and lack of technical man power, the facilities constructed to treat wastewater do not function properly and remain closed most of the time. Utilization of biogas generated from UASB reactors or sludge digesters is also not adequate in most of the cases. In some cases the gas generated is being flared and not being utilized. One of the major problems with waste water treatment methods is that none of the available technologies has a direct economic return. Due to no economic return, local authorities are generally not interested in taking up waste water treatment. A performance evaluation of STPs carried out by CPCB in selected cities has indicated that out of 92 STPs studied, 26 STPs had not met prescribed standards in respect to BOD thereby making these waters unsuitable for household purpose. As a result, though the waste water treatment capacity in the country has increased by about 2.5 times since 1978-79 yet hardly 10% of the sewage generated is treated effectively, while the rest finds its way into the natural ecosystems and is responsible for large-scale pollution of rivers and ground waters (Trivedy and Nakate, 2001).

Particulars	Primary treatment system	Primary + ultra filtration system	Primary + ultra filtration system + reverse osmosis
Capital cost (Rs lakhs)	30.0	90.64	145
Annualized capital cost (@15% p.a. interest & depreciation	5.79	18.06	29.69
Operation and maintenance cost (lakhs/annum)	5.88	7.04	12.63
Annual burden (Annualized cost +O&M cost) Rs. Lakhs	11.85	27.1	42.5
Treatment cost Rs./kl (Without interest and depreciation)	34.08	52.40	73.22

Table 1: Economics of different levels of treatments through conventional measures.

GENERATION AND CHARACTERIZATION OF WASTEWATER

Restaurant wastewater is the raw sewage which contains high density organic, suspended solids, oil and grease. It has high BOD, COD, suspended solids, oil and grease which pose serious harm to the environment and human health. This type of wastewater not only increases the load of wastewater treatment plants, but also affects the discharge capacity of urban drainage pipe, add to the pipe clearing cost, deteriorate the water quality, and threaten the environment and human health. Oils, fats and grease coat the inside of wastewater pipe. Solid food particles in wastewater stick to the oil and grease on the inside of the pipe which clogs the pipes in the facility. Oil and grease traps are used to control certain amount of oil and grease. These devices employ the principle of gravity; the lighter fats and oil immediately separate, rise to the top and remain trapped in the retention area of the tank. The heavier, clean water portion of the flow is allowed to exit and be discharged in to drain lines. Therefore it is significant to treat the wastewater generated in the kitchen unit of the restaurant. It has environmental and social benefits, which not only protect ecological environment and also relieve the harm to urban drainage pipe.

Quantification of Wastewater –

The primary source of wastewater in a restaurant is washing of utensils, washing of hands by customers and occasionally washing of floors. The quantity of effluent generated from kitchen is given in table 2.

Characterization of Wastewater –

Washing and cleaning of a variety of items including cooking pots, serving pots, different varieties of utensils etc are done in restaurants. Therefore the restaurant wastewater composition is greatly dependent on the variety of items washed. The wastewater generated is of interest from the standpoint of environmental impact in terms of both wastewater volume and contaminant loading. The major contaminants in the wastewater are suspended solids, oil and grease, leftovers, Biochemical Oxygen Demand and Chemical Oxygen Demand.

S. No.	Restaurant Name	No. of Seats	Total water consumption (Liters per day)*	Water consumption in kitchen (Liters per day)**	Wastewater generated through kitchen (Liters per day)
1.	Restaurant A	80	5600	2400	1920
2.	Restaurant B	150	10500	4500	3600
3.	Restaurant C	40	2800	1200	960
4.	Restaurant D	200	14000	6000	4800

* 70 liters per seat, as per manual on water supply and treatment by CPHEEO, Govt. of India; Clause 2.2.8.3, pp.11

** 30 liters per seat or 7 liters per meal by CPHEEO, Govt. of India

Table 2. Quantity of Effluent Generated from Restaurants based on seating capacity.

Parameter	Value
BOD_5 (mg/l)	1000 – 2000
TSS (mg/l)	300 – 625
Oil & Grease(mg/l)	100 – 300

Table 3. Characteristics of Liquid Waste from a typical Indian Restaurant.

Effects of Direct Discharge into Sewers/Inland Water Bodies -

The main restaurant wastes that can affect the publicly owned treatment works (POTW) are:

Fats, Oils and Grease (FOG) : Most wastewater collection system blockages can be traced to FOG. Blockages in the wastewater collection system are serious, causing sewage spills, manhole overflows, or sewage backups in homes and businesses.

Solids: Untreated wastewater makes water turbid and reduces light penetration and hence reduces the photosynthetic process of micro plants in the water body. They can also constrict sewer flows and contribute to bad odour and potential pipe failure.

BOD/ COD Ratio: BOD/COD ratio is the conventional index. As a first approximation it could be said that higher this ratio, better the biodegradability. Lower this ratio, lower the biodegradability. However this general expected behaviour has to be checked by pilot scale experimentation for industrial effluents characterized by a small BOD/COD ratio. The principal deleterious effect of this effluent on streams and water courses is their deoxygenating which poses as a threat to the aquatic life and our limited water resources.

TREATMENT OF WASTEWATER

The unit provided for Effluent Treatment Plant (ETP) for treatment of wastewater prior to discharge in public sewer should comply with the requirements of pollution control board. Treatment starts from collection of wastewater. ETP should be designed on the basis of combined primary, secondary and tertiary treatment system. Secondary and tertiary treatment sections are designed on the basis of biological treatment process of organic matter operated on a continuous mode. The ETP includes oil and grease trap, collection cum equalization tank, reaction tank, chemical dosing tank, settling tank, multimedia filter, activated carbon filter, sludge holding tank, sludge drying beds, blower and pump. In general, wastewater is collected in collection cum equalization tank, transferred to reaction tank where dosing of chemical is done as per requirement and wastewater is put for reaction. Then wastewater is transferred to settling tank for settlement of flocs/sludge. The supernatant is passed through the multimedia filter followed by activated carbon filter. Finally the treated water is disposed off. The sludge is transferred to sludge drying beds and dewatered there. The consolidated sludge is removed and disposed of in an eco-friendly manner.

Treatment Process Description -

As per the operational procedure of treatment plant handling, the effluent generated is collected into collection cum equalization tank. It is then pumped to reaction tank. The desired chemical dosing is mixed properly. The chemical added for this purpose include lime, sodium meta- bisulphate and polyelectrolyte. The lime is added to make the pH in the range of 8-8.5.Coagulant is added at the rate of about 200mg/l. These chemicals are mixed within separate reaction tanks and are added by gravity into the reaction tank, as an aqueous solution through respective valves to achieve proper control. The mixed effluent is then settled within the settling tank, where the flocculated particles are allowed to settle down. The settled solids in the settling chamber is allowed to flow to a set of sludge drying beds for dewatering and the dewatered sludge is packed in plastic bags and stored in a container designed for the purpose. The clear filtrate from the sludge drying bed is taken back to the equalization tank for further treatment.

Treatment Scheme -

The Effluent Treatment Plant consists of the following treatment units:

1. Oil and grease trap.
2. Collection sump.
3. Equalization tank.
4. Bar screen.
5. Aeration tank.
6. Multimedia filter.
7. Activated carbon filter.
8. Dosing tanks.
9. Raw water storage tank.
10. Sludge holding tank.

Oil and grease trap - The wastewater from the kitchens is pre-treated separately for removal of oil and grease. For this purpose an O & G trap have been provided for the respective streams. The outgoing streams of O & G trap, guestrooms, common toilets, floor washing, restaurant and other sources join together at the bar screen chamber of the ETP.

Bar Screen - Raw sewage from the source is manually received into the bar screen chamber by gravity. Screen provided removes all floating and big size matter such as plastic bottles, polythene bags, glassed, stones etc; which may otherwise choke the pipeline and pumps.

Equalization Tank - Usually, sewage generation is more during morning hours and evening hours. Visually no sewage is generated during night hours. Any biological system needs constant feed for bacteria to work efficiently. Hence, it is important to put an equalization tank to collect the excess flow during peak hours and feed sewage in lean hours. Provision of air grid is made for thoroughly mixing of sewage to make it of homogenous quality and to keep the suspended matter in suspension and to avoid septic condition.

Transfer of sewage - The sewage transfer pump of non submersible type is provided. The operation of the pump is controlled manually. The sewage from equalization is transferred to aeration tank.

Aeration Tank - Here provision of air grid is made for thoroughly mixing of sewage to make it of homogenous quality and to keep the suspended matter in suspension and to avoid septic condition. Here the organic matter gets converted into new bio-mass. After activated sludge process the effluent is gravitated to clarifier.

Tube settler - The main objective of the settling tank is to separate water and sludge in achieving high suspended solid concentration for recirculation purpose. For this purpose tube settler is provided. Tube settler is a hopper bottom tank fitted with PVC synthetic tubular media. The solids are settled at the bottom of the tank and clear water from the top overflows to clear water tank. The clear water is transferred to chlorine contact tank. The solid settled at the bottom is returned back to the aeration tank partially. The excess sludge is collected in sludge holding tank and fed to sludge filter press. The sludge cake from the filter press is disposed off and filtrate from the filter press is returned to the equalization tank.

Treated water collection tank -The treated water is collected from the tube settler and further pumped through the multimedia filter and activated carbon filter. Generally, the treated water is used for horticulture and miscellaneous uses or to sewerage system.

Sludge - The sludge from the tube settler is partially taken into aeration tank and excess sludge is removed once in a day and transferred to sludge holding tank and fed to sludge drying beds.

TREATING RESTAURANT WASTEWATER USING A COMBINED ACTIVATED SLUDGE-CONTACT AERATION SYSTEM

The quality of restaurant wastewater varies with the type of food served, for example, Japanese, European buffet, Western and Chinese. Both the pollutant load and in particular oil content increase in the order of the food listed. Furthermore, wastewater quality can also vary greatly over the course of a day. Hence, a biological system intended for use to treat such wastewater, must be able to withstand different magnitudes of quality and quantity spike loading.

Since the quantity and quality of restaurant wastewater can fluctuate widely, a large equalization tank would be needed. However, most restaurants are situated in urban surroundings where space is very constrained. Hence, most restaurants use physical and chemical means for treating their wastewater. This leads to the discharge of chemical sludge's into the sewage system with possibly high operating costs.

Most restaurants are small operations. Thus, the initial investment and operating cost for wastewater treatment must be kept low. The electrocoagulation process, for example, consumes the aluminum electrodes at 17.7 g/m^3 to 106.4 g/m^3, and the power requirement is approximately 1.5 KW h/m^3 (Chen et al., 2000). Thus these make the electrocoagulation process costly. Although conventional biological treatment processes have lower operating costs, they require larger land space, and are poor in treating high O and G concentrations.

Their average O and G removal rate is just 20~30%. It has been noted the maximum O&G concentration activated sludge systems can efficiently decompose is 30mg/l.

The combined activated sludge/contact aeration (AS/CA) system proposed in this study combines suspended and attached microbes to provide a longer food chain and more complex biophase. This is to enhance the removal of COD, O and G and true color. The system is also expected to exhibit increased tolerance to spike loading, and would require a smaller land area. The biodiversity of a microbial consortium can be examined, through DGGE analysis and polymerase chain reaction (PCR) techniques which can amplify DNA material extracted from microbes. Each type of microbe has its own set of 16S-rDNA, and by extracting a sample's 16S-rDNA and matching its amount and characteristics, to known microbes, the amount and types of microbes present in a population can be determined.

The restaurant's wastewater is pretreated with a CPI O&G separator. The average number of diners at the restaurant is 500, and the average quantity of wastewater is 50m3/d, which equates to 0.1m3of wastewater per person per meal. The equalization tank is just 1m3 and odor is a minor issue, because the AS/CA system is an aeration system and the substrates were decomposed into CO2 and H_2O. The wastewater collector was long open channel (20m) middle the kitchen, and the equalization tank could issue hot air.

The reaction tanks were ordered as follows: one activated sludge tank, one contact aeration tank and one settling tank. Table 4 lists the effective volume. Fig. 3 shows the process flow chart. The equipment used included: a metering pump, sludge recycling pump, four blowers, and 13.5 litre of biological contact filters (Table 5 lists details of contact filter), a DO controller, a pH controller, an ORP controller, and a MLSS controller. ORP meter can monitor the degree of chemical and biological reaction, and control the condition of aeration advanced. We can use it to control the nitrification and DE nitrification process precisely, and get the high efficiency.

Reaction tank	Dimension cm	Effective volume liter	Material
Activated sludge tank	30L×30W×32H	27	Acrylic
Contact aeration tank	30L×30W×32H	27	Acrylic
Settling tank	30ø×32H	19	Acrylic

Table – 4: Measurements of the effective volumes of each reaction tank.

Type	Type	Demensions mm	Density (kg/m^3)	Surface area (m^2/m^3)	Void space (%)	pcs/m^3
Double ball	2"	50×44	60	155	96	12000

Table – 5: Details of contact filter

	COD (mg/l)	BOD (mg/l)	Suspended solids (SS) (mg/l)	Oil and grease (mg/l)	True colour	NO_2^--N (mg/l)	NO_3^--N (mg/l)	NH_4^+-N (mg/l)	T (°C)	pH
Influent	356	165	88	62	5	29	1.3	4	19	6.5
Effluent from activated Sludge	210	82	35	18.6	2	32.5	1.8	3.8	18	6.9
Effluent from contact Aeration tank	78	36	20	12	1	39.7	2.6	3.3	18	6.9
Effluent from settling tank	57.8	21	12	6	1	41	2.7	2.8	17	7
Effluent standard	–	50	50	10	–	–	50	10	35	6~9
Total removal %	84	87	86	90	80	–	–	–	–	–

Table – 6: Test results of 24 hr mixed water samples from each tank after 8 hr of HRT.

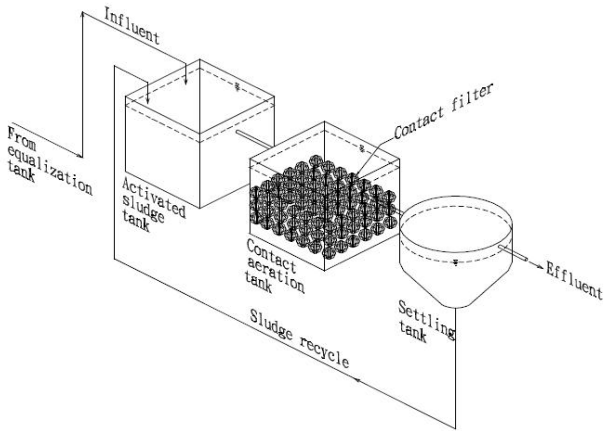

Fig. 3: 3D experimental flow chart.

CONCLUSION

In developing countries like India, the problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to find such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources. The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment. Compared to the conventional treatment systems, constructed wetlands need lesser material and energy, are easily operated, have no sludge disposal problems and can be maintained by untrained personnel. Further these systems have lower construction, maintenance and operation costs as these are driven by natural energies of sun, wind, soil, microorganisms, plants and animals.

Hence, for planned, strategic, safe and sustainable use of wastewaters there seems to be a need for policy decisions and coherent programs encompassing low-cost decentralized waste water treatment technologies, bio-filters, efficient microbial strains, and organic/inorganic amendments, appropriate crops/cropping systems, cultivation of remunerative non-edible crops and modern sewage water application methods.

Following conclusions are drawn from the study:

1. Considering the very high amount of oil/ grease and TSS present, the wastewater is beyond the treatment capacity of municipal treatment plants; hence it becomes mandatory to have their own effluent treatment plants with the units.

2. Environmental pollution takes place due to solid waste. This solid waste could be put to better use than thrown in landfills. Hence, for total waste management in restaurants solid waste management is an integral part. The biogas system by ARTI is a very cheap and effective means for solid waste management in restaurants.

3. Wastewater from restaurants is passed through Oil and grease trap, Collection sump, Equalization tank, Bar screen, Aeration tank., Multimedia filter, Activated carbon filter, and Dosing tanks after which it is safe to be disposed.

4. The water once treated from the above units meets all the norms for safe disposal into any water body with a with a COD of less than 250mg/L, BOD of less than 30mg/L and TSS of less than 100mg/L.

5. Owing to the large number of restaurants in Hauz Khas village the environmental load on nearby water bodies and landfills increases and causes municipal and civil problems.

6. Minimum treatment should be given to the wastewater by setting up ETPs in/near the restaurants for their environmental friendly disposal.

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