STUDY ON THE EFFECTIVE MANAGEMENT OF SANITATION AND WASTEWATER BY DECENTRALIZED WASTEWATER TREATMENT SYSTEMS (DEWATS)

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Abstract : This research demonstrates that the use of decentralized systems approach to wastewater treatment has had more success and there is a need to make wastewater treatment people-centric and effective through the "waste to resource" approach. There is a need for capacity building of community institutions and participation by rural bodies in order to become aware, scale up and improves these innovative approaches in the future at rural centers. Decentralized systems that can be operated and managed by users are much more likely to reach the poor in the short and medium term than the centralized piped systems and treatment works. Providing reliable and affordable wastewater treatment in rural areas is a challenge in many parts of the world. Decentralized concepts provide treatment facilities on a comparable small scale, mostly for domestic wastewater from private households or communal institutions. As they are not restricted to merely managing individual user systems, they can close the gap between on-site systems and the conventional, centralized system. Since smaller distance between the place of origin and waste water treatment facility, there is no need for an elaborate collection system. This ultimately reduces the demand for material, technical equipment, sewerage maintenance and capital investment**.**

***IndexTerms* - waste water, sanitation, decentralized system.**

I. INTRODUCTION

Effective management of sanitation and wastewater is a growing challenge in dense urban settlements. Rapidly increasing urbanization and, along with that, rising settlement densities in low-income urban and peri-urban areas highlight the need for sanitation technologies and management systems that are robust and affordable, and which lessen the pollution load on local water sources. In many developing countries, centralized sewerage and wastewater treatment systems cover only a portion of larger urban areas, and are often not yet planned for smaller towns and densely populated, low-income areas of cities. On-site sanitation is often inappropriate in the denser settlements and slum areas, thus requiring intermediate and complementary solutions. Decentralized wastewater treatment systems (DEWATS) connected to simplified sewer systems or communal sanitation centers have the potential to close the gap between on-site and centralized systems. Community-managed DEWATS offer the possibility of swift sanitation improvements in high priority neighborhoods that communities can manage themselves, where local government does not yet provide a full sanitation service.Wastewater management helps to attain high environmental quality, high yields in food and fiber, low consumption, good quality, high efficiency production and full utilization of wastes. The problem with the current treatment technologies is they lack sustainability. The conventional centralized system flushes pathogenic bacteria out of the residential area, using large amounts of water and often combines the domestic wastewater with rainwater, causing the flow of large volumes of patho-genic wastewater. Decentralized Wastewater Treatment Systems applications are based on the principle of low-maintenance since most important parts of the system work without electrical energy inputs and cannot be switched off intentionally.

2. LITERATURE REVIEW

Finding Better Solutions for Waste Water Management in a Semi Local Authority by Bandunee Champika Liyanage, Renuka Gurusinghe, Sunil Herat, Masafumi Tateda(2015), stated that "The reduction of waste water is a critical process for sustainable management. Currently, people in the area do not have much interest in waste recycling to decrease the cost of waste water management. It was therefore concluded that raising people's awareness would play an important role in the reduction of waste water management. Decentralized Approaches To Wastewater Treatment And Management applicability by May A. Massoud Akram Tarhini , Joumana, A. Nasr, (2009)Choosingthe ''Most Appropriate Technology'' is not an easy task but it could reduce the risk of future problems and failures. The two key issues in choosing a treatment technology are affordability and appropriateness. Disposal methods can be simple disposal methods such as the evaporation and evapotranspiration, surface water discharge and reuse. Characteristics Of Waste Water In Sewage Treatment Plant Of Bhopal, (India) By Ram Kumar

Kushwah, Avinash Bajpai And Suman Malik,(2011) This study was conducted to determine the pollutants level in final treated water from sewage treatment plant Bhopal and compare with BIS and World Health Organization (WHO) guidelines. The increasing population has resulted in many problems, most important being producing sewage. Sewage is water-carried waste, in solution or suspension that is intended to be removed from a community. Biochar In Nutrient Recycling - The Effect And Its Use In Wastewater Treatment By Bente Foereid,(2015) Biochar,i.e. charred organic material, appears to increase nutrient retention in soil. The mechanism for how this happens is not clear. Here two possible mechanisms, adsorption and microbial immobilisation, are suggested and compared. It is also suggested that we use biochar in wastewater treatment, and so potentially integrate it better into the total waste management cycle. The Comparison Of MBBR And ASP For Treatment On Wastewater by C.-Y. Cao and Y.-H. Zhao,,(2010) In order to study the character of a Moving Bed BiofilmReactor (MBBR) in treating petrochemical wastewater, the authors offer the comparison experiment between MBBR and activated sludge process (ASP) regarding such factors as hydraulic retention time (HRT), organic loading rate, and air flow rate.While the organic loading rate reaches the value of 2.0 kg COD/(m3·day), the removal of COD is more than 70%. Under the optimal conditions, the removal of COD produced by MBBR is higher than ASP in all the process. MBBR has stronger capacities regarding the impact of organic loading compared with ASP. Aerobic MBRs For Domestic Wastewater Treatment: A Review With Cost Considerations, M. Gander, B. Jefferson, S. Judd,(2000) Membrane bioreactors (MBRs)present a means of intensively biologically treating high COD or BOD wastewaters but, like other membrane processes, are constrained by their tendency to foul. Fouling is the general term given to those phenomena responsible for increasing membrane hydraulic resistance. It can be reduced by maintaining turbulent conditions, operating at sub-critical flux and/or by the selection of a suitable fouling-resistant membrane material. The performance of various MBRs is appraised with reference to fouling propensity, and removal of organics and microorganisms. Moving Bed Biofilm Reactor – A New Perspective in Wastewater Treatment Borkar R.P, Gulhane M.L, and Kotangale A.J,(2013)A new advancedbiological reactor for waste water treatment, Moving Bed Biofilm Reactor (MBBR) is discussed. General description of expected setup of reactor is given. The proposed results from different applications when used for domestic waste water will be discussed. Moving Bed technology presents several operational advantages, compared to other conventional biological treatmentsConditions which may be studied will include COD removal, or COD and nutrients removal, with different primary treatments. Smaller biological reactor volumes and smaller secondary settling surface are needed. In conclusion, the results can indicate that MBBR with polyethylene media as Biofilm carrier may possess great potential to be used for OMs removal from water and wastewater.

3. METHODOLOGY AND FEASABLITY STUDIES

Figure 1:Method of treatment process

The first step in the planning for DEWATS is the site selection. The potential sites are identified based on

i) Population density, land availability,
ii) Topography,
iii) Reuse potential,
iv) Existing streams for discharge of treated wastewater if required.

The following topics are listed below:

Layout of hospital

Population Density
Source of water supply to the hospital
Waste water collecting areas in the hospital

Layout Of the hospital

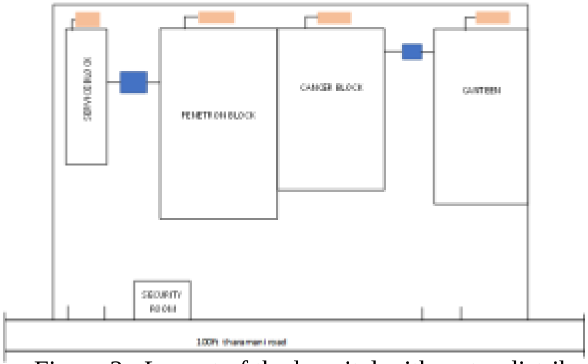


Figure.2 : Layout of the hospital with water distribution line


Figure 3: Source of fresh water near hospital

3.1 Waste Water Collection and Disposal

Waste water generated in hospital are collected in septic tanks at respective source of generation. Main source of waste water is generated from flushing from toilets , Canteen wastes , Food waste etc. Below are the pictures of waste water generated areas in hospital.


Figure..4: Disposal of waste water from near hospital


Figure.5: Disposal of waste water from canteen

Method of disposal of waste in the hospital is the major dispute. Waste water collected are collected in septic tank and after preliminary treatment they are let out into the ground. This ultimately causes contamination and land and affects the the soil quality. Since source of fresh water is located near the disposal area , this affects the ground water easily. Agricultural lands surrounded by the hospital depends only on ground water for irrigation.If ground water is affected by these effluents , agriculture is affected to a larger extent. On the Other hand near the locality of hospital, there are many water purifying companies i.e., Mineral water purifiers and Water is transported from near by areas by trucks to the city. In future years, demand for fresh water ultimately increases and there will be increased rate in water supply to the from the hospital locality.
Hence, to meet the demand and save the agricultural land around the hospital Decentralized Method of wastewater treatment is chosen.This will provide a dependable source of water to the hospital. Fresh water usage can be reduced and ground water can be preserved to meet the future demands.

Table 1:Population Density

S.NO	SOURCE	POPULATION IN NO'S
1	Patients	1950
2	Visitors	150
3	Staffs	300
	Total	2400

No. of population	=	2400
Amount of water used/head/day	=	135 L(staffs)
	=	450 x 135
	=	60750 L
	=	60.75 m^3/day
Amount of water used per head/day	=	60 L (patients)
	=	1950 x 60
	=	117000 L
	=	117 m^3
Total amount of water	=	177.75 m^3
80% of waste	=	142.2 m^3
Total Amount of waste water generated in hospital	=	143 m^3 (143000 L / Day)

3.2 WASTE WATER SAMPLE COLLECTION

Since waste water disposal in 3 main areas is improper it leads to greater impact to the college environment. Hence Wastewater samples are collected from those areas.

The Places are

- Canteen
- Main block

-
- Penetron Block

Figure .6: Waste water sample collection from canteen Figure.7 : Waste water sample collection from main block

4. CLASSIFICATION OF WASTE WATER SAMPLE

4.1 Waste Water Charecterstics

Characterization of wastes is essential for an effective and economical waste management programme. It helps in the choice of treatment methods deciding the extent of treatment, assessing the beneficial uses of wastes and utilizing the waste purification capacity of natural bodies of water in a planned and controlled manner. Domestic sewage comprises spent water from kitchen, bathroom, lavatory, etc. The factors which contribute to variations in characteristics of the domestic sewage are daily per capita use of water, quality of water supply and the type, condition and extent of sewerage system, and habits of the people. Municipal sewage, which contains both domestic and industrial wastewater, may differ from place to place depending upon the type of industries and industrial establishment. The important characteristics of sewage are discussed here.

4.2 Temperature:

The observations of temperature of sewage are useful in indicating solubility of oxygen, which affects transfer capacity of aeration equipment in aerobic systems, and rate of biological activity. Extremely low temperature affects adversely on the efficiency of biological treatment systems and on efficiency of sedimentation. In general, under Indian condition the temperature of the raw sewage was observed to be between 15 to 350C at various places in different seasons.

4.3 pH:

The hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage is slightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

4.4 Colour And Odour

Fresh domestic sewage has a slightly soapy and cloudy appearance depending upon its concentration. As time passes the sewage becomes stale, darkening in colour with a pronounced smell due to microbial activity.

4.5 Solids (TSS, TDS)

Though sewage contains only about 0.1 percent solids, the rest being water, still the nuisance caused by the solids cannot be overlooked, as these solids are highly putrescible and therefore need proper disposal. The sewage solids may be classified into dissolved solids, suspended solids and volatile suspended solids. Knowledge of the volatile or organic fraction of solid, which decomposes, becomes necessary, as this constitutes the load on biological treatment units or oxygen resources of a stream when sewage is disposed of by dilution. The estimation of suspended solids, both organic and inorganic, gives a general picture of the load on sedimentation and grit removal system during sewage treatment.

4.6 Biochemical Oxygen Demand (BOD)

The BOD of the sewage is the amount of oxygen required for the biochemical decomposition of biodegradable organic matter under aerobic conditions. The oxygen consumed in the process is related to the amount of decomposable organic matter. The general range of BOD observed for raw sewage is 100 to 400 mg/L.

4.7 Chemical Oxygen Demand (COD)

The COD gives the measure of the oxygen required for chemical oxidation. It does not differentiate between biological oxidisable and nonoxidisable material. However, the ratio of the COD to BOD does not change significantly for particular waste and hence this test could be used conveniently for interpreting performance efficiencies of the treatment units. In general, the COD of raw sewage at various places is reported to be in the range 200 to 700 mg/L.

4.8 Waste Water Sample Tests And Results

In order to find the quality of sewage collected , laboratory tests are performed. Laboratory tests are performed to find the parameters such as pH, Total Susupended Solids (TSS) , Total Dissolved Solids (TDS) , Biological Oxygen Demand (BOD) ,Chemical Oxygen Demand (COD) , Oil and grease. The Resuls for samples are discussed below.

Table 2: Determination of pH vaule for the waste water sample

S.NO	SAMPLE NAME	TSS (mg/l)
1	SAMPLE A	272
2	SAMPLE B	380
3	SAMPLE C	392

Table 3: Determination of TSS value for the waste water sample

S.NO	SAMPLE NAME	pH VALUE @ 25^0 C
1	SAMPLE A	8.5
2	SAMPLE B	7.6
3	SAMPLE C	6.7

Table 4: Determination of TDS value for the waste water sample

S.NO	SAMPLE NAME	TDS (mg/l)
1	SAMPLE A	1254
2	SAMPLE B	1168
3	SAMPLE C	1128

Table 5: Determination of BOD value for the waste water sample

S.NO	SAMPLE NAME	BOD (mg/l) 5day @20^0C
1	SAMPLE A	150
2	SAMPLE B	190
3	SAMPLE C	210

Table 6: Determination of COD value for the waste water sample

S.NO	SAMPLE NAME	COD (mg/l)
1	SAMPLE A	280
2	SAMPLE B	365
3	SAMPLE C	626

Table 7: Determination of Oil Grease for the waste water sample

S.NO	SAMPLE NAME	OIL & GREASE
1	SAMPLE A	< 2
2	SAMPLE B	< 2
3	SAMPLE C	< 2

Table 8: Characteristics of sewage

S. No	Parameters	Range
1	Temperature	15 – 35 ˚C
2	pH	5.5 – 8.0
3	BOD	100-400 mg\l
4	COD	200-700 mg\l

Table 9: Sewage constituents per head production (Approx.)

S.NO	PARAMETERS	RANGE
1	BOD	27 (50-80) mg\l
2	COD	45.9 (100-160) mg\l
3	TSS	40.5 mg\l
4	Settablesolids	60 mg \ l
5	Suspended Solids	30 mg \ l

Table 10: BOD level of treated sewage quality and sewage

S.NO	Inland Surface Water (mg\L)	Public Sewer	Land for Irrigation
1	100	600	200
2	30	350	150
3	250	-	-

5 SELECTION OF AVAILABLE TECHNOLOGY

5.1 Appropriate Waste Water Treatment :Technologies in India

A single wastewater treatment technology would be inappropriate for a country like India which has several different geographical and geological regions, varied climatic conditions and levels of population.It is more appropriate to address the potential of identifying appropriate solutions for different regions. In addition, the solutions for wastewater treatment are a response to several factors including: i) the volume of wastewater; ii) type of pollutants; iii) the treatment cost; iv) extent of water scarcity, and v) dilution of pollution in the water resources.The five main wastewater treatment technologies that are commonly used are as given below: i) waste stabilization ponds; ii) wastewater storage and treatment reservoirs; iii) constructed wetlands; iv) chemically enhanced primary treatment; and v) up flow anaerobic sludge blanket reactors. These are suitable for different conditions and have advantages and disadvantages, especially in terms of requirements for land, cost, remediation efficiency and other factors.All these solutions for wastewater treatment aim at innovations across a broad range of environmental issues including: i) reuse of wastewater; ii) removal of nutrients from effluent; iii) management of storm water; iv) managing solid wastes; v) flood mitigation; and vi) tackling erosion around water bodies, including ponds, lakes and riverbank.

5.2 Moving Bed Bio-Film Reactor (MBBR)

Limited water resources and increasing urbanization require a more advanced technology to preserve water quality. One of the important factors affecting water quality is the enrichment of nutrients in water bodies. Wastewater with high levels of organic matter (COD) Phosphorus (P) and Nitrogen (N) cause several problems, such as eutrophication, oxygen consumption and toxicity, when discharged to the environment. It is, therefore, necessary to remove these substances from wastewaters for reducing their harm to environments. Biological processes are a cost-effective and environmentally sound alternative to the chemical treatment of wastewater.Biological processes based upon suspended biomass (i.e., Activated sludge processes) are effective for organic carbon and nutrient removal in municipal wastewater plants. But there are some problems of sludge settle ability and the need of large reactors and settling tanks and biomass recycling. Biofilm processes have proved to be reliable for organic carbon and nutrients removal without some of the problems of activated sludge processes. Biofilm reactors are especially useful when slow growing organisms like nitrifiers must be kept in a wastewater treatment process. Both nitrification and denitrification have been individually successful in the Biofilm reactor. Due to the rapid urbanization, wastewater has been continuously and excessively released into the environment, causing significant impacts on human and wild life. Many organic compounds in municipal wastewater are detected in different types of wastewater, affecting water quality, human health and biodiversity in the ecosystems. These compounds have significant impacts on receiving water bodies so as finding an appropriate treatment technology to effectively remove organic matters (OMs) in wastewater is very essential. Two technologies are commonly used for biological treatment of sewage: activated sludge and trickling filters. A moving bed biological reactor (MBBR) is a compilation of these two technologies. The biomass in the MBBR exists in two forms: suspended flocks and a biofilm attached to carriers. It can be operated at high organic loads and it is less sensitive to hydraulic overloading. The MBBR was developed in Norway at the Norwegian University of Science and Technology in co-operation with a Norwegian company Kaldnes Miljǿteknologi (now Anox Kaldnes AS). The first MBBR was installed in 1989. Although it is a relatively new technology to the United States (first introduced in 1995), there are now over 400 installations worldwide in both the municipal and industrial sectors with over 36 in North America.

5.3 Operating Principle

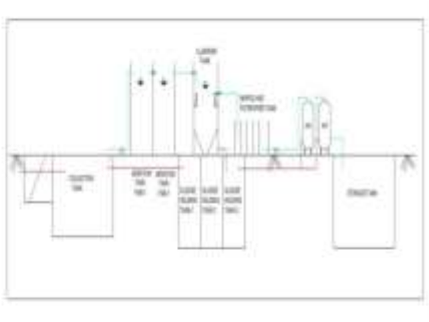
The MBBR is a complete mix, continuous flow through process which is based on the biofilms principle that combines the benefits of both the activated sludge process and conventional fixed film systems without their disadvantages. The basic principal of the moving bed process is the growth of the biomass on plastic supports that move in the biological reactor via agitation generated by aeration systems (aerobic reactors) or by mechanical systems (in anoxic or anaerobic reactors). The moving bed processes come from the current trend in wastewater treatment, from the use of systems that offer an increased specific surface in the reactor for the growth of the biomass, achieving significant reductions in the biological reactor volume. Reactor can be operated at very high load and the process is insensitive to load variations and other disturbances.

Table 11: Properties of bio-Film Media

MATERIAL	Polypropylene, plastic, ceramic, porous
SHAPE	Corrugated cylinder, chips, hollow, curved
DENSITY	0.95 g/cm^3
DIMENSIONS	10×15 mm
SPECIFIC SURFACE	260 m^2/m^3

Table 12: Removal efficiency of MBBR treatment

Parameters & Unit	**Influent IN**	**MBBR Output**
Turbidity (NTU)	30 – 50	<1
Odour	Possible	No
Visible Particles	High Level	None
pH	6.5 - 10	6.5 - 8
COD, mg/l	540 - 600	<50
BOD, mg/l	230 - 300	<10
Total N, mg/l	20 – 40	<5
TSS, mg/l	360 - 500	<10
Total P, mg/l	<5	<1



Proposed Treatment Pro

Figure..8:Bio-film media Figure8.:Bio-film with ully grown bacteria Figure. 9: Treatment process Figure.10: Prefabricated Steel

A sewage treatment plant ("STP") must handle the designed quantity of sewage and deliver Satisfactory quality of treated water, on a consistent, sustained basis over typically 10-15 years. This requires proper design and engineering; followed by proper operation and maintenance throughout its life. There are as many variations in the design and engineering of an STP as there are permutations and combinations of Builders/ developers, architects, Utility Consultants, Vendors. It cannot be gain said then that each of these agencies will have its own set of priorities and constraints which may adversely impinge on the design and engineering of the STP, thereby diluting to various degrees the very function and objective of the STP. Some of these constraints observed in the past on the part of these agencies are:

- Lack of commitment to the environment
- Lack of appreciation of the enormous benefit of recycle and reuse
- Funding constraints
- Lack of necessary knowledge and skill on the part of the designer
- Lack of commitment for proper operation & maintenance
- External pressures, etc.

Certain basic minimum criteria must be followed in the design and engineering of an STP, irrespective of all constraints, if the Plant is to deliver its stated objectives. The following sections outline in brief these basic minimum requirements in terms of design and basic engineering of the various units in the STP.

6. Treatment Process

Treatment of wastewater collected begins from Screening chamber to Storage tank. Various process involved are discussed below.

1. Coarse Screen Chamber
2. Fine Screen Chamber
3. Collection tank
4. Aeration tank
5. Clarifier tank with Hopper
6. Baffle wall and Filter Feed wall
7. Pressure Sand Filter (PSF)
8. Activated Carbon Filter (ACF)
9. Storage Tank

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