A COMPARATIVE STUDY OF DIFFERENT TECHNOLOGIES OF SEWAGE TREATMENT PLANT

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF DEGREE

OF
MASTER OF TECHNOLOGY
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Submitted by
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CANDIDATE'S DECLARATION

I, Keshav Sharma, Roll No.2K19/ENE/22 of Masters of Technology in Environmental Engineering, hereby declare that the project Dissertation titled "A COMPARITIVE STUDY OF DIFFERENT TECHNOLOGIES OF SEWAGE TREATMENT PLANT" Whatever I have submitted to the Department of Environmental Engineering, Delhi Technological University, Delhi in partial fulfilment of the criteria for the granting of a Master of Technology in Environmental Engineering is original and has not been plagiarized without due citation. This work has never been used to give a degree, diploma associateship, fellowship, or other equivalent title or honor.

Place: D.T.U, Delhi, India

Keshav Sharma
MAY 2022

CERTIFICATE

I hereby certify that the project Dissertation titled "A COMPARATIVE STUDY OF DIFFERENT TECHNOLOGIES OF SEWAGE TREATMENT PLANT" submitted by Keshav Sharma, Roll No. 2K19/ENE/22 (Department of Environmental Engineering), Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the M. Tech degree is a record of the project carried out by the student under my supervision. This work has not been submitted in part or in full for any degree or diploma at this university or elsewhere, to the best of my knowledge.

PLACE: DELHI

Dr. Geeta Singh
(SUPERVISOR)

ACKNOWLEDGEMENT

I'd like to express my gratitude to my supervisor, Dr. Geeta Singh (Assistant Professor, Environmental Engineering Department, Delhi Technological University, Delhi), for her guidance, assistance, helpful suggestions, and supervision, without which this report would not have been possible to show a proper direction while completing the project. I also have to recognize the unrestricted freedom to conceive, plan, execute, and express myself that I was allowed at every stage of my project while maintaining faith and confidence in my talents.

Above all, I owe it all to my Almighty God for providing me with the intelligence, health, and strength to complete this study assignment.

PLACE: DELHI
MAY 2022

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ABSTRACT

The Yamuna River runs through Noida on the west and southwest, while the Hindon River runs through it on the east and south. Noida is a part of the Yamuna River's catchment area. In the last 10 years, Noida has become a center for the real estate, electronics, and software development sectors. As a result, an beneath land network of conduits for the discharge of wastewater generates in the complex area is necessary to relieve pressure on existing municipal sewage treatment facilities. The sewage system for the complex was designed to take into account the natural slope. Three STPs for large group housings are being proposed in Noida: STP Group Housing 1 in sector 71 uses MBBR (Moving Bed Biofilm Reactor) technology, STP Group Housing 2 in sector 136 uses MBR (Membrane Bioreactor) technology, and STP Group Housing 3 in Greater Noida West Sector 1 uses SBR (Sequential Batch Reactor) technology. These facilities are designed and constructed with the purpose of eliminating organic material, sediments, and other pollutants from waste water before it reaches a water source.

The effluent from these STPs is used for flushing water, irrigation, and the rest of the discharge into Municipal Drains. Many Physio-Chemical and Biological parameters are evaluated and compared in this study to the Central Pollution Control Board (CPCB) General Standards for the Discharge of Environmental Pollutants Part–A: Effluents into Inland Surface Water, as set forth in The Environment (Protection) Rules, 1986 Schedule–VI. Each STP's performance was also assessed in terms of Removal/Reduction Efficiency.

Because Group Housing 1, uses 390 KLD of STP treated waste water for irrigation, the average effluent of this STP is compared to the CPCB Effluent Discharge Standards into Land for Irrigation.

According to the findings, the BOD value of STP 2 and STP 3 effluent was not under the permissible level for the period of the research, and the Average Phosphate value of STP 3 was exactly up to the limit, as directed by the Central Pollution Control Board.

General Standards for the Discharge of Environmental Pollutants Part –A: Effluents into Inland Surface Water is established by the Environment (Protection) Rules, 1986 Schedule-VI.

According to the findings, according to CPCB Effluent Discharge Standards into Land for Irrigation and Inland Surface Water, all of the Physio-Chemical and Biological parameters examined for STP 1 were within limits.

Furthermore, when compared to removal/reduction efficiency in other parameters including TSS (Total Suspended Solids), BOD (Biochemical Oxygen Demand), and COD, the performance analysis found that the three STPs described above performed badly in terms of TDS (Total Dissolved Solids) removal (Chemical Oxygen Demand).

The most efficient removal/reduction sequence was *1. TDS (40%) 2. COD (49%) 3.TSS (75%) 4.BOD (80%), 1.TDS (44%) 2.TSS (51%) 3.BOD (73%) 4.COD (75%) and 1.TDS (53%) 2.COD (65%) 3.TSS (79%) 4.BOD (83%)* respectively in STP 2, STP 3 and STP 1. In compared to the other two STPs, STP 1 in Sector-71 produced superior effluent outcomes and had a higher reduction efficiency for the effluent. BOD is 87% and is highest among STP 2 at Sector 136 and STP 3 at Greater Noida West Sector 1 which is 79% and 73% respectively.

Sector 71 STP1, based on MBBR technology, has more stable outcomes than Sector 136 STP2, based on MBR technology, and Greater Noida west Sector 1 STP3, based on SBR technology, according to the review. The following is the ranking of overall performance for the technologies examined in various STPs: 1. MBBR, 2.MBR 3.SBR, which demonstrates that in the treatment of sewage, MBBR (with ultrafiltration) tech is superior to MBR & SBR tech.
The functioning concept, as well as issues related to the operation and maintenance of all three STPs, are also covered.

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LIST OF ABBREVIATIONS

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
FIG	Figure
CPCB	Central Pollution Control Board
mg/L	**Milligram Per Liter**
TDS	**Total Dissolved Solids**
TSS	**Total Suspended Solids**
NO3 -N	**Nitrate Nitrogen**
NH3 –N	**Ammonia Nitrogen**
Cl-	**Chloride**
PO4-	**Phosphate**
Temp	**Temperature**
MPN	**Most Probable Number**
STP	**Sewerage Treatment Plant**
ASP	**Activated Sludge Process**
MBR	**Membrane Bio-Reactor**
MBBR	**Moving Bed Biofilm Reactor**
SBR	**Sequential Batch Reactor**
oC	**Degree Celsius**

CHAPTER 1

INTRODUCTION

1.1. General

In past Humans gathered, transported, and disposed of waste items, including human excreta, manually in the early days of mankind, a technique known as dry conservancy. This system produces a foul odor and is hazardous to one's health. With the advancement of civilization and development, effective waste disposal is now accomplished by a new system known as sewerage, which has supplanted the previous dry conservancy system. Sewage is waste that has been combined with water in the sewerage system. Sewage is transported by gravity to a Sewerage Treatment Plant through close pipes or lines known as sewers that are located away from residential areas (STP). Sewage is processed in this facility before being released into the environment.

Local with Govt. pollution control jurisdiction developed freshness criteria are required to remove contamination of Environmental waterways. Whenever Garbage is released in manageable amount, the state authorities' criteria should meet. Toilets, lavatories, urinals, bathtubs, showers, home laundries, and kitchens all contribute to domestic sewage. Similar wastes from medical clinics and hospitals are also included i.e., Treatment Plant (STP). Sewage treatment is processed here before being released into the environment.

1.2. Treatment Methods Generally Followed at an STP

When feces is collected from residential, commercial, and industrial sources, a sewage treatment facility eliminates toxins that impair water quality and jeopardize public health and safety when released into water receiving systems.

Its goal is to make it possible to dispose of human, residential, and industrial effluents without endangering human health or causing unacceptable environmental harm.

To remove particles, organic refuge, and nutrients from wastewater, Physical, chemical, and biological processes and activities are used in traditional treatment.

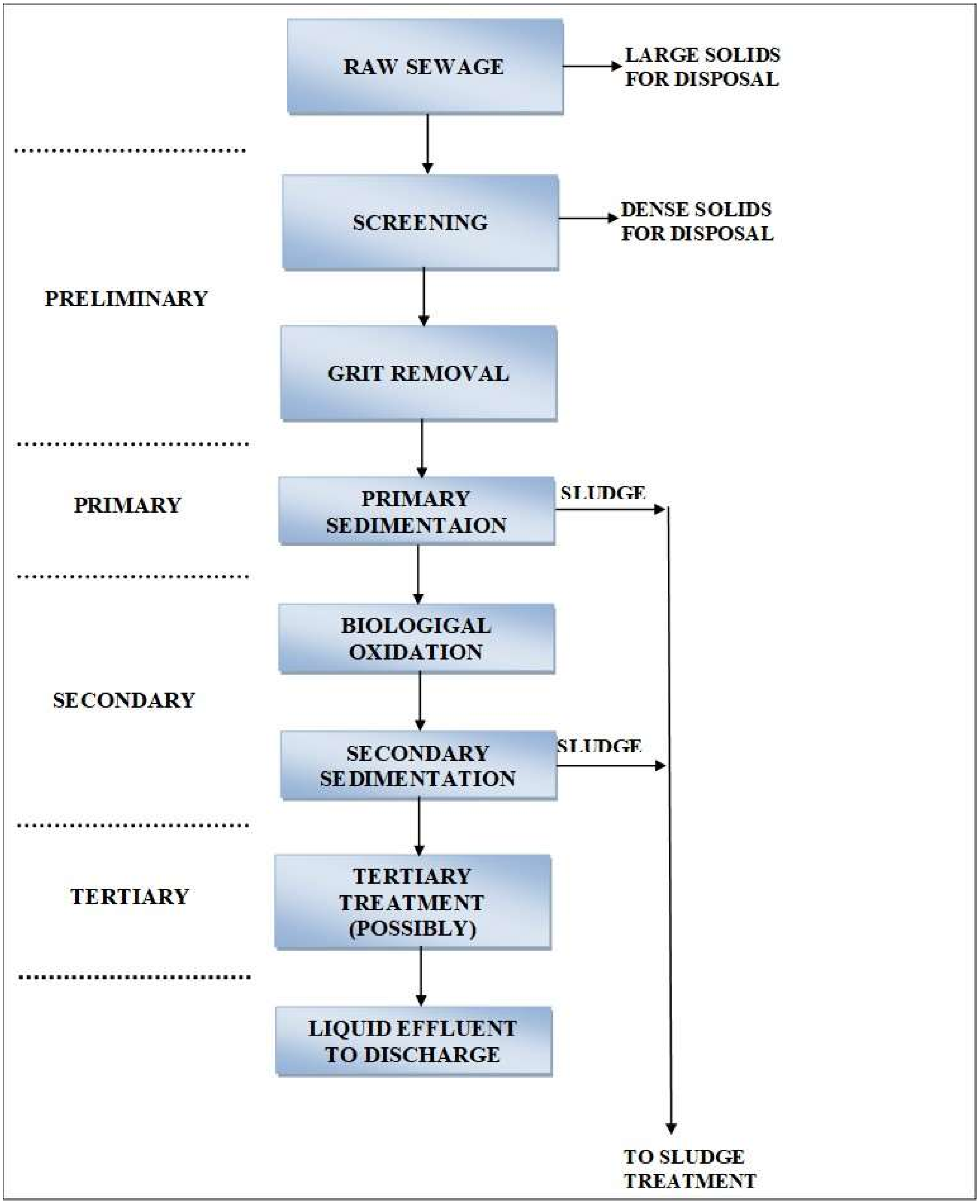

Figure 1.1: - TYPICAL STAGES IN CONVENTIONAL TREATMENT OF SEWAGE

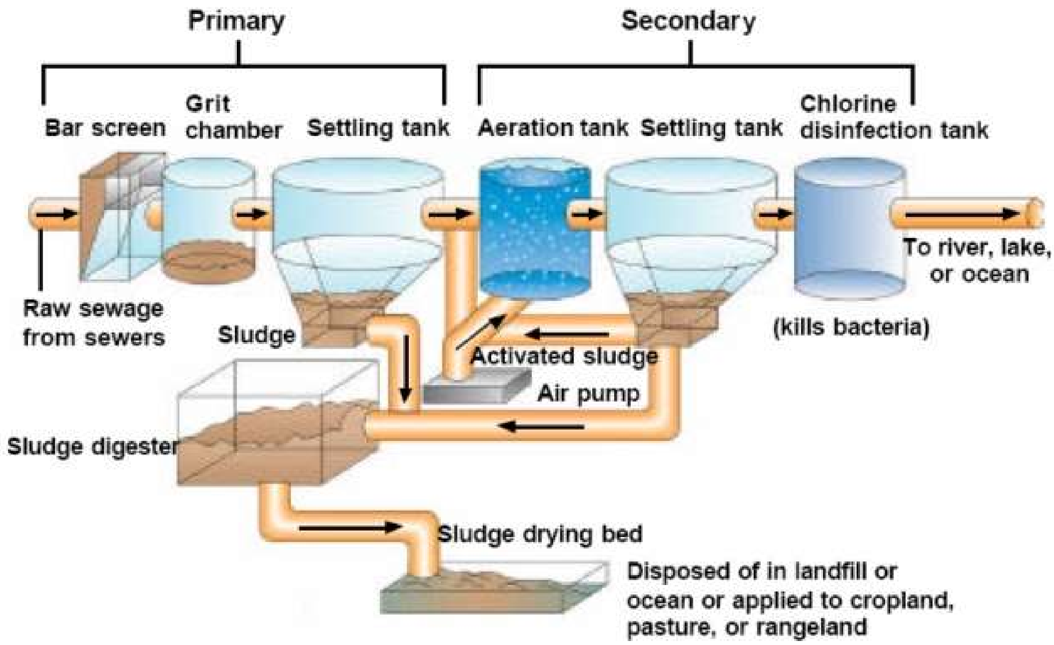

Figure 1.2: - General Diagram Showing Various parts of a STP

1.3. 1.5 MLD Sewerage Treatment Plant, "Sector 71" on MBBR Technology, at Noida

This Sewerage Treatment Plant, located at a group housing spread over an area of 160 acres, is located at Sector 71 Noida. The present capacity of the Sewerage Treatment Plant is 1.5 MLD. Sewage is treated in three stages at this STP: primary, secondary, and tertiary. 1.5 MLD being treated up to tertiary treatment and beyond of 1.5 MLD, 390 KLD Waste water or sewage that has been cleaned is recycled for watering of open areas and gardens. The 1.12 MLD In an open drain, treated sewage is disposed away.

The main components of STP "Sector 71", Primary Treatment (MBBR Technology)

1. Raw Sewage Sump
2. Inlet Channel
3. Settling Chamber
4. Mechanical Screens
5. Grid Separators

Secondary Treatment Components

1. Fluidized Aerobic Bioreactor Media
2. MBBR units (Moving Bed Bio Film Reactors):
3. Clarities settlers

Tertiary Treatment Components

1. Disinfection (Chlorine contact), Chlorine Contact Tank: 1

2. Filtration: Dual filter Media, one coconut shell filter media & other coarse fine aggregates as the other media.

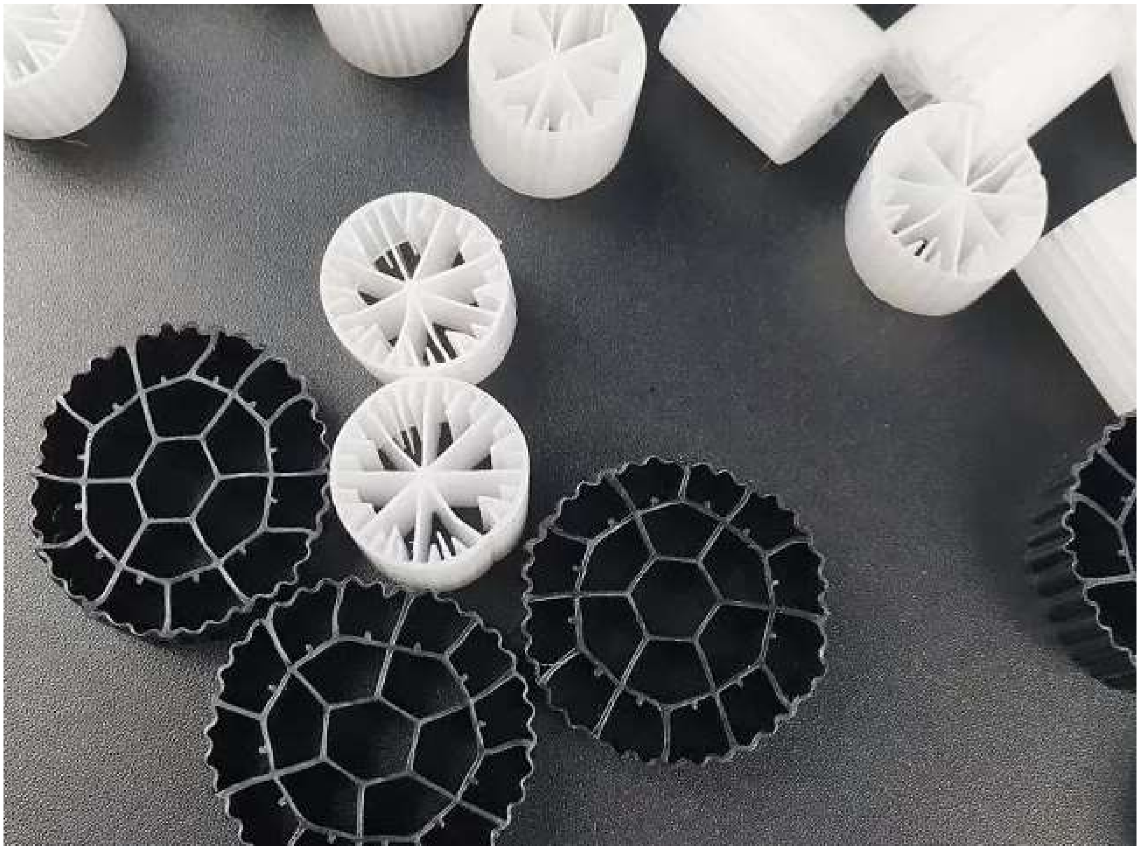

Figure1.3: - Tube Chip Shaped Bio-Carriers in MBBR tech

Bio-carriers in the shape of tube chips are shown in the fig above. The bio-carriers were created by combining an organic polymer (high density polyethylene) with nano-sized inorganic ingredients (cokes powder, zeolite, and other materials); the nano-sized inorganic ingredients were purposefully mixed to increase the carrier's surface area and roughness for better microorganism accommodation.

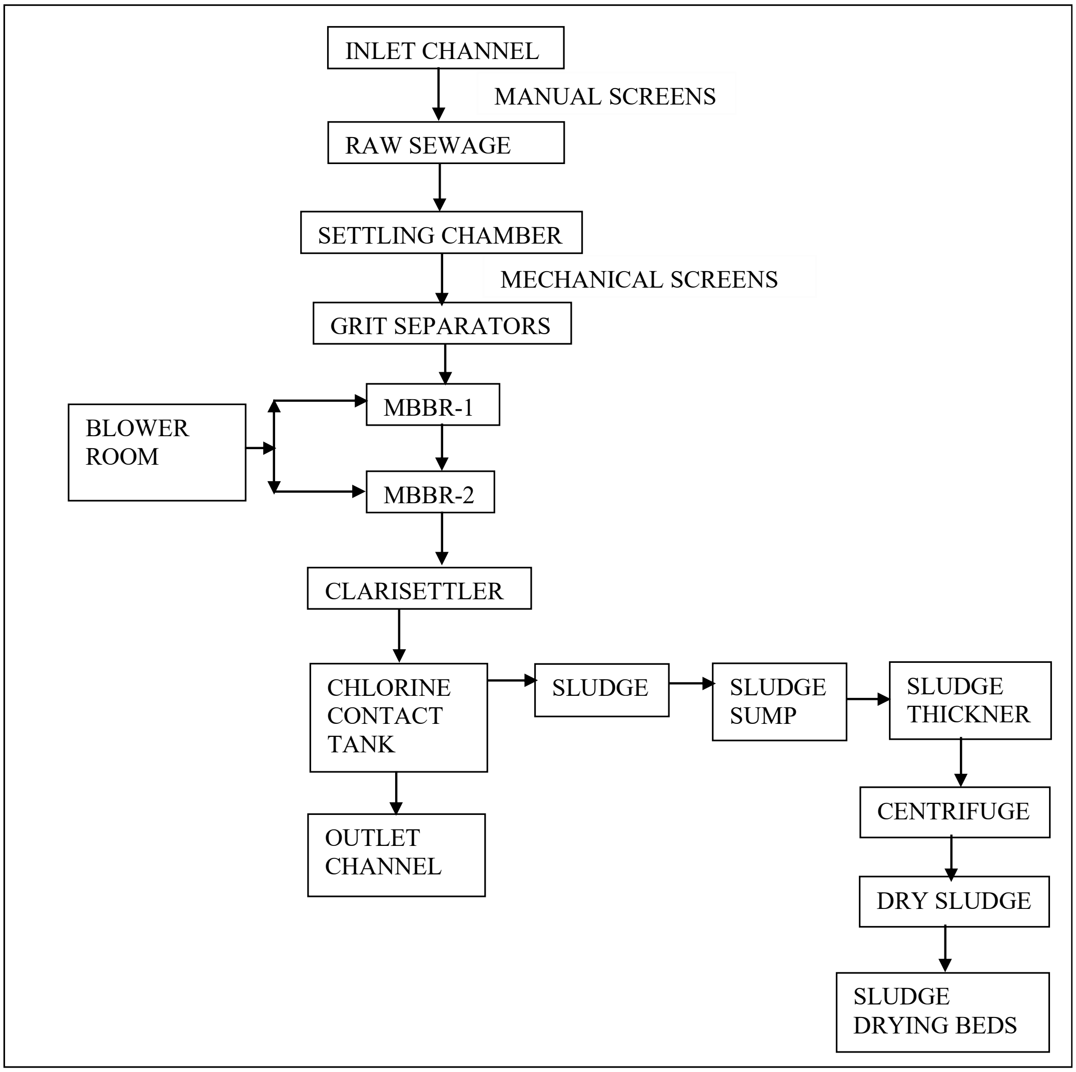

Figure 1.4:- Flow diagram showing MBBR technology

1.4. 0.7 MLD Sewerage Treatment Plant based upon MBR Technology of Group Housing 2, Sector 136, Noida

The main components of STP (MBR Technology)

1. Inlet Screen Chamber
2. Equalization Tank
3. Air Blowers :
4. MBR Tank
5. Air Diffuser :
6. Sludge Holding Tank :
7. Disinfection Tank :
8. Sewage Feed, Sludge Transfer & Suction Pump
9. Sludge Transfer and Disposal Pumps :
10. Tertiary Treatment :
11. UV Unit/ System

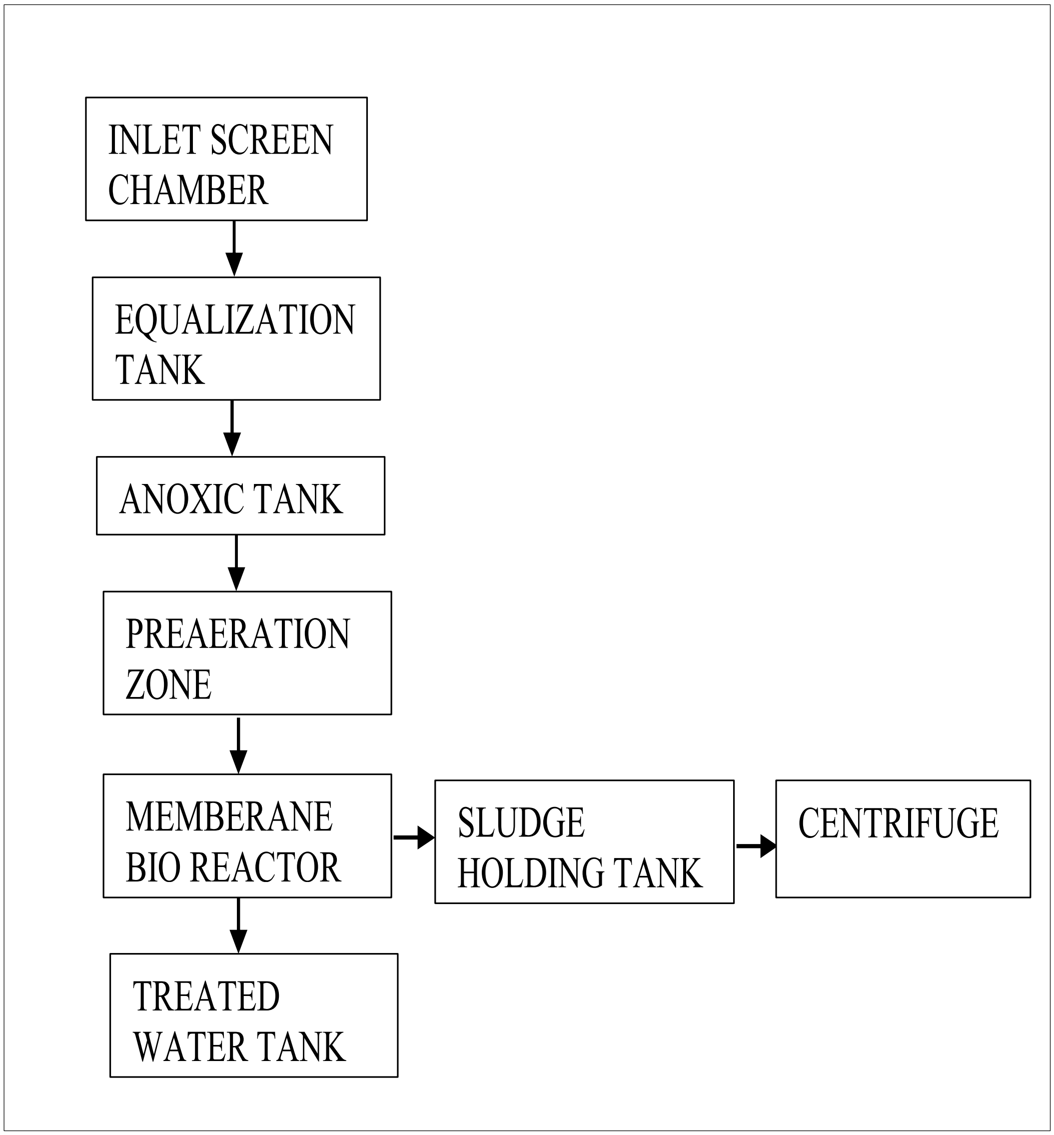

Figure 1.5: - FLOW DIAGRAM OF SHOWING MBR DIAGRAM

1.5. 1.25 MLD Sewerage Treatment Plant base upon SBR Technology at "Group Housing 3", Sector-1, Greater Noida West.

The main components of STP.

1. Bar screen
2. Oil/Grease Interceptor
3. Equalization tank
4. Sequencing Batch Reactor Tank
5. Decant Tank
6. Sand & Acti. Carbon filter
7. Chlorinator
8. Final treated effluent tank
9. Sludge holding tank
10. Filter press

1.6. Aim of the Study

- To analyze influent and effluent's physio-chemical parameters for all the STP's studied.
- To study the influent and effluent biological parameters for all the STP's.
- To determine the Nutrient Load in each of the STP studied.
- To get a practical understanding of the functioning principles of all three STPs covered.
- The entire performance of each STP in terms of removal/reduction efficiency must be determined.

1.7. Significance of the Study

Proper treatment should be given to sewage in Sewerage Treatment Plant before their disposal into inland surface water or for reuse of sewage effluent for irrigation purposes.

My study on the above three STP’s is done to check whether the effluent from the three STP’s studied complies with the Central Pollution Control Board (CPCB) General Standards for the discharge of environmental pollutants Part –A: Effluents, into Inland Surface Water according to The Environment (Protection) Rules,1986 Schedule-VI, because the discharge from the STP’s meet the river Yamuna River i.e., the source of Inland Surface Water.

Also, this study will help us to know that among MBR, MBBR and SBR which technology is better for the treatment of sewage and producing effluent of good quality.

CHAPTER 2

LITERATURE REVIEW

2.1. Fluidized Bed Biofilm Reactor for wastewater treatment

Wen K. Shieh and John D. Keenan (1986) invented the fluidized bed biofilm reactor (FBBR), which is a relatively new biofilm process invention. Microbes got immobilized on medium's small, fluidized particles, resulting in a heavy biomass halt in reactor, allowing the procedure to work at substantially greater fluid through outs while neglecting biomass washout.

FBBRs are particularly useful in biological effluent treatment, ethanol & commercial biomass conversion and biochemical applies due to their procedure intensify (i.e., a reduces in process sizes while retaining workability). Present state in knowledge on biofilm criteria that occur during operation of FBBR is discussed in the paper.

2.2. Treatment of raw domestic sewage in an UASB reactor

Raw home sewage was treated in an up flow anaerobic sludge blanket (UASB) reactor with a volume of 120 liters & depth of 1.92 meters in an experiment conducted by R.A. Barboza and G.L. Saint Anna Jr. (1989). The sewage had a BOD_5 of 357 mg l1 and a COD of 627 mg l1 on average. The suspended fraction contained approximately 75% of the organic components.

During the test, the temperature of the sewage lies between 18 to 28 degrees Celsius. Duration of nine-month period, Reactor was evaluated self-inoculation and raw residential sewage purification. For the length of the experiment, the unit was started without inoculum and ran considering hydraulic detention time of 4 hrs. In duration of testing, a sludge bed was discovered. At last of the experiment, major quantity of spherical granular particles with diameters of 6–13 mm was observed. After a four-month procedure, the inoculation and acclimatization phases were finished. There were 78 percent removal efficiencies for BOD_5, 74 percent removal efficiencies for COD, and 72 percent removal efficiencies for TSS. The biogas had a COD content of 69 percent and a standard gas production factor of 80 l kg1 COD.

2.3. Technical review on the UASB process

Kwan Chow Lin et al. (1991) conducted research on the UASB wastewater treatment method in depth. The effects of several factors on anaerobic sludge granulation, process start-up, and UASB reactor operation are studied. The design and construction criteria for the UASB reactor are presented, together with research on analytical modelling of liquid flow pattern, biological substrate & sludge distribution converts in the UASB reactor. Finally, the application of approach to treatment of several kind of wastewaters is explored.

2.4. Microbial growth in Fixed-Film Reactors: Process startup considerations

A.P. Annachatre and S.M.R. Bhamidimari (1992) studied that A completely grown and mature biofilm is required for optimal steady-state performance of any biofilm reactor. Biofilm is developing during the beginning phase of a fixed-film reactor, making it difficult to measure process performance. During reactor starting, environmental, cellular, and surface variables all have a significant impact on biofilm development.

Improved understanding of the nutritional, toxicological, and environmental needs of wastewater-degrading microorganisms has aided in the development of optimal microbial growth environments. Small microbial increase rates, rigorous natural conditions, & the restricted capacity of archaebacteria to attach and form fixed biofilms stymie the beginning of anaerobic fixed film reactors. Proper support medium selection and creation of appropriate inoculation processes and starting tactics might overcome these hurdles.

2.5. Small wastewater treatment plants — A challenge to wastewater engineers

Markus Boller (1997) found that Three conferences conducted by the IAWQ Specialist Group on "Small Wastewater Treatment Plants" illustrate international interest and activity in this topic, as well as the need to share expertise in the design, building, maintenance, and management of compact treatment plant. In the not-too-distant future, the number of tiny treatment works will skyrocket, resulting in a surge in demand for knowledge on relevant techniques and technology.

Minor wastewater flows cause pollution in tiny areas, but given the high per capita expenditures, treatment needs and alternatives must be extensively examined. More pronounced and diff. boundary conditions, operation and maintenance issues, such as load fluctuations, per capita costs, and a wide range of feasible treatment and disposal systems, necessitate the use of experienced engineers with a broad and thorough understanding of rural water quality management, in comparison to larger plants. When comparing technical options ranging from mechanical and simple biological low-rate systems like ponds, sand filters, and reed beds to complex high-rate suspended and fixed biomass reactors, plant size, operation safety, reliability, demand for skilled personnel, investment, and operation costs must all be taken into account.

In this regard, water engineers are increasingly pushed, not only to cope with a wide range of existing and future treatment technologies, but also to consider economic and social considerations in their analyses.

2.6. A review: The anaerobic treatment of sewage in UASB and EGSB Reactors

Lucas Seghezzo et al. (1998) conducted the research and discovered that anaerobic treatment is becoming more widely recognized as a method of advanced tech for nature protection and resource preservation, and that when combined with other appropriate procedure, it represents a sustainable and appropriate effluent treatment system for countries those are developing.

Sanitary engineers and decision-makers are increasingly interested in anaerobic sewage treatment. It works well in tropical areas and has the potential to work well in subtropical and temperate climates as well.

The essential aspects of anaerobic sewage treatment are discussed in this review study, with a specific focus on the up flow anaerobic sludge blanket (UASB) reactor. Examples from Americas, Asia, & European Union, the UASB method is used to the direct treatment of sewage. The UASB reactor looks to be a reliable technology today, and it is the most extensively utilized high-rate anaerobic sewage treatment technique.

2.7. The innovative Moving Bed Biofilm Reactor/ solids contact reaeration process for secondary treatment of municipal wastewater

Bjorn Rusten et al. (1998) carried out research on the revolutionary moving bed biofilm reactor con tact re-aeration (MBBR/SCR) technology has been selected for a updated Effluent treatment facility at Moa Point, Wellington, New Zealand, servicing a population of 200,000. Because the MBBR/SCR combination was novel, the contract included a pilot-scale demonstration project. The MBBR procedure delivered requisite waste water quality at loads greater than those employed in the original design, according to extensive pilot testing employing a wide variety of biological loads in steady-flow situations. At biological load on the MBBR of 15 grams B.O.D_5/ sqm-d (5.0 kg B.O.D_5/cum-d), a final effluent with a 5-day biochemical oxygen demand (BOD_5) of less than 10 mg/L was reached at three days mean cell residence time (MCRT) in the SCR stage. At a 20 g B.O.D_5/sqm d (6.7 kg B.O.D_5/cum d) organic load on MBBR, a final effluent of less than 15 mg B.O.D_5/L was attained using the same MCRT. Dynamic loading experiments revealed that the best-quality effluent was generated when the MBBR was loaded with more than 40 g BOD_5 sqm-d (13.3 kg BOD_5/cum-d) during the peak hour. The MBBR/SCR process was found to be more compact and cost-effective at the Moa Point location than the standard trickling filter/solids contact or activated-sludge procedures. Water Environ. Res., 70, 1083, Activated-sludge process at Moa Point site.

2.8. Biological Fixed Film Systems

Mark W. Fitch et al. (1999) conducted research and stated that the work discussed was featured during the year 1999 and elaborated study on biofilms as pollution treatment. Medicinal biofilms, It cause rust, & biofilm production of domestic water treatment and transfer systems are all specifically excluded from this analysis. The study on anaerobic biofilm treatment systems isn't covered here, but list of sourced are supplied. Researchers, on the other hand, have integrated denitrification coverage in typical biofilm treatment methods. Similarly, Gas release from treatment Facilities part of this problem, biofilm mechanism for the treatment air pollutants are discussed.

2.9. The Moving Bed Bio Film Reactor

H. Odegaard et al. (1999) studied the Moving Bed Bio Film Reactor is a novel biofilm reactor for wastewater treatment (MBBR). The results of numerous studies (carbonaceous removal, nitrification removal, and nitrogen removal) are discussed when they are applied to municipal effluent treatment. The design values were provided, and it is demo that this reactor produces very compact treatment facilities.

2.10.Performance evaluation of a UASB – activated sludge system treating municipal wastewater

M. von Sperling*, V.H. Freire and C.A. de Lemos Chernicharo (2001): Recent study shown benefits in mixing anaerobic & aerobic methods for municipal wastewater treatment, particularly in warm-climate nations. Although this arrangement is viewed as a cost-effective option, it has not been thoroughly examined on a global scale.

The findings of monitoring pilot-scale plant with a UASB and ASP mechanism cleaning genuine wastewater received through Brazilian city are presented in paper. System was meticulously monitored and operated for 261 days, spanning 5 stages and functioning with both constant and fluctuating inputs.

Plant performed well in terms of C.O.D prevention, with working quality ranging from 69 to 84 percent of UASB reactor, 43 to 60 percent for the AS system alone, & 83 to 95 percent of entire system. In usual phases of the investigation, the ultimate effluent suspended particles content was relatively lower, with mean ranging from 11 to 15 mg/l.

Based on system's excellent overall performance, it is thought to be choice for hot-climate countries than the traditional ASP system, specially when consider total small hydraulic retention time (4 hours UASB; 2.8 hours aerobic reactor; 1.1 hours clarifier), lack of primary sludge, thickening potential & energy efficient.

2.11.Removal of slowly biodegradable COD in combined Thermophilic UASB and MBBR System

M.Ji et al (2001) studied that in industrial wastewaters, cellulose, starch and polyvinyl alcohol are typical substrates for the controlled biodegradable C.O.D. In combination system comprising a thermophilic up flow anaerobic sludge blanket (TUASB) reactor (55°C) and an aerobic MBBR, the discharge individual and mixed SBCOD substrates was examined (MBBR).

The three SBCOD substrates have quite distinct removal processes. In the two reactors, starch-COD was almost equally used and eliminated. Microbial entrapment and sedimentation of the cellulose fibers entirely eliminated cellulose-COD from water in the TUASB reactor (97-98 percent). The combined reactors hardly biodegraded and eliminated PVA on its own.

Because of the presence of PVA macromolecules in the binary solution, bacterial activities in the TUASB reactor were disrupted, resulting in the formation of fatty acids (volatile), which moved total C.O.D removal from the TUASB to MBBR reactor, eradicating SBCOD, including PVA-COD. The combined reactors performed better and more consistently than solo reactors because the three SBCOD substrates were removed in distinct ways.

2.12.Anaerobic sewage treatment in a one-stage UASB reactor and a combined UASB-Digester system

Nidal Mahmood et al. conducted another research (2004) The sewage treatment at 15°C was checked in a single UASB reactor and a UASB-Digesting system. UASB reactor and a digesting are joined for treatment of sewage and sludge stabilization. The UASB was worked with a 6-hr hydraulic detention time and a temperature controlled at 15°C, which is the average sewage temperature in many Middle Eastern countries throughout the winter. The digester was switched on at 35°C. The UASB system has much greater C.O.D removal efficiency than the single-stage UASB reactor (significance level 5 percent). In the UASB- Digester system, total, suspended, colloidal, and dissolved COD removal efficiencies were 66 percent, 87 percent, 44 percent, and 30 percent, respectively, while in the one-stage UASB reactor, 44 percent, 73 percent, 3 percent, and 5 percent. The effluent sludge from the single-stage UASB reactor and the UASB-Digester system had stability values of 0.47 g CH4-COD/g COD and 0.36 g CH4-COD/g COD, respectively. As a result, anaerobic sewage treatment with a UASB-Digester system at low temperature appears promising.

2.13.Developments in wastewater treatment methods

Amit Sonune and Rupali Ghate (2004) studied that Wastewaters of the community that are releases into manholes as waterborne liquids & solids. Wastewater consists dissolved & suspended organic matter that are biologically degradable or "putrescible." Domestic & industrial wastewaters are treated as two groups of wastewaters that not fully distinct.

The process of partially removing and partially changing the particles in wastewater from highly complexity, putrescible biological materials to mineral or reasonably stable biological solids is referred to as waste water treatment. During primary & secondary treatment, the majority of B.O.D and suspended particles in wastewaters are eliminated. This treatment, however, is becoming not sufficient to protect receiving streams or provide recyclable water for industrial & household reusing.

As a result, wastewater treatment plants have introduced additional treatment procedures to remove more organic and solids, as well as nutrients and/or dangerous substances. In the realm of water treatment, there have been a number of revolutionary advances in recent years. There are now alternatives to traditional and conventional water treatment procedures.

As people, community, corporations, and govt. methods to maintain important resources available and fit for use, advanced wastewater treatment has become a global emphasis. Wastewater treatment tech, in combination with wastewater removal and water reuse activities, offers the possibility of decreasing, if not stopping, the losses of useful water. These technologies are highly compatible for waste water reusing and recycle. Membranes may different component with vast variety of sizes of substances and molecule weights in a selective manner. Membrane technology has evolved into a respectable separation technique throughout the millennia. Membrane technology's key convenience that it works without chemicals being used, very little energy consumption, and has well-organized flow of process. This document discusses all advanced wastewater treatment and reuse technologies.

2.14.Potential of a Combination of UASB and DHS Reactor as a Novel Sewage Treatment System for Developing Countries: Long-Term Evaluation

In a study made by Madan Tandukar et al. (2006) With raw sewage as an influent, an innovative effluent treatment system have of a combined UASB and DHS after treatment unit was assessed for more than 3 years. The device was placed at a sewage treatment plant and ran at a temperature of 25±3 degrees Celsius. The findings of a long-term monitoring of the system are presented in this publication. The entire experiment was separated into three phases, each with its own set of operational circumstances. In the anaerobic UASB pretreatment unit, organic contaminants were only partly eliminated. The DHS post-treatment unit virtually fully eliminated the residual organics and nitrogenous substances. Throughout complete phases, the mechanism continuously achieved discard efficiency of greater than 94% for unfiltered biological oxygen demand (B.O.D), 80% for unfiltered C.O.D, and 70% for suspended solids. With just 4–9 milli gram. Liters of residual unfiltered BOD, the system generated outstanding effluent quality. Although no aeration was given to the DHS system, the final effluent included 5–7 mg/L of dissolved oxygen. Furthermore, extra sludge formation from DHS was limited, resulting in the absence of secondary sludge, which is difficult to dispose of.

In addition, the system demonstrated significant stability when subjected to a 2fold hydraulic shock load and a 4fold organic shock load. Findings showed that the proposed technology may viable municipal effluent treatment option in varying situations.

2.15.Treatment of pesticide wastewater by Moving-Bed Biofilm Reactor combined with Fenton-coagulation pretreatment

Sheng et al. (2006), South Korea conducted the study The Fenton-coagulation procedure was utilized initially to reduce COD and enhance biodegradability in pesticide wastewater with a high COD value and poor biocompatibility, followed by biological treatment. Fe_2+ conc. of 40 mol/Liters and H_2O two No. of dosage of 96 mol/Liters, starting pH 3 were found to be the best experimental conditions for the Fenton process. The break the P S double bond & sulphate ions created and different intermediates of organic, followed the synthesis of phosphate and subsequent oxidation of intermediates, was proposed as mechanism of interaction between organophosphorus pesticides and hydroxyl radicals. To correct the pH and further coagulate the contaminants, 3.2 g/Liters $Ca(OH)_2$ being added in the biological treatment.

By using Fenton coagulation & oxidation, COD value of wastewater reduced from 33,600 - 9400 mg/Liters, & ratio of biological oxygen demand ($B.O.D_5$) to C.O.D of the wastewater increased to above 0.47. Pre-treatment of wastewater then biologically oxidized in a MBBR, where tube chips type bio-carriers liquidized by air bubble.

The bio-carrier quantity ratio kept above 20% and pre-treated wastewater consisting 3000 mg/Liter of inlet C.O.D fed at 1 day of hydraulic detention time (HRT), a COD removal efficiency of more than 85% was achieved, but when the carrier volume was reduced to 10%, only 72 percent was achieved. High reduction efficiency and Inert operation in the biotic process could be accomplished even at a high C.O.D loading of 37.5g COD/kg utilizing Fenton pre-treatment, also due to the large conc of biomass and high biofilm activity employing the fluidizing bio-carriers (sqm carrier day).

2.16.Combined Anaerobic/Aerobic secondary municipal wastewater treatment: Pilot-Plant demonstration of the UASB/Aerobic Solid Contact System

Municipal wastewater is increasingly being treated with anaerobic pretreatment and aerobic posttreatment, according to Enrique J. La Motta et al. (2007). Recent study using anaerobic fluidized bed reactor/aerobic solids contact combination has demonstrated the process's technical potential.

The study emphasizes the necessity of a combined-up flow anaerobic sludge bed (UASB) system for municipal waste effluent cleaning, with the objective of proving the technical feasibility of employing the UASB process as both a pretreatment unit and a waste activated sludge digesting system. According to the data, the UASB reactor has a total C.O.D reduction efficiency of 34 percent and a total suspended particle removal efficiency of roughly 36 percent. Microorganisms' breakdown 33% of the solids retrieved by the device, while 4.6 percent accumulates in the reactor. The UASB reactor was able to function for three months without sludge waste due to its low solid buildup rate. This unit's longer solids retention duration is comparable to that of standard sludge digestion units, allowing waste activated sludge to be stabilized before being reintroduced to the UASB reactor.

The aerobic unit needed at least 100 minutes of post-aeration time to work well since particle flocculation was poor in the UASB reactor. Polymer synthesis, which is essential for good biological flocculation, was almost non-existent in the anaerobic unit; hence, polymer production at optimal levels required dissolved oxygen levels greater than 1.5 mg L in the aerobic solids contact chamber. The quality of the settled solids contacts chamber effluent always satisfied the secondary effluent standards of 30 mg BOD/L and 30 mg SS/L whenever these parameters were fulfilled.

2.17.Performance comparison of a pilot-scale UASB and DHS system and activated sludge process for the treatment of municipal wastewater

Madan Tandukar et al. (2007) from Japan conducted a study comparing the working of pilot-scale combined performance of DHS and UASB technology to that of the ASP for municipal sewage treatment. All the technologies were run inside tandem, with the same sewage. Investigation lasted over 300 days and found that the biological organic waste reduction effectiveness of the DHS plus UASB system was equivalent to the ASP. Both technologies removed more than 90% of the unfiltered BOD. In terms of pathogen elimination, however, the UASB + DHS system outperformed the ASP system. Furthermore, the quantity of extra sewage produced by DHS +UASB 15 times smaller than that makes by ASP.

Furthermore, unlike ASP, the UASB + DHS system does not require aeration to operate, making it a cost-effective treatment solution. Based on the foregoing findings, determined the DHS + UASB technologies can be a cost-efficient and feasible alternative to ASP for the treatment of municipal sewage, particularly in low-income nations.

2.18.Efficiency evaluation of sewage treatment plant with different technologies in Delhi (India)

Priyanka Jamwal and Atul Mittal (2008) carried out a study on in the context of diverse treatment technologies used in these plants, the chemical, Physical & microbiological efficiency of STPs situated in Delhi have been determined. A total of seventeen STPs handling household wastewater were investigated over the course of a year. These STPs were developed using the ASP (Activated Sludge Procedure), Ex. Aeration (Extended Aeration), BIOFORE (Physical, Biological Removal & chemical Treatment), and the oxidation pond treatment process. Except for the "Mehrauli" STP, which used an extended aeration procedure, & the "Oxidation Pond," waste water from all STPs surpassed the F-C threshold of 103 MPN/100 ml set by National River Conservation Directorate for unrestricted irrigation (NRCD). Based on physical, biological, and microbiological removal efficiencies and influent sewage parameters, the integrated efficiency (IEs) of every STP was assessed and comparison to the integrated efficiency (IEs). STPs with prolonged aeration, BIOFORE, and oxidation pond treatment processes produced the greatest results and may thus be safely utilized for irrigation.

2.19.Treatment of domestic wastewater in an Up-Flow Anaerobic Sludge Blanket reactor followed by Moving Bed Bio film Reactor

A.Tawfik et al. (2009), The Netherlands made an study at a temperature of (22–35 °C) to test the effectiveness of lab-scale treatment system of sewage comprising of an UASB reactor & a MBBR. The treatment technology was run on varied hydraulic detention duration (HRTs) of 13.3, 10, and 5.0 hours. At a total HRT of 5–10 hours, overall decrease of 80–86 percent for C.O.D total, 51–73 percent for C.O.D colloidal, and 20–55 percent for C.O.D reduction was detected. C.O.D total, C.O.D colloidal, and C.O.D solubility removal efficiency rose to 92, 89, and 80 percent, respectively, when HRT was extended to 13.3 hours. However, enhancing the total HRT from 5 to 10 hrs. & from 10 to 13.3 hrs. had no effect on the removal efficiency of C.O.D suspended in the combined system. This suggests that the suspension of COD was not reliant on the HRT administered. Organic loading rate has a substantial impact on ammoniacal nitrogen reduction in MBBR processing UASB reactor effluent (OLR). At an OLR of 4.6 grams C.O.D m-2 day-1, 62 percent of ammonia was removed. At higher OLRs of 7.4 and 17.8 g COD m-2 day-1, respectively, removal efficiency was reduced by 34 and 43 percent.

At a HRT of 13.3 h, the average overall residual quantity of fecal coliform in the last effluent were 8.9 9 104 MPN per 100 ml, 4.9 9 105 MPN per 100 ml at a HRT of 10 hrs., and 9.4 9 105 MPN per 100 ml at a HRT of 5.0 hrs., respectively, corresponding to log10 reductions of 2.3, 1.4, and 0.7. The sludge released from MBBR–UASB has outstanding setting properties. Furthermore, at a total HRT of 13.3 hours, the net yield of sludge were 7% in the MBBR & only 6% in the UASB reactor of the total C.O.D of influent. As result, with a HRT of 13.3 hours, the MBBR+UASB technologies for sewage treatment is recommended.

2.20.Assessment of the efficiency of Sewerage Treatment Plants

In, study maee by Ravi Kumar et al. (2010), Bangalore city has two Urban Waste effluent Treatment Plants (UWTPs) on outskirts of the Vrishabhavathi valley, villages of Nagasandra and Mailasandra, Karnataka, India. These plants are built with the goal of minimizing and/or reducing nutrients, sediments, disease-causing organisms, organic debris and other pollutants from wastewater when it reaches a water body.

The performance analysis found that the two treatment plants' effectiveness was inadequate when it came to removing total dissolved solids, compared to removing/reducing other metrics including TSS, B.O.D, and C.O.D.

TDS, B.O.D, TSS and C.O.D removal efficiency in Mailasandra STP was 20.01, 94.51, 94.98, and 76.26 percent, respectively, whereas TDS, B.O.D, TSS and C.O.D reduction efficiency in Nagasandra STP was 28.45, 99.0, 97.6, and 91.60 percent, respectively.

In Mailasandra and Nagasandra STPs, the order decrease efficiency was TDS< COD<BOD<TSS & TDS<COD<TSS<BOD, respectively. Furthermore, related issues to the maintenance & operation of wastewater effluent plants are examined.

2.21.Biofilms in Water and Wastewater treatment

Rakmi Abd.Rahman et.al (2010) study that Biofilm reactors are increases being utilizes to clean difficult-to-treat effluents from industries. Sort of process has been used for clean waste effluent consisting a variety contaminant, including chlorinated organics. Due to their recalcitrance, standard activated sludge methods have not been able to successfully remove them. Biofilm reactors feature biomass that is activate at low conc, of target organics, making them efficient at eliminating hazardous chemicals from wastewaters. Biofilm processes with large biomass concentrations have found to be low susceptible to hazardous and inhibitory chemicals and more shock resistant than scattered growth systems. Such features are critical in an environment where space of floor is increasingly scarce & a pressing need for cleanse & polis effluents prior to recycle.

The distinction between effluent polishing and water treatment is blurring as rivers become more polluted by trace industrial and home chemicals and medications, and as demand for water grows. With better awareness of the health impacts of trace contaminants, a more effective and cost-efficient water purification system than the traditional method must be researched. The traditional coagulation, settling, and filtration water treatment procedure eliminates mostly suspended particles, but trace and resistant organics pass through.

Greater usage of shallow aquifer water & tougher water regulations for drinking, like the new EU Drinking Water Directive (EU DWD), have paved way for biofilm technologies to be used in water treatment, as seen in northern Italy.

Here are the findings of ongoing study on the use of biofilm technologies for water treatment and sewage treatment. Biofilm columns are used for river water treatment and rainwater cleaning, as well as for the removal of chloro-organics and heavy metals. In all of these investigations, biofilm columns were found to be extremely successful in the removal of organics and nutrients from river waters, as well as the removal of chloro-organics and heavy metals from wastewaters.

Biodegradation of PCP reductive dichlorination was detected in the reactor by metabolite analysis, indicating that biofilms provided both oxidative and reductive cond. Aside from these unique qualities, neither chemical were used in the biofilm treatment of water and Sewage. As a result, nor chemical sludge produced, and cleaning costs were reduced owing to chemicals. The biofilm technologies described here have the potential to be developed further into less expensive, more ecologically friendly procedures for treating organics and heavy metals in water and wastewater.

2.22.Comparison of overall performance between "Moving-Bed" and "Conventional" Sequencing Batch Reactor

E. Hosseini Koupaie et al. (2011) carried out a studied in which the study's major goal to evaluate the efficiency of a "traditional" & "moving-bed" sequencing batch reactor. Diff. experimental parameters were computed for this purpose, including dye concentrations, C.O.D, turbidity, MLVSS/MLSS ratio, MLSS concentration, Oxidation-Reduction Potential (ORP) & sludge volume index (SVI). This investigation used Traditional SBR and three moving-bed sequencing batch reactors (SBR-MB). Each SBR-MB was outfitted with a biofilm carrier that moved.

Findings of dye, turbidity, C.O.D studies revealed there were no changes in effluent quality between the moving-bed and traditional sequencing batch reactors.

Moving-bed sequencing batch reactors had a larger MLSS concentration variation and also a higher SVI than traditional sequencing batch reactors. In compared to those evaluated in the traditional sequencing batch reactor, the reactors equipped with moving carriers had higher ORP values, indicating a larger oxidation potential.

2.23. Integrated application of Up flow Anaerobic Sludge Blanket Reactor for the treatment of wastewaters

Muhammad Asif Latif et al (2011) observed that, among other treatment approaches, the UASB process identified as basic procedure of latest tech for natural protection. The treatment of 7 kinds of waste effluent by the UASB method is highlighted in this paper: palm oil mill effluent (POME), slaughterhouse wastewater, distillery wastewater, dairy wastewater, piggery wastewater, municipal wastewater (black and grey) & fisheries wastewater. The goal of this research is to find out how polluted these wastewaters are and how they can be treated in an up flow anaerobic sludge blanket technique.

The study goes over general parameters of waste effluent, treatment in the UASB reactor with, reactor performance & operating parameters in terms of C.O.D reduction and methane gas generation. The tangible data depicts the reactor setup, providing the most comprehensive understanding of the up flow anaerobic sludge blanket reactor for further study. Future research requirements are also discussed.

2.24. Sustainable options of post treatment of UASB effluent treating sewage: A review

According to Abid Ali Khan et al. (2011), the up flow anaerobic sludge blanket (UASB) technique is a sustainable solution for the treatment of household wastewaters in underdeveloped nations and small settlements. The failure of the UASB procedure to satisfy the intended disposal requirements, on the other hand, has provided adequate motivation for future post-treatment. Various technological options are available to update UASB-based treatment plants (STPs) to overcome desired treated water quality for reuse and discharge, with preliminary post-treatment for the reduction of inorganic and suspended matter, organic compound and secondary post-treatment for the reduction of hardly decomposable soluble matter, nutrients, colloidal and polishing systems for pathogen removal.

As a result, the alternative techniques for treating UASB reactor effluent treating sewage are discussed in this study. Furthermore, based on review of diff. integrated combinations, i.e., UASB-different aerobic systems to meet all practical aspects to make it a sustainable for environmental protection was conducted.

2.25.Upgrading Activated Sludge Systems and reduction in excess sludge

Hossein Hazrati and Jalal Shayegan (2011) studied on They discovered that the majority of Iran's 200 activated sludge plants are overcrowded, and result, their workability is low. At the project, a plant is built & installed in 1 of Tehran's effluent treatment plants in the west. In this pilot, a MBR and UASB were employed as pre-treatment units instead of traditional activated sludge. An enriched municipal wastewater was used as the pilot's influent for the sake of data accuracy and precision. The efficient detention duration in kind of technology was 4 hours, and the overall C.O.D reduction effectiveness was 98 percent, according to results. Overall, upgrade will boost the plant's quantity from a factor of five while also lowering surplus sludge by a factor of ten. After granulation, the sludge volume index in the anaerobic reactor was around 12.

2.26.Improvements in Biofilm Processes for Wastewater Treatment

Husham T. Ibrahim et al. (2012) made an effort this paper aims for offer an overview of biofilm system as another to traditional water treatment methods. Method has grown in famous over time, owing to the fact that many wastewaters treatment plants that still employ the ASP have flaws when subjected for rising organic & hydraulic loads. Biofilm kinds and specification, Pros and Cons, and Parameters for design are three areas that cover the basics of biofilm research. Unsubmerged fixed film systems and submerged fixed film systems reactors are covered in this review.

2.27.Performance evaluation of Moving Bed Bio-Film Reactor technology for treatment of domestic waste water in Industrial Area at MEPZ (Madras Exports Processing Zone), Tambaram, Chennai, India

Ravichandran.M and Joshua Amarnath.D (2012) carried out a study on MEPZ, an industrial complex constructed by the Ministry of Commerce and Industries of the Government of India and located in Tambaram, Chennai, is discharging household waste water created by employees, which is cleaned in a 1.0MLD capacity STP with MBBR. The efficiency of MBBR system in removing B.O.D and TSS was calculated in this study by testing treated effluent & raw sewage under a variety of conditions, including heavy organic shock loading, normal weather, when artificial aeration is disrupted due to a power outage & dilution with storm water. The testing results showing that the reduction performance of $B.O.D_5$ and Suspended Solids from municipal waste effluent is more than 98 percent in normal weather conditions, that the performance of MBBR is not affect by that the efficiency and heavy Organic shock loading is around 90 percent when artificial aeration is disrupted.

The carrier element's surface area per unit volume was improved, as planned by M/s Anox Kaldnes, a Norwegian corporation, to achieve this degree of efficiency. When space is limited, it is proposed that the MBBR system might be effective and efficient solution for the cleaning of municipal waste water.

2.28. The performance enhancements of Up flow Anaerobic Sludge Blanket (UASB) reactors for domestic sludge treatment – A State of the art review

Siewhui Chong et al. (2012) made a study in which he found that nowadays, the issue of carbon emissions and, as a result, the water utilities carbon footprint is crucial. In this regard, one shall think about how small and big wastewater treatment plants may lower their carbon impact. Because no aeration is necessary and biogas may be utilized with in plant, using anaerobic rather than aerobic treatment procedures would achieve this goal. Because of its large loading capacity and minimal sludge output, high-rate anaerobic digesters are attracting a lot of attention. Up flow anaerobic sludge blanket (UASB) reactors have been the most commonly employed among them. However, there are still unsolved concerns that are preventing the general use of this system in underdeveloped nations with varying climatic temperatures. A vast amount of research being conducted in try to improve the performance of UASB reactors, however updated documentation is lacking.

2.29. Wastewater Treatment in Baghdad City Using Moving Bed Biofilm Reactor (MBBR) technology

Mohammed A. Abdul-Majeed et al. (2012) conducted a study in which, a lab-scale (MBBR) system utilized to treat municipal wastewater from a home neighborhood in Baghdad City, resulting in BOD-free water suitable for irrigation or disposal to the river. The reported experiment to compare a low-cost MBBR with an activated sludge system (AS); another goal of this research was to develop effective MBBR wastewater reuse programs in Iraq. The laboratory studies were split into two parts: first, with a B.O.D_5 load of roughly (150-200) mg/l, the plastic element filling ratio in the MBBR reactor was 40%. The majority of the biodegradable organic materials was absorbed by the aerobic reactor. The removal efficiencies of BOD_5 for MBBR and AS were 78 and 90 percent, respectively. The second phase occurs when the BOD_5 load is around (900-1300) mg/l and the filling ratio is 67 percent (synthetic wastewater). BOD removal efficiencies for AS were 73 percent, and for MBBR they were at 88 percent.

2.30.A review of the Up flow Anaerobic Sludge Blanket Reactor

Chidozie Charles Nnaji (2013) conducted a study in which Since its creation in the Netherlands, the (UASB) reactor has found widespread use in the cleaning of wastewaters of industries. On both a home and industrial scale, it has been used to treat a wide range of wastewaters. This acceptability arises from its simplicity, cost-effectiveness, and potential for energy recovery. There have been several studies on UASB reactors, and while there have been some discrepancies in the results, experts agree that the reactor is effective in treating high to medium-strength wastewaters with readily hydrolysable substrate. On both a home and industrial scale, it has been used to treat a wide range of wastewaters. This acceptability arises from its simplicity, cost-effectiveness, and potential for energy recovery. There have been several studies on UASB reactors, and while there have been some discrepancies in the results, experts agree that the reactor is effective in treating high to medium-strength wastewaters with readily hydrolysable substrate.

This document provides a quick but thorough overview of the UASB reactor and related research. Using facts and data culled from the literature, Key working concerns such as methanogenesis, granulation, efficiency, hydraulic retention time, toxicity, biogas recovery & UASB reactor changes were evaluated. This review demonstrates that by modifying UASB reactors, they may be used to treat practically any form of wastewater.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1.Site selection and sampling points

The three STPs listed above provided samples for examination, namely:

3.1.1. Group Housing 1 Sector 71 STP

3.1.2. Group Housing 2 Sector 136 STP

3.1.3. Group Housing 3 Greater Noida West Sector 1 STP

The sampling points, or the main region from which samples were taken, were:

1. Inlet and Final Outlet of Sector 71 STP
2. Inlet and Final Outlet of Sector 136 STP
3. Inlet and Final Outlet of Greater Noida West Sector 1 STP

3.2.Collection of Samples

Grab samples were taken according to the American Public Health Association's Standard Methods for Examination of Water and Wastewater. During the study, samples were taken three times, once in each of the months of FEBRUARY, MARCH, and APRIL.

3.3.Parameters Analyzed

3.3.1. Physio-chemical parameters

Temp (Temperature), pH, TDS (Total Dissolved Solids), TSS (Total Suspended Solids), Grease and oil, Chemical Oxygen Demand (COD) & Chlorides were the parameters investigated in this study.

3.3.2. Biological parameters

Biochemical Oxygen Demand was one of the biological factors examined in this study (BOD).

3.3.3. Nutrient Load

The Nutrients analysis in this research were Ammoniacal Nitrogen (NH_3 – N), Nitrate-Nitrogen (NO_3 –N) and Phosphate (PO_4^-).

Table 3.1: Parameters and Methods for their Analysis

PARAMETER	TEST METHOD
pH	Electrometric
Temperature	Digital Thermometer
Oil and Grease	Soxhlet Extraction
Total Suspended Solids	Membrane Filtration
Total Dissolved Solids	Gravimetric
Biochemical Oxygen demand	Winkler's Titration
Chemical Oxygen Demand	Closed Reflux Titrimetric
Chlorides	Argentometric Titration
Nitrate – Nitrogen	Acid Treatment followed by Spectrophotometry
Ammoniacal – Nitrogen	Distillation Titrimetric
Phosphate	Ascorbic Acid Spectrophotometry

3.4.Methods for Parameters Analysis

3.4.1. pH

Method: Electrometric method was adopted for the determination. Procedure

1. Standardize the pH meter by submerging the electrode in a buffer solution with a defined pH range, typically 4 to 9.
2. Read the pH and calibrate it until the pH of the buffer solution is right. Immerse the electrodes in the sample after rinsing them in distilled water.
3. Read the pH value.

3.4.2. Temperature (Temp)

Method: Digital Thermometer was used for analysis of temperature. Procedure

1. Fill a beaker with 100 mL of sample.
2. Put Digital Thermometer in the beaker containing sample.
3. The instrument will show the reading related to temperature in ^{o}C.

3.4.3. Oil and Grease

Method: Soxhlet Extraction Method Procedure

1. Prepare a filter by layering filter paper over a Muslin cloth disc. Soak the cloth and the paper in water.
2. Using suction, pass 100 mL of filter aid suspension through the prepared filter, then wash with 1 liter distilled water. Filter the acidified material once it has been acidified.
3. Vacuum the filter paper until no more liquid sample goes through.
4. Transfer the filter paper to a watch glass using forceps. Attach the material to the muslin fabric disc's edges.
5. Wipe the sides and bottom of the collecting vessel and the Buchner funnel with filter paper soaked in solvent, being careful to remove any grease films and collect all sediments.
6. On the watch glass, place pieces of filter paper. Roll up all of the filter paper.

7. Place any residual material on the watch glass. Place the watch glass in the thimble after wiping it with filter paper soaked in solvent.
8. Bake the thimble for 30 minutes at 10-30 degrees Celsius. Glass wool or little glass beads can be used to fill the thimble.
9. Weigh the extraction flask and use hexane to extract oil and grease in the Soxhlet Apparatus at a rate of 20 cycles per hour for 4 hours (counting the first cycle).
10. Place the flask in a water bath at 700°C for 15 minutes, then use a vacuum to pull air through it for the last minute.
11. Allow to cool in desiccators for 30 minutes before weighing.

Calculation

$$\text{Oil and Grease, mg/L} = \frac{M \times 1000}{V}$$

Where,

M = Mass, in mg, of the residue

V = Volume in ml of the sample taken for test

3.4.4. Total Suspended Solids (TSS) Method: Membrane filtration Method Procedure

1. In a Gooch crucible, place 50 mL of sample.
2. Place the Gooch crucible on the glass fiber apparatus.
3. Switch on the electrical supply.
4. Liquid passes in the glass fiber.
5. Solids remains on the Asbestos layer.
6. Weigh the empty Gooch crucible before the experiment and after drying the crucible at about 103^0c in oven to 15 mins.

3.4.5. Total Dissolved Solids (TDS)

Method: Gravimetrically after drying in an oven Procedure

1. Filter paper is cleaned by placing it in the filtration assembly and filtering three 20 mL volumes of distilled water in succession. Suction is kept going to remove any remaining water. Washings are thrown away.
2. The evaporating dish is dried for one hour at 104 ± 10°C, then cooled and stored in a desiccator. It is promptly weighed before usage.
3. A measured volume is pipette on to the filter using a wide bore pipette while the sample is agitated with a magnetic stirrer. The sample volume is designed to provide a dried residue of between 10 and 200 mg. Then three 10 mL measures of distilled water were rinsed in a row. After the filtering is finished, the suction is kept going for roughly 3 minutes.
4. The whole filtrate is transferred to a weighted evaporating plate and dried in an oven at 104 10C with washings. After evaporation, if necessary, repeated amounts are applied to the same dish to provide between 10 and 200 mg dry residue. To avoid splattering, decrease the oven temperature by 20 degrees below boiling point at first, then raise it to 104 degrees after 1 hour of evaporation. Then it was weighed after cooling in a desiccator.

Calculation

$$\text{mg Dissolved Solids/L} = \frac{(A - B) \times 1000}{\text{mL sample}}$$

Where:

A = Weight of dried residue + dish, mg B = Weight of dish, mg.

3.4.6. Biochemical Oxygen Demand (BOD)

METHOD: Winkler's Titration

Procedure

To make dilution water, combine 1-liter distilled water with 1 mL each of phosphate buffer, magnesium sulphate solution, calcium chloride, and ferric chloride solution.

1. Determine the exact capacity of three BOD bottles. Find out the D.O of undiluted sample and designate as $DO_{S.}$
2. Prepare the desired percent mixture by adding samples in dilution water.
3. Fill up one bottle with the mixture and the other one with dilution water blank.
4. Incubate at a fix temperature for 27°C, 3 days.
5. Find out DO in both bottles after incubation and designate mixture as DO_i, blank as DO_b.

Calculation

$BOD_{3,\ 27\ °C}$ (mg/L) = $[(DO_B - DO_i)\ D.F - (DO_b - DO_S)]$

Where,

DO_B = DO of blank solution (dilution water) DO_b = DO of incubated blank solution

DO_i = DO of incubated sample that has been diluted DO_S = DO of undiluted sample (sample)

$$D.F = \text{dilution factor} = \frac{\text{Total vol. of sample + Blank}}{\text{mL of Sample}}$$

3.4.7. Chemical Oxygen Demand (COD) METHOD: Closed Reflux Titrimetric Method

1. In a refluxing flask, dilute 50 mL of sample or a lower quantity to 50.0 ml.
2. Mix 1 g of $HgSO_4$ and 5 ml of H_2SO_4 together (in which 1gm of silver sulphate is present in every 75ml acid).
3. Slowly add $HgSO_4$ to dissolve it. Allow the mixture to cool. Mix with 25.0 ml 0.25N $K_2Cr_2O_7$ solution once more. Connect the condenser and begin the cooling process.

4. Using the open end of the condenser, add the remaining acid agent, 70 ml, and mix the reflux mixture. Apply heat to the mixture and allow it to reflux for 2 hours before cooling.

5. Dilute the mixture to about 300 mL and use Ferroin indicator to titrate the surplus dichromate with standard ferrous ammonium sulphate. The color shifts from yellow to green to blue to crimson. Keep track of how much titrant you used in ml.
6. Reflux a blank of distilled water equal to the volume of the sample and the reagents in the same way. Titrate according to the sample. Keep track of how much titrant you used in ml.

Calculation

$$\text{COD} = \frac{(A-B)\,C \times 8 \times 1000}{\text{mL Sample}}$$

where, A = 1 mL of Ferrous ammonium sulphate used for zero.

B = mL of Ferrous ammonium sulphate used for sample.

C = normality of ferrous ammonium sulphate solution. Chloride (Cl^-)

Method: Argentometric Titration Procedure

1. Fill a conical flask with 100 ml of sample.
2. Dissolve 1 ml of potassium chromate indicator in 1 ml of water. The color of the sample changes to yellow.

3. Titrate with normal N/35.5 $AgNO_3$ solution until the color turns brick red. Take note of the amount of titrant that was utilized.

Calculation

$$\text{Chlorides as } Cl^- = \frac{\text{ml of } AgNO_3 \text{ used for sample} \times 1000}{\text{ml of sample}}$$

3.4.8. NITRATE – NITROGEN (NO_3 –N)

Method: Acid Treatment followed by Spectrophotometry Procedure

1. Sample treatment: 1 ml HCl is added to 50 mL clear/filtered sample and stirred well.
2. Standard curve preparation: Calibration standards are created in the range of 0-7 mg NO_3—N/L by diluting to 50 ml, adding 1 ml of HCl, and mixing.

Nitrate, ml	1	2	4	7	10	15	20	25	30	35
Volume of Sample, mg/L	0.2	0.4	0.8	1.4	2.0	3.0	4.0	5.0	6.0	7.0

3. Spectrophotometric measurements: Absorbance or transmittance is read against re-distilled water set at zero absorbance or 100 % transmittance. A wavelength of 220 nm is used to obtain NO_3- reading and a wavelength of 275nm to determine interference due to dissolved organic matter.

Calculation

To obtain absorbance owing to NO_3^-, subtract 2 times the absorbance reading at 275nm from the reading at 220nm for sample and standards. The absorbance due to NO_3 is plotted against the NO_3-N concentration of standards to create a standard curve. Using adjusted sample absorbance, sample concentrations are calculated directly from the standard curve.

3.4.9. Ammoniacal- Nitrogen (NH_3 –N)

Method: Distillation Titrimetric Method Procedure

1. Set up the necessary equipment: In a distillation flask, combine 500 mL water and 20 mL borate buffer, then adjust the pH to 9.5 with 6N NaOH solution. With the addition of a few glass beads or boiling chips, this combination is utilized to steam out distillation gear.
2. A dechlorinated sample of 500 mL or a known part of 500 mL is utilized. The sample volume is determined using the table below.

Ammoniacal Nitrogen, mg/L	Volume, mL
0.1-5	500
5-10	250
10-20	100
20-50	50
50-100	25

3. Using a pH meter, adjust the pH to 9.5 using 25 mL borate buffer and 6N NaOH.
4. It is distilled at a rate of 6 to 10 mL/min in a 500 mL Erlenmeyer flask with tip of the delivery tube below the surface of 50 mL indicting boric acid. Distillate must be collected in quantities of at least 200 ml. The distillate-receiving flask is lowered for a minute or two after the heater is turned off to clean the condenser and prevent suction of the distillate into the condenser.
5. Titrate ammonia in the distillate with 0.02 N H_2SO_4 titrant until the indicator turns pale purple.
6. A blank is used throughout the process, and any necessary corrections are made to the results.

Calculation

$$\text{mg NH}_3-\text{N/L}=\frac{(A-B)\times 280}{\text{mL sample}}$$

where:

A = mL H_2SO_4 titrated for sample B = mL H_2SO_4 titrated for blank

3.4.10. Phosphate (PO_4^-)

Method: Ascorbic Acid Spectrophotometry Method

1. Sample treatment: 1 drop of phenolphthalein indicator is added to a 50 ml sample in a 125 ml conical flask. By adding 5N H_2SO_4, any red color is removed. A total of 8 ml of combined reagent is added and thoroughly mixed.
2. Each sample's absorbance is measured at 880nm after 10 minutes, but no more than 30 minutes. As a reference, a reagent blank is employed.
3. To prepare a sample blank for turbid or colorful samples, combine all reagents except ascorbic acid and potassium antimonial tartrate with the sample. The sample's absorbance is subtracted from the blank's absorbance.
4. Establishing a calibration curve: A calibration curve is established using a series of standards ranging from 0.15 to 1.30 mg P/L. (for a 1 cm light source). A distilled water blank is used with the combination reagent.
5. A straight line is drawn on a graph of absorbance vs phosphate concentration. With each batch of samples, at least one phosphate standard is evaluated.

Calculation

$$PO_4 \text{ as mg P/L} = \frac{\text{mg P}_{\text{from the calibration curve}} \times 1000}{\text{mL sample}}$$

Table 3.2: Central Pollution Control Board (CPCB) General Standards for the Discharge of Environmental Pollutants according to The Environment (Protection) Rules, 1986 Schedule-VI Part –A: Effluents

Parameter	**Inland surface water**	**Public sewers**	**Land for irrigation**	**Marine/Coastal areas**
Color and odor	-	-	-	-
Suspended solids mg/l, max.	100	600	200	) For process waste water (b) For cooling water effluent 10 per cent above total suspended matter of influent.
Particle size of suspended solids	shall pass 850 micron IS Sieve	-	-	(a) Floatable solids, max. 3 mm (b) Settleable solids, max 856 microns
pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0

Temperature	shall not exceed 5°C above the receiving water temperature			shall not exceed 5°C above the receiving water temperature
Oil and grease, mg/l max,	10	20	10	20
Total residual chlorine, mg/l max	1.0	-	-	1.0
Ammoniacal nitrogen as N; mg/l, max.	50	50	-	50
Total Kjeldahl nitrogen (as N);mg/l, max. mg/l, max.	100	-	-	100
Free ammonia (as NH3), mg/l, max.	5.0	-	-	5.0
Biochemical oxygen demand (3 days at 27°C), mg/l, max.	30	350	100	100

Chemical oxygen demand, mg/l, max.	250	-	-	250
Arsenic (as As).	0.2	0.2	0.2	0.2
Mercury (As Hg), mg/l, max.	0.01	0.01	-	0.01
Lead (as Pb) mg/l, max	0.1	1.0	-	2.0
Cadmium (as Cd) mg/l, max	2.0	1.0	-	2.0
Hexavalent chromium (as Cr + 6), mg/l, max.	0.1	2.0	-	1.0
Total chromium (as Cr) mg/l, max.	2.0	2.0	-	2.0
Copper (as Cu) mg/l, max.	3.0	3.0	-	3.0

Zinc (as Zn) mg/l, max.	5.0	15	-	15
Selenium (as Se)	0.05	0.05	-	0.05
Nickel (as Ni) mg/l, max.	3.0	3.0	-	5.0
Cyanide (as CN) mg/l, max.	0.2	2.0	0.2	0.2
Fluoride (as F) mg/l, max.	2.0	15	-	15
	5.0	-	-	-
Sulphide (as S) mg/l, max.	2.0	-	-	5.0
Phenolic compounds (as C_6H_50H)mg/l, max.	1.0	5.0	-	5.0

Radioactive materials: (a) Alpha emitter’s micro curie mg/l, max. (b)Beta emitters icro curie mg/l	10 -7 10 -6	10 -7 10 -6	10 -8 10 -7	10 -7 10 -6
Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
Manganese	2 mg/l	2 mg/l	-	2 mg/l
Iron (as Fe)	3mg/l	3mg/l	-	3mg/l
Vanadium (as V)	0.2mg/l	0.2mg/l	-	0.2mg/l
Nitrate Nitrogen	3.4.1. 10 mg/l	-	-	20 mg/l

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1.RESULTS

Concentration in mg/L, for all parameters except pH and Temp (°C)

Table 4.1: Characteristics of INFLUENT and EFFLUENT of all the 3 STP's in the month of FEBRUARY

Parameters	STP 3(SBR Technology)		STP 2 (MBR Technology)		STP 1 (MBBR Technology)	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
Ph	7.5	8.3	7.4	8.1	7.2	8.2
Temp	18.9	18.2	18.5	18.1	18.6	17.5
TSS	153.0	33.0	165.0	63.0	174.0	28.0
TDS	279.0	155.0	284.0	167.0	289.0	104.0
Oil and Grease	3.5	0.5	4.3	0.4	5.1	0.15
BOD3, 27 °C	153.0	32.0	139.0	35.0	182.0	18.0
COD	365.0	191.0	394.0	73.0	377.0	51.0
Cl^-	191.0	87.0	117.0	99	165.0	103.0
NO_3 -N	1.9	1.3	2.5	1.6	3.4	1.1
NH_3 –N	28.9	30.1	25.6	28.2	19.8	24.0
PO_4^-	15.0	3.6	20.5	4.2	25.3	1.3

Table 4.2: Characteristics of INFLUENT and EFFLUENT of all the 3 STP's in the month of MARCH

Parameters	**STP 3(SBR Technology)**		**STP 2 (MBR Technology)**		**STP 1 (MBBR Technology)**	
	Influent	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**
pH	7.5	8.5	8.5	8.7	7.7	8.3
Temp	24.8	23.1	24.9	22.1	23.7	22.2
TSS	127.0	28.0	239.0	156.0	151.0	40.0
TDS	293.0	172.0	313.0	123.0	298.0	138.0
Oil and Grease	2.5	0.3	3.7	0.8	4.8	0.8
BOD3, 27 °C	165.0	31.0	150.0	46.0	186.0	26.0
COD	348.0	104.0	378.0	98.0	358.0	64.0
Cl^-	180.0	56.0	110.0	78.0	173.0	198.0
NO_3 -N	2.7	1.2	4.2	1.3	4.8	1.3
NH_3 –N	29.6	38.2	34.7	29.4	21.5	17.5
PO_4^-	19.3	5.1	15.1	7.7	15.8	1.9

Table 4.3: Characteristics of INFLUENT and EFFLUENT of all the 3 STP's in the month of APRIL

Parameters	**STP 3(SBR Technology)**		**STP 2 (MBR Technology)**		**STP 1 (MBBR Technology)**	
	Influent	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**
pH	6.7	7.6	6.8	7.6	7.1	7.8
Temp	26.2	27.1	26.3	27.6	26.2	26.3
TSS	133.0	31.0	142.0	52.0	148.0	31.5
TDS	234.0	153.0	228.0	146.0	253.0	132.0
Oil and grease	2.8	0.5	3.7	0.8	3.2	0.3
BOD3, 27 °C	178.0	34.0	148.0	32.0	188.0	25.0
COD	296.0	143.0	357.0	71.0	311.0	83.0
Cl^-	167.0	52.0	146.0	32.0	157.0	112.0
NO_3 -N	4.6	3.1	5.8	2.4	5.1	2.3
NH_3 –N	19.4	28.7	23.3	37.7	17.3	23.4
PO_4^-	11.6	5.3	17.3	4.2	13.5	2.7

Table 4.4: Average characteristics of INFLUENT and EFFLUENT of all the 3 STP's

Parameters	**STP 3(SBR Technology)**		**STP 2 (MBR Technology)**		**STP 1 (MBBR Technology)**	
	Influent	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**
pH	7.2	8.1	7.6	8.1	7.3	8.1
Temp	23.3	22.8	23.2	22.6	22.8	22.0
TSS	137.7	30.7	182.0	90.3	157.7	33.2
TDS	268.7	160.0	275.0	145.3	280.0	124.7
Oil and grease	2.9	0.4	3.9	0.7	4.4	0.4
BOD3, 27 °C	165.3	32.3	145.7	37.7	185.3	23.0
COD	336.3	146.0	376.3	80.7	348.7	66.0
Cl^-	179.3	65.0	124.3	69.7	165.0	137.7
NO_3 -N	3.1	1.9	4.2	1.8	4.4	1.6
NH_3 –N	26.0	32.3	27.9	31.8	19.5	21.6
PO_4^-	15.3	4.7	17.6	5.4	18.2	2.0

Graphical Representation of Average characteristics of Influent and Effluent of all the 3 STP's.

X-Axis: Influent and Effluent

Y-Axis: Concentration in mg/L, for all parameters except pH and Temp (ºC)

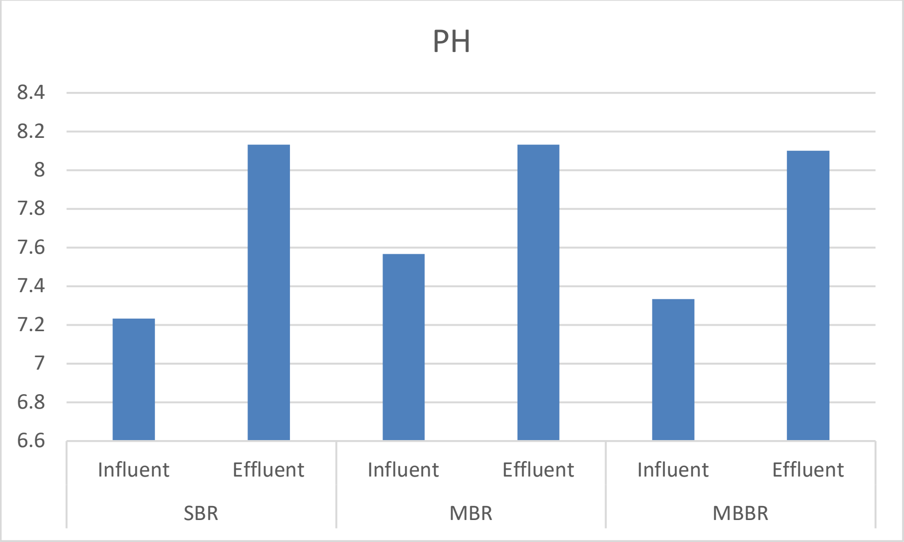

Figure 4.1: Graphical Representation of pH

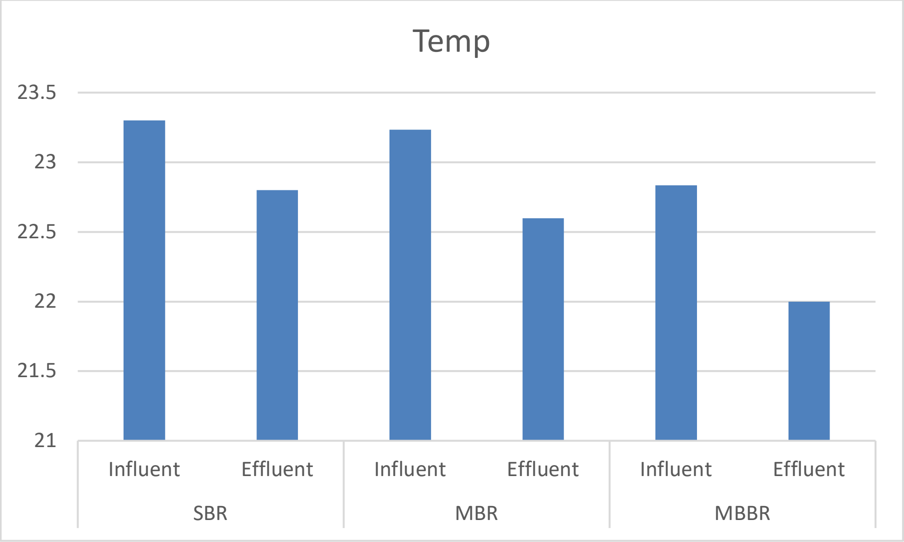

Figure 4.2: Graphical Representation of Temp.

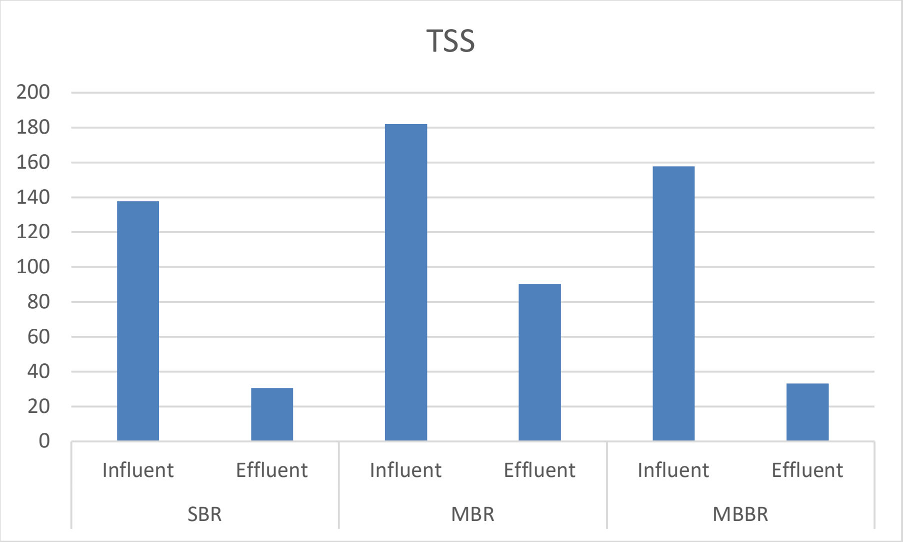

Figure 4.3: Graphical Representation of TSS

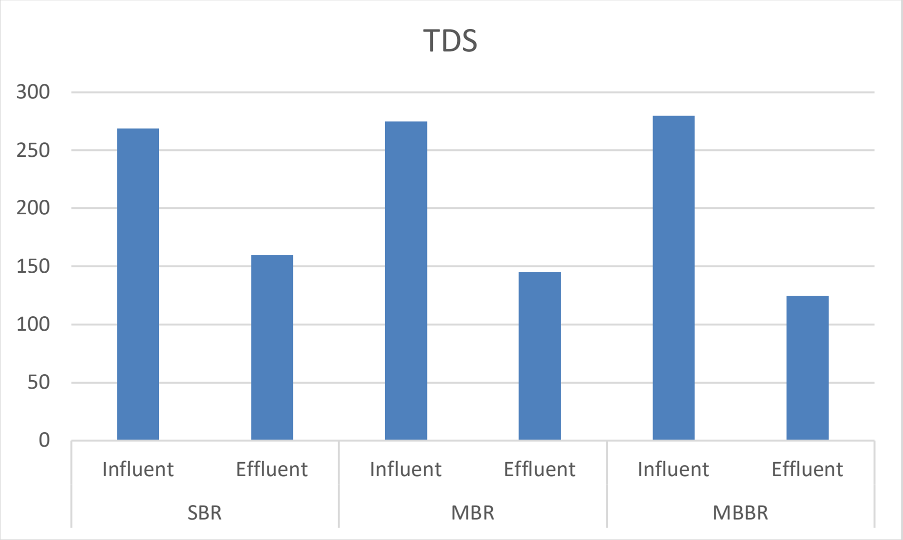

Figure 4.4: Graphical Representation of TDS

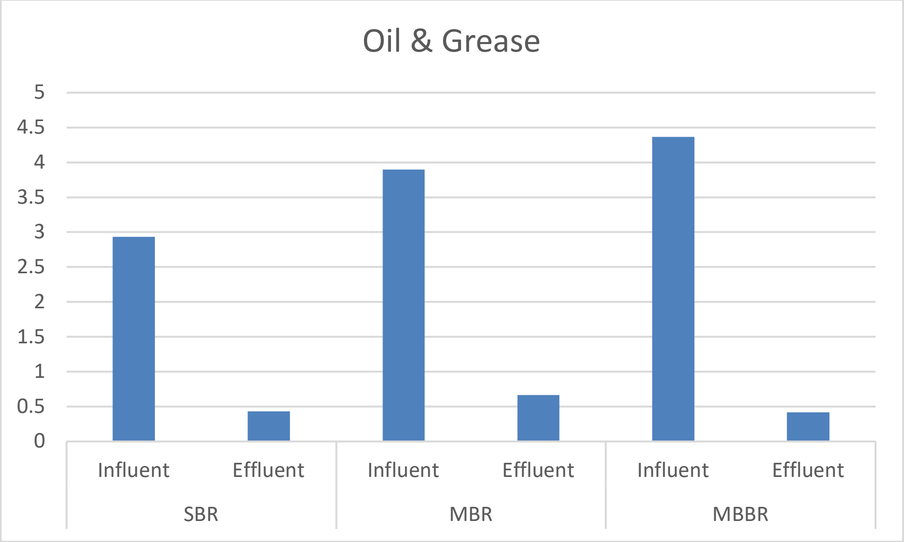

Figure 4.5: - Graphical Representation of Oil & Grease

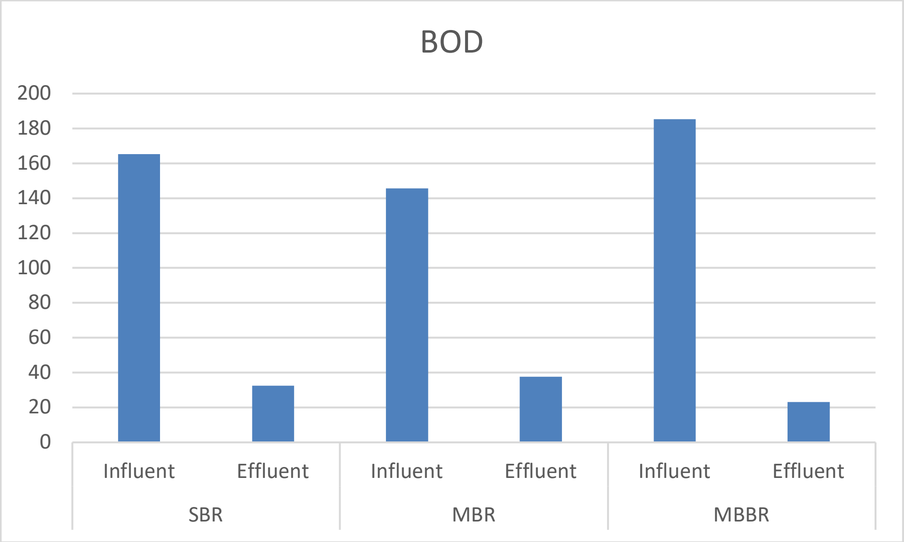

Figure 4.6: Graphical Representation of Biological Oxygen Demand

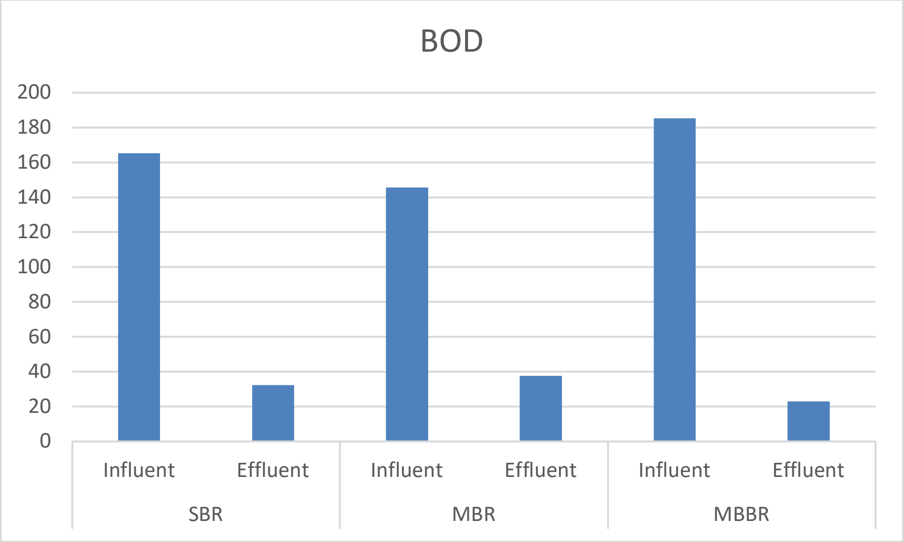

Figure 4.7: Graphical Representation of Chemical Oxygen Demand

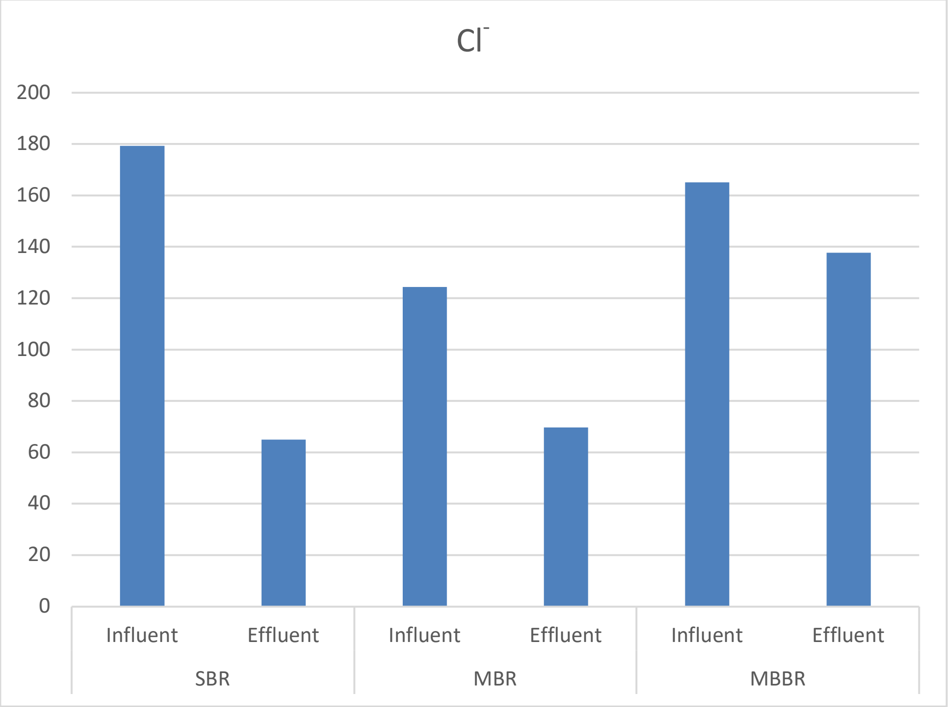

Figure 4.8: Graphical Representation of Cl^-

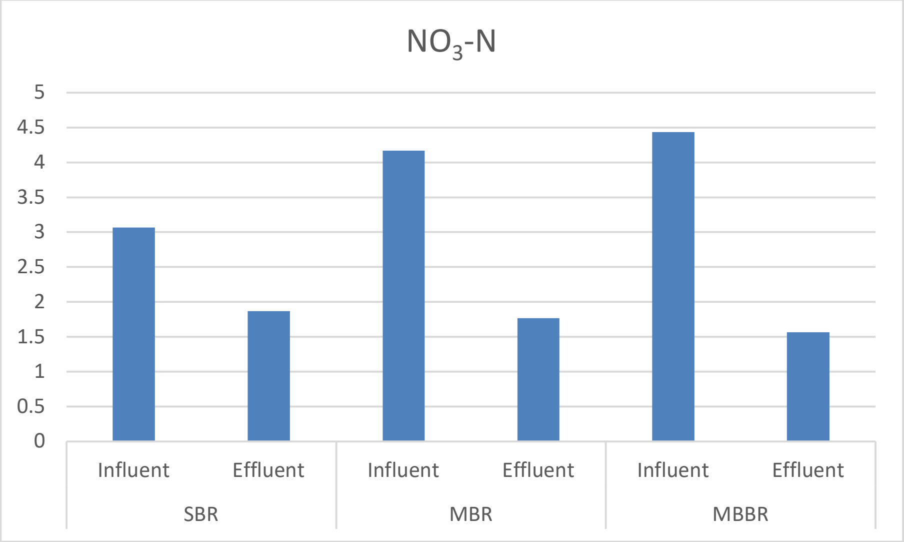

Figure 4.9: Graphical Representation of NO_3*-N*

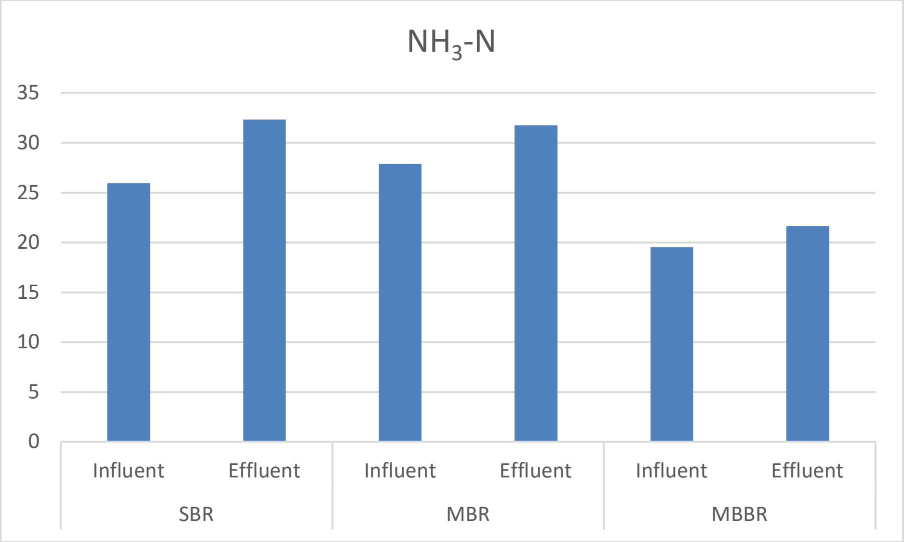

Figure 4.10: Graphical Representation of NH_3*-N*

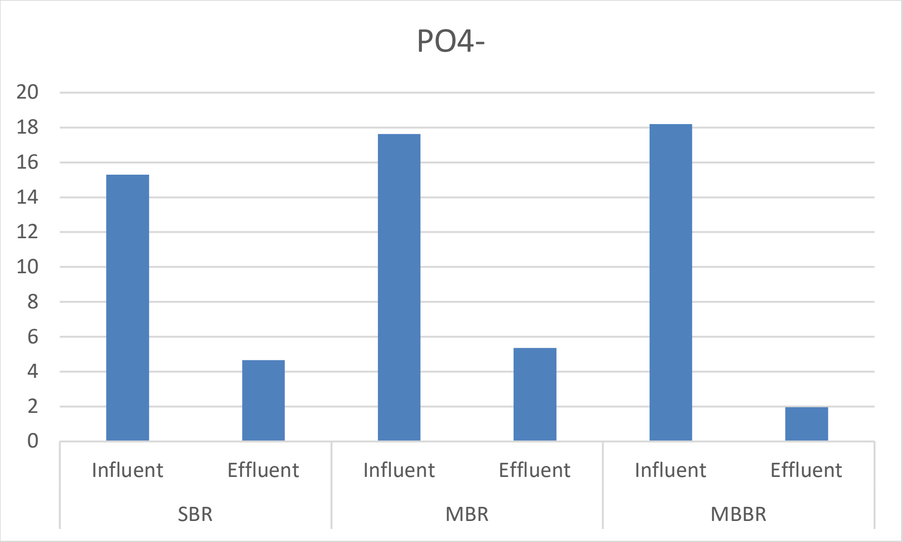

Figure 4.11: Graphical Representation of PO_4^-

Table 4.5: Comparison of all the three STP's Effluent with Central Pollution Control Board (CPCB), General Standards for the Discharge of Environmental Pollutants according to The Environment (Protection) Rules, and 1986 Schedule-VI.

Parameters	**STP 3 (SBR Technology)**	**STP 2 (MBR Technology)**	**STP 1 (MBBR Technology)**	**Comparison Result With CPCB Effluent Discharge Standards into Inland Surface Water**
ph	8.1	8.1	8.1	Not Exceeding Permissible Limit
Temp	22.8	22.6	22.0	Not Exceeding Permissible Limit
TSS	30.7	90.3	33.2	Not Exceeding Permissible Limit
TDS	160.0	145.3	124.7	Not Exceeding Permissible Limit
Oil & Grease	0.4	0.7	0.4	Not Exceeding Permissible Limit
BOD_3, 27°C	32.3	37.7	23.0	Higher than Permissible Limit for SBR and MBR
COD	146.0	80.7	66.0	Not Exceeding Permissible Limit
Cl^-	65.0	69.7	137.7	Not Exceeding Permissible Limit
NO_3-N	1.9	1.8	1.6	Not Exceeding Permissible Limit
NH_3-N	32.3	31.8	21.6	Not Exceeding Permissible Limit
PO_4^-	4.7	5.4	2.0	Higher than Permissible Limit for MBR

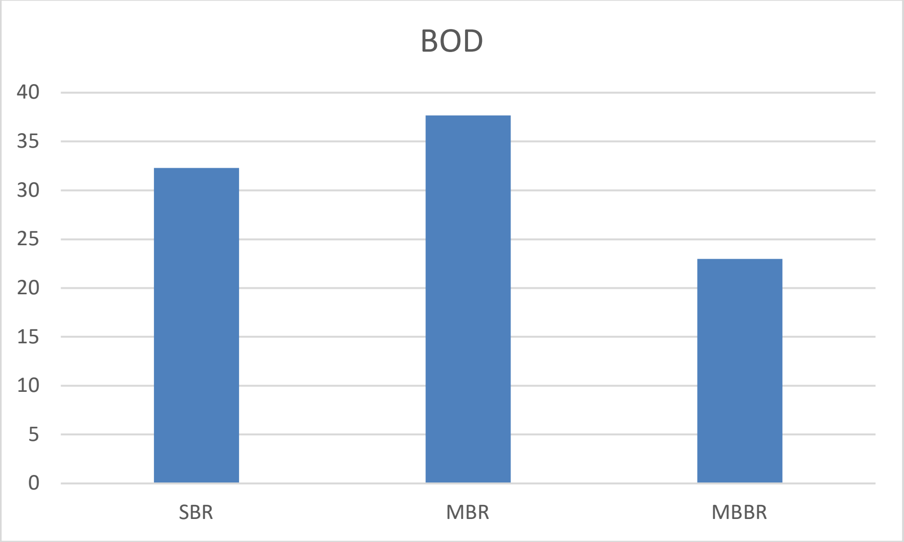

Figure 4.12: Graphical Representation of Parameter BOD Exceeding CPCB Standard

TSS, TDS, COD, and BOD are the four key criteria used to evaluate a STP's overall performance/efficiency. Reduction / Removal The following formula is used to calculate efficiency:

$$Er = \frac{\text{Initial Amount} - \text{Reduced Amount X 100}}{\text{Initial Amount}}$$

Table 4.6: Overall Performance of Removal/Reduction Efficiency of all the 3 STP's

Removal/ Reduction Efficiency	**TSS**	**TDS**	**COD**	**BOD**
SBR	78	40	57	80
MBR	50	47	79	74
MBBR	55	90	17	81

Figure 4.13: Graphical Representation of TSS for Overall Performance or Removal/ Reduction Efficiency of all the 3 STP's.

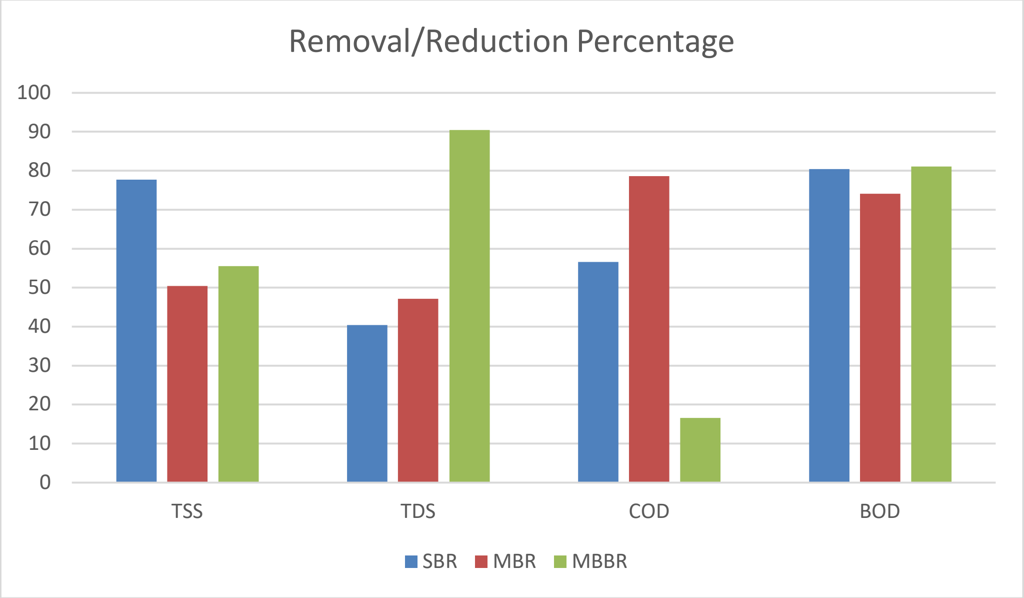

Figure 4.14: - Graphical Representation of overall performance or Removal/Reduction Efficiency of all the 3 STP's

4.2.DISCUSSIONS

4.2.1. pH

The -ive log of the h ion conc. in sewage is represented by the pH value of sewage. As a result, it may be used to tell whether sewage is acidic or alkaline. The sewage acidic when the pH value less than 7, & alkaline when the pH value more than 7. The pH value must be set since the efficiency of numerous treatment approaches is depends on sufficient pH value available. Because most biological life depends on a restricted and important pH range, the pH has a direct impact on the efficacy of a secondary treatment procedure. pH is also an indicator of biological life since most biological life thrives within a small and crucial pH range. Chemical techniques for coagulating wastewater, dewatering sludge, or oxidizing specific chemicals, like ion of cyanide, all require that the pH be controlled within a restricted range. As a result, any deviation from the permitted range might be lethal to a certain organism.

Throughout the investigation, pH changes from alkaline to acidic, i.e., 6.5-7.5, 6.4-8.2, and basic, i.e., 7.1-7.3 of Influents of STP 1, STP 2, and STP 3, respectively. The greatest pH value was found for all three STPs in the months of February, March, and April, respectively. The average pH values of the Influent for STP 1, STP 2, and STP 3 were 7.4, 7.6, and 7.3, respectively, depicting the Influent was basic in nature. During examination, pH values for Effluent of STP 1, STP 2, and STP 3 were recorded, and they varied from 7.7-8.6, 7.7-8.9, and 7.6-8.4, suggesting that the Effluent of all three STPs was alkaline throughout.

In the months of February, March, and April, the highest pH value for effluent from STP 1, STP 2, and STP 3 was recorded, correspondingly. STP 1, STP 2, and STP 3 effluent pH readings were 8.2, 8.3, and 8.0, indicating that the effluent from the first three STPs was alkaline. Furthermore, according to Central Pollution Board Effluent Discharge Standards into Surface Water, the mean pH of the waste water all three STPs was within the Permissible Limit. Because 390 KLD of STP treated effluent is recycled for irrigation in family lawns. The Mean Effluent pH value noted for these STP was likewise below the CPCB Effluent Discharge Standards into Land for Watering allowed limit.

4.2.2. Temperature (Temp)

Temperature monitoring is critical because it influences both the biological activity of bacteria and the solubility of gases in sewage. Furthermore, sewage viscosity is affected by temperature, which impacts the sedimentation process during treatment.

The effects of STP 1, STP 2, and STP 3 were studied at temperatures ranging from 17.4 to 25.3 °C, with an average of 17.6 °C. The highest temp. value of waste water was measured in April for all 3 STPs. The mean temp for the Influence of STP 1, STP 2, and STP 3 was 22.1 °C, 23.3 °C, and 22.2 °C, respectively. Between the three STPs, the temperature of Influence did not differ much. Temperatures for STP 1, STP 2, and STP 3 effluent were reported to be 17.9-26.9 °C, 18.5-27.2 °C, and 17.2-26.2 °C, respectively. The largest temp value of treated was reported in April for all 3 STPs. The mean temp. of effluent from STP 1, STP 2, and STP 3 was 22.5 °C, 22.3 °C, and 22.0 °C, respectively. The effluent temperature did not differ significantly amongst the three STPs. Furthermore, the average temperature value of the effluent for all three STPs was within the Permissible limit.

4.2.3. Total Suspended Solids (TSS) and Total dissolved Solids (TDS)

Compared to vast volume of water in sewage, there are normally only a few particles (99.9 percent). Sewage contains both organic and inorganic components. In most cases, the presence of inorganic particles in sewage is not harmful. Mechanical equipment may be used to remove them from the treatment facility. Suspended and dissolved organic contaminants, on the other hand, are responsible for producing annoyance if not handled.

Total solids have a significant impact on the management of biological and physical waste water treatment processes (TS). These values must be assessed since TSS and TDS are similar indicators of wastewater. They are also important factors for a STP's overall operation. TDS in wastewater is also a problem because it reduces the hydraulic conductivity of irrigated land, making effluent unfit for agricultural use.

4.2.4. TSS

In the current study, TSS for STP 1, STP 2, and STP 3 effects range from 125-155 mg/L, 140-235 mg/L, and 145-160 mg/L, respectively. Highest TSS values for STP 1, STP 2, and STP 3 were reported in the months of February, March, and April, respectively. The Influent's average TSS values for STP 1, STP 2, and STP 3 were 137.6, 179.3, and 155.0 mg/L, respectively. The mean TSS record for the Influent of all 3 STPs recorded considerable varies in TSS value for the Influence among the three STPs, which could be indicated to large variances in inorganic and organic load of liquid with solid content in all 3 STPs. TSS levels in STP 1, STP 2, and STP 3 effluents were tested and varied from 27 to 35, 49 to 152, and 29-35 mg/L, respectively. The mean TSS values of STP 1, STP 2, and STP 3 effluent were reported in February, March, and April, respectively. 76 The average TSS value of the Effluent for STP 1, STP 2, and STP 3 was 31.5, 87.5, and 155.0 mg/L, respectively.

The mean TSS value of the Effluent of the 3 STPs revealed significant variation in TSS value for the Effluent among the three STPs, owing to significant differences in organic and inorganic solids loading with liquid content in each STP. Furthermore, according to CPCB Effluent Discharge Standards into Surface Water, the mean TSS value of the effluent for all three STPs was within the Permissible Limit. The total volume of STP treated waste water is 1.5 MLD, because 390 KLD of it is utilised for watering in gardens and lawns. CPCB Effluent Discharge Standards into Land for Irrigation, the average TSS value measured for this STP was likewise under the allowed level.

4.2.5. TDS

Under the impact of STP 1, STP 2, and STP 3, TDS was observed to range between 235-290 mg/L, 225-311 mg/L, and 256-295 mg/L in the current study. Influent's TDS value was the highest for all three STPs in March. The Influent's average TDS values were 269.6, 273.3, and 279.3 mg/L, respectively, for STP 1, STP 2, and STP 3. The average TDS value for the Influent of all three STPs exhibited minimal variation, which may be attributed to the inorganic and organic load of particles w/ equal liquid content in all 3 STPs.

TDS levels STP 1, STP 2, and STP 3 effluents were tested and determined to be 155-171, 119-165, and 105-139 mg/L, respectively. In the months of March, February, and March, maximum TDS values for STP 1, STP 2, and STP 3 effluent were reported, correspondingly. The average TDS value of the Effluent for STP 1, STP 2, and STP 3 was 161.3, 145.0, and 124.6 mg/L, respectively. The average TDS value for the Effluent of all three STPs showed significant fluctuation, which may be ascribed to significant differences in organic and inorganic particle loading with liquid content in each STP. Furthermore, the mean TDS of the treated for all 3 STPs was in the Permitted Limits, according to CPCB Effluent Discharge Standards into Inland Surface Water.

4.2.6. Oil and grease

Oil and grease are produced by animal and vegetable waste discharges in sewage, which often come from kitchens, hotels, and restaurants, among other locations. The presence of oil and grease in sewage must be discovered because it creates deposition on the tops of tanks and clogs the pores in filtering medium. As a result, they obstruct typical treatment approaches, necessitating careful detection and removal.

For the Influence of STP 1, STP 2, and STP 3, the grease & oil concentrations range from 2.3-3.5 , 3.5-4.3, and 3.2-5.1 mg/L, respectively. Oil and grease concentrations in STP 1, STP 2, and STP 3 effluents are 0.21-0.63, 0.27-0.88, and 0.15-0.88 mg/L, respectively. Oil and Grease had a low Influence and Effluent value for all three STPs, suggesting that the effluent from the many sources of Grease & oil had less greasy &oily material during the study.

Furthermore, according to CPCB Effluent Discharge Standards into Inland Surface Water, the average grease &oil value of effluent for all three STPs was within the Permissible Limit. Because 390 KLD of STP treated waste water is utilised for watering gardens and lawns, the total volume of STP treated waste water is 1.5 MLD. According to CPCB Effluent Discharge Standards into Land for Irrigation, the average Effluent Value of Grease and Oil noted for these STP was likewise within the allowed level.

4.2.7. Biochemical Oxygen Demand (BOD)

Under aerobic conditions, the B.O.D is quantity of O_2 required for bacteria to stabilize biologically degradable organic matter (BOD). BOD is important to determine since it may be used to calculate waste strength in terms of necessary oxygen. Estimating the amount of decomposable organic matter present may be done using the amount of oxygen necessary. The rate of BOD exertion is influenced by the characteristics of sewage, its decomposable organic matter, bacterial population, and temperature. Furthermore, BOD is the most crucial metric for measuring a STP's overall effectiveness.

During the study, the effects of STP 1, STP 2, and STP 3 on BOD ranged from 151-165, 135-147, and 181-179 mg/L, respectively. In months of February, March, & April, the BOD values of STP 1, STP 2, and STP 3 were at their greatest. The highest BOD value reported for the Influence of the above three STPs shows that the greatest amount is due to considerable inorganic and organic loading with low water in months supplied. STP 1, STP 2, and STP 3 each had an average BOD of 165.3, 145.6, and 184.6 3 mg/L, respectively. High average BOD value for all three STPs demonstrates the extent of Influent pollution in each STP. Furthermore, DO was very low at all three STPs' intakes, which was caused by ammonia towards nitrates oxidation, skeptic conditions, & large organics load, resulting in high B.O.D values at all three STPs' intakes. For STP 1, STP 2, and STP 3, the average BOD value for Effluent was 31.5-34.6, 32.5-49, and 15-25 mg/L, respectively, for the three STPs stated above. For Effluent, the average BOD values for STP 1, STP 2, and STP 3 were 33.3 mg/L, 38.2 mg/L, and 23.1 mg/L, respectively.

The highest BOD value provided for the Influence of the three STPs above demonstrates that the high value is due towards significant inorganic and organic load with low water in the months supplied.

4.2.8. Chemical Oxygen Demand (COD)

Because it is a calculation of oxygen equivalent to organic matter of water allowed to oxidized by a vigorous chemical oxidant, Chemical Oxygen Demand (C.O.D) is an indicator of organic pollutants in river. Test calculates the quantity of oxygen necessary to convert organic molecules the sample to CO_2 and water by chemical oxidation. C.O.D is another significant water parameter for determining the health of freshwater systems.

COD analysis is important since it is commonly used to measure the amount of pollution in wastewater. Except for a few exceptions, strong oxidizing agents may oxidize any organic molecules to carbon dioxide and water, regardless of their biological absorption. The COD values for the effects of STP 1, STP 2, and STP 3 are 288-356, 353-385, and 308-361 mg/L, respectively. The month of February saw the highest COD value of Influent for all three STPs. A considerable organic load combined with a scarcity of water resulted in the highest COD value in February. STP 1, STP 2, and STP 3 had average COD impact values of 337.2 mg/L, 370.3 mg/L, and 336.6 mg/L, respectively. C.O.D value for STP 1, STP 2, and STP 3 Influence exhibited minimal variation. COD values for STP 1, STP 2, and STP 3 effluents limits from 104 - 195, 71 - 98, and 55 to 83 mg/L, respectively. The average COD values for STP 1, STP 2, and STP 3 effluent were 147.3, 82, and 65.6 mg/L, respectively. The mean C.O.D value for STP 1, STP 2, and STP 3 effluent was within the permissible threshold, according to CPCB Effluent Discharge Standards for Inland Surface Water.

4.2.9. Chloride (Cl-)

Chlorides are produced by human feces and urine discharges and are often detected in urban sewage. Because chloride is one of the most common inorganic ions in water, determining its concentration is essential. Although chloride is not classified as a pollution, large concentrations can affect agriculture and cause metal corrosion in pipelines. Large amounts of chloride can enter sewage from places like ice cream factories and meat salting plants, raising the chloride level. The Cl- value for Influence of STP 1, STP 2, and STP 3 is 170-195, 12-143, and 152-171 mg/L, respectively. STP 1, STP 2, and STP 3 had average Cl- Influence values of 179.6, 122.3, and 163.6 mg/L, respectively. The Cl- value for the Influence of STP 1, STP 2, and STP 3 changed little, suggesting that there is little industrial waste or seawater penetration, both of which add to sewage strength. Cl- values for STP 1, STP 2, and STP 3 effluents were reported as 51-86, 32-95, and 103-195 mg/L, respectively. For the Effluent of STP 1, STP 2, and STP 3, respectively, the average Cl- values were 66.0, 70.0, and 138.6 mg/L. The average Cl- value of Effluent for the three STPs reveals considerable differences in chloride content.

The average Cl- value for STP 1, STP 2, and STP 3 effluent was within the permissible threshold, according to CPCB Effluent Discharge Standards for Inland Surface Water.

4.2.10. Nutrient Load

Nitrogen in sewage indicates the presence of organic compounds, and it can be found as free ammonia, ammoniacal nitrogen, nitrates, or nitrates. The main sources of nitrogenous organic compounds in sewage are animal and human waste. Ammoniacal nitrogen (NH3 –N) is the amount of nitrogen present in sludge before the decomposition of biotic materials occurs. The presence of nitrates in sewage denotes the presence of completely oxidized organic components.

4.2.11. Ammoniacal nitrogen (NH_3 –N)

In this investigation, the effects of STP 1, STP 2, and STP 3 on NH3 –N range from 18.6-28.9 , 25.4-35.9, and 18.2-22.4 mg/L, respectively. The average NH3 –N influent values for STP 1, STP 2, and STP 3 were 25.1, 27.2, and 19.3mg/L, respectively, depicting a small amount of NH3 –N variability between the three STPs. The NH3 –N effluent values for STP 1, STP 2, and STP 3 were 28.5 to 38.2, 28.4 to 3.5, and 17.1 to 24.3 mg/L, respectively. The mean NH3 –N effluent values for STP 1, STP 2, and STP 3 were 25.7, 27.3, and 19.2 mg/L, respectively. Throughout Sewage Treatment Plant Number 1 investigation, the effluent value exceeded the influent value in all months, designating that nitrogen biological matter is efficiently digested and Ammoniacal Nitrogen is created as an end product. Furthermore, the three STPs' average effluent value for NH3 –N was below the Standard threshold, according to Central pollution board's Discharge Standards for Inland Surface Water.

4.2.12. Nitrate nitrogen (NO_3 –N)

Variables such as activity influence the rate at which nitrate is created in the human body. As a result, one of the indicators of human waste interaction is the presence of nitrates in wastewater. NO_3 –N values were 1.4-4.5, 2.5-5.8, and 3.2-5.1 mg/L, respectively, for the Influence of STP 1, STP 2, and STP 3. The average NO_3 –N content in inlets of STP 1, STP 2, and STP 3 was 3.3, 4.3, and 4.9 mg/L, respectively, implying that NO_3 –N content in the inlets of all three STPs was almost identical to the same quantity of nitrogenous organic matter entered in all three STPs.

In the current study, the NO_3 –N Effluent values for STP 1, STP 2, and STP 3 were determined to be 1.2-3.5 , 1.2-2.5, and 1.5-2.6 mg/L, respectively. The average NO_3–N content in STP 1, STP 2, and STP 3 outlets was 2.0, 1.5, and 1.4 mg/L, respectively, depicting that NO_3–N quantity in the effluent of all three STPs was more or less similar. Furthermore, the mean value for NO3 –N of all three STPs was within the allowable limit, according to Central Pollution Board's Waste Water Discharge Standards for Surface Water.

4.2.13. Phosphate (PO_4^-)

The phosphates present in wastewater are known as phosphates. Because these elements are major components of many commercial cleaning preparations, phosphorus enters sewage mostly through detergents, which are applied during laundry or other cleaning. Organic phosphates are mostly obtained by biological activity. Sewage is made up of body waste and food leftovers. In bottom sediments and biological sludge, phosphorus can be present in both precipitated inorganic forms and incorporated into organic molecules. STP 1, STP 2, and STP 3 have different effects on PO_4^-, ranging between 12.2-15.6 mg/L, 14.1-19.24 mg/L, and 13.3-23.5 mg/L, respectively. Mean PO_4^- impact values for STP 1, STP 2, and STP 3 were 16.3, 18.9, and 19.5 mg/L, indicating that the phosphate content entering the intake of all three STPs was identical. The PO_4^- value for STP 1, STP 2, and STP 3 Effluents, respectively, varies from 3.9-6, 4-7.5, and 2.3-3.7 mg/L. Mean PO4- discharge values for STP 1, STP 2, and STP 3 were 16.3 mg/L, 18.5 mg/L, and 19.2 mg/L, respectively. Mean PO4- effluent values for STP 1, STP 2, and STP 3 were 5.7 mg/L, 6.5 mg/L, and 2.4 mg/L, respectively. In addition, Mean Effluent Value for PO_4^- of STP 1 and STP 2 was below the Limits into Inland Water permissible limit, but the Mean Effluent Value for PO_4^- of STP 3 exact up to the Pollution Board's Waste Water Discharge Standards into Surface Water limits. The determination of all three minerals was very important since larger quantities in sewage might cause health problems promote, eutrophication of the Yamuna River, which gets sewage from all three STPs, is a goal. As a result, before sewage effluent is released into a water body, appropriate concentrations of all three nutrients must be maintained.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

The results were drawn from a study comparing three STPs in the Noida and Greater Noida metropolitan area:

- All physiochemical and biological parameters measured for STP 1 during the study were within the Central Pollution Board’s Waste Water Discharge Standards into Surface Water's allowable limits.
- In 1.5 MLD of STP treated waste water, 390 KLD is used for gardening in Group housing gardens and lawns. Following the evaluation of many Physio-Chemical and Biological parameters for this STP, it was revealed that, over the duration of the study, all of the parameters evaluated were within the CPCB Effluent Discharge Standards into Land for Irrigation permitted limits. As a consequence, this STP's effluent is appropriate for agricultural use.
- According to the (CPCB) Standards for the Discharge of Environmental Pollutants Part –A: Effluents, into Inland Surface Water according to The Environment, the BOD value of the STP 2 and STP 3 Effluent was not below the permissible limit during the study, and the Average Phosphate value of STP 1was exactly up to the permissible limit.
- The efficiency of removal/reduction was graded in sequence. TDS (total dissolved solids) (90 percent) 2.BOD (81 percent) TSS (Three Steps) (55 percent) 1COD (17%), 4COD (17%) (79 percent) 2.BOD (74 percent) TSS (Three Steps) (50 percent) TDS (total dissolved solids) (47 percent) as well as 1.BOD (80 percent) TSS is the second step (78 percent) COD 3 (57 percent) 4.TDS (40%) in STP 1, STP 2, and STP 3, respectively.
- In terms of effluent removal/reduction efficiency, STP 3 outperformed the other two, with an 88 percent removal/reduction efficiency for BOD, compared to 79 percent and 73 percent for STP 2 and STP 3, respectively. The better removal/reduction efficiency is due to the chemical treatment utilized at STP 1 in the form of sewage Tertiary Treatment.
- Based on the findings of the evaluation, STP 3 based on MBBR technology is more stable than STP 1 based on SBR technology and STP 3 based on MBR technology.

- The technologies assessed in different STPs are ranked in order of overall performance which reveals that MBBR technology with tertiary treatment beats MBR and SBR technologies in sewage treatment (which do not have tertiary treatment).

5.2. RECOMMENDATIONS

MBBR technology is recommended over MBR and SBR technology because of the following reasons (Advantages of MBBR technology over MBR and SBR technology):

1. It has shown to be well founded, long-lasting, and closed packed effluent treatment reactor.
2. The module efficacy has been indicated in many processes, including Parameter removal.
3. It may be used to cultivate little and huge plants alike. Although MBBR is less expensive than other systems, it does not require sludge recirculation.
4. Its adaptability, in comparison to other biofilm processes, allows it to be employed in practically any reactor configuration and to select different working loads in a reactor volume simply by adjusting the carrier loading. Industrial waste water, such as that produced by the food, paper, and pulp sectors, might potentially benefit from this strategy.
   MBR technology is favored over SBR technology for the following reasons:
5. It is simple to use and gives enough performance at relatively low operating and maintenance costs.
6. There is no need for electrical energy or mechanical equipment in MBR and SBR.
7. It eliminates the expenditures of energy and aeration equipment, as well as their maintenance, because it does not require external aeration.
8. When compared to MBR, the surplus sludge produced by this system is minimal, minimizing the cost of sludge management and treatment. Sludge treatment and disposal are both technically and economically problematic.
9. Compared to SBR, MBR technology may be a more cost-effective and viable option for municipal sewage treatment, especially in low-income countries.

Final Recommendation for treatment of sewage;

1. MBBR Technology

2. MBR Technology

3. SBR Technology

5.3. Future Scope of Work

Future Scope for MBR Technology:

1. The method reduces just two wastewater metrics: BOD and suspended Solids (SS). The approach finally fails to eliminate potentially hazardous substances such heavy metals that may be present in certain effluent. As a result, if the wastewater contains hazardous compounds, the MBBR system will need to be complemented by secondary disposal systems.
2. SBR reactors, like all other aerobic high-rate systems, require more organic matter than conventional aerobic reactors. As a result, in order to maintain microbial growth and metabolism in SBR systems, 20 to 30 times more organic matter must be digested than in MBR systems. To ensure the efficacy of SBR, at least 10% suspended particles must be present in the wastewater, which necessitates an increase in surface area, which can only be achieved in bigger SBR plants.
3. Treatment systems must be operated and maintained effectively, raw sewage sources must be identified, and existing facilities must be modernized.
4. To ensure effective operation and maintenance, professional and experienced personnel must check treatment performance at regular intervals and run and maintain the apparatus properly.
5. The STP should be run at full capacity to regulate the quality of the final effluent.
6. Sludge thickening is a common issue that must be handled, particularly when industrial wastewater has a high carbohydrate content or antibacterial properties.
7. To maintain the plant's performance, the amount of returned sludge must be adjusted whenever the amount of sewage flow changes.
8. Future Potential of MBR Technology:
9. The most important piece of advice for MBBR technology is to explicitly specify design criteria in order for it to work effectively.
10. Due to the absence of energy production in MBBR technology, actions should be taken to increase energy production in these technologies.

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