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Domestic Liquid Waste Purification and Recycling

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ABSTRACT

Rapid industrialization and urbanization subsequently brought many variations in the environment and ecosystems in the world, as a result there is proportionate increase in the domestic waste generation in India. Growth of urban areas, increase pressure on local water supplies. Already, usage of groundwater aquifers by over half of the world population are being over drawn, as a result, it is no longer advisable to use water once and dispose of it, so reuse and recycling of water is must. For formulating a sustainable water policy, a reliable source of water such as Recycled water should be taken into account. Recycling and reuse of water should be made obligatory to reduce the huge pressure on demand of fresh water. Waste water from water intensive activities should be recycled and reused and make the reclaimed water available for use in the secondary activities either within or outside the locality, resulting in saving lot of water. The total quantity of water used by the domestic sections is much less than that for irrigation. However, the liquid waste released from the domestic sections has a huge amount of pollutants and is discharged at specific disposal points. Thus, the purification of liquid waste generated from domestic projects is of much more importance. The quantity of organic matter in liquid waste is of great importance due to its polluting potential. The availability of oxygen for fish and other aquatic organisms can be reduced due to direct discharge of this matter into water bodies. Here comes the Purification and Recycling of domestic liquid waste into picture. Water recycling, also referred to as water reuse or water reclamation, is an effective method of treating captured or conveyed wastewater and redistributing it to benefit other water-dependent applications. Unlike traditional approaches where water is merely discharged as waste after use, water recycling provides a reliable local water supply, helping improve water conservation, cut energy use and costs, minimize diversions from local water bodies, and prevent water pollution [1]. The objective of this work is to study about domestic liquid waste i.e. sewage its purification and recycling. With the help of some case studies this paper gives information about the processes and various units of purification and how the waste water is recycled after getting treated and its application.

***KEYWORD:** Waste generation; liquid waste; polluting potential; water recycling; conveyed water; water conservation*

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INTRODUCTION:

Fresh water as a commodity generates concern being an exhaustible resource and due to the environmental issues related to its degradation. It is well known that the demand for water for various uses is on the rise in India. While the Standing Subcommittee of the Ministry of Water Resources, Government of India estimates that the total water demand across all sectors in India will rise from 813 Billion Cubic Meters (BCM) in 2010 to 1093 BCM in 2025 and 1447 BCM in 2050 [2]. This problem is much worse in urban areas due to increasing congestion and population density in cities. Hence, it is the reason, Water and Wastewater recycling has been looked up as a potential option to cope up with the increasing water stress and also to prevent our freshwater resources, both surface and underground, from getting polluted. The term water recycling is generally used synonymously with water reclamation and water reuse.

Water recycling is reusing treated waste water for beneficial purposes such as agricultural and land scape irrigation, toilet flushing, industrial processes, public parks, vehicle washing and replenishing a ground water basin (ground water recharge). Water is sometimes recycled and reused onsite, for example, when an industrial facility recycles water used for cooling processes. A reliable alternative water resource is reclaimed water from municipal wastewater, or sewage. Water recycling also provides tremendous environmental benefits and can be used to create or enhance wetlands and plant vegetation seen along the river margins (riparian habitat).

Some advantages of water recycling are as follows:

- Decreases the extraction of water from sources that may be declining and stop being feasible as habitats for valuable and endangered wildlife.
- Can be used to create wetlands and improve the quality of existing ones.

- It can reduce and prevent pollution by leaving pollutants at the treatment plant.
- Recycling wastewater can decrease effluents discharge which would result in damaging and polluting the ecosystems.
- Low cost treatment: In land application methods, if applied correctly, over certain soils and crops, irrigation can be a low-cost, simple and effective means to recycle effluent.
- Greening: In arid zones, green spaces play a vital role in people's psychological health and comfort. Plantations, such as stands of fast-growing trees, greenbelts and various shelterbelts, can be established based on existing wastewater supplies.

LOCATIONS FOR CASE STUDIES

To understand the various processes and units in water treatment plants three residential housing societies were chosen for case studies, where purification and waste water recycling is done. Chandani Chowk is considered as a reference location and distances of the Location A, B and C are approximately 22 km, 11 km and 13 km respectively as from reference one. Three study locations as shown in the figure below are as follows:

1. Location A
2. Location B
3. Location C

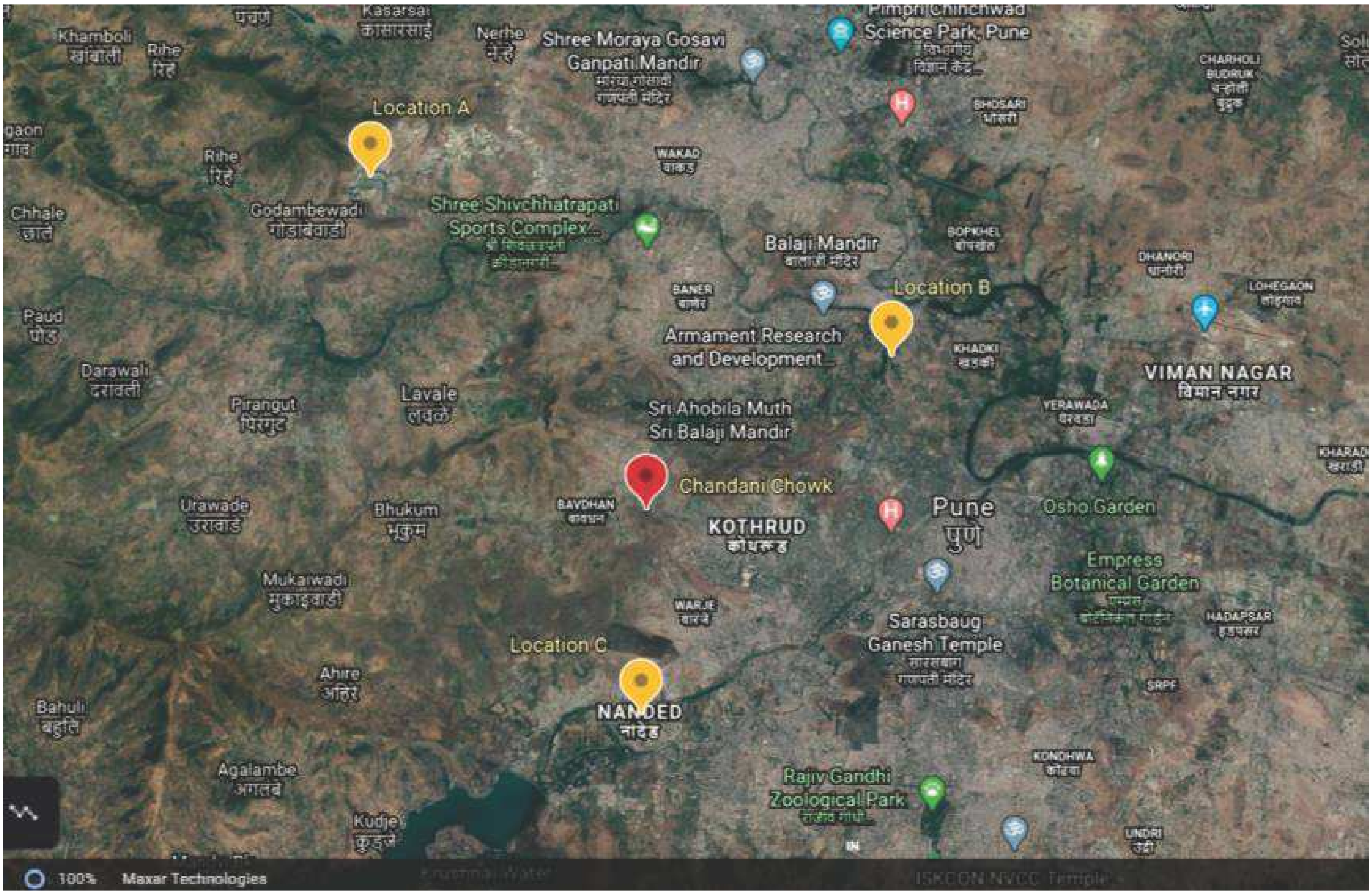

Fig 1: Figure showing locations for case studies.

METHODOLOGY

Wastewater treatment and reuse is not new and knowledge on this topic has evolved and advanced throughout human history. Reuse of untreated municipal wastewater has been practiced for many centuries with the objective of diverting human waste outside of urban settlements. Likewise, land application of domestic wastewater is an old and common practice, which has gone through different stages of development. This has led to better understanding of process and treatment technology and the eventual development of water quality standards [3].

Different methods of treatment of waste water are required for their removal or reduction to acceptable limits. The water must be free from disease spreading germs. Absolutely pure water is rarely found in nature, impurities occur firstly based on size i.e., suspended solids, colloids and dissolved solids. Secondly, based upon on chemical nature i.e., organic and inorganic. Thirdly, based upon state of matter i.e., physical, chemical and biological.

In most of cases more than one treatment process is needed to achieve the desired change in quality so that the treatment plants usually consist of a chain of processes, which operate in sequence. Each process has a particular area of applicability and it is important that the processes are selected in relation to the nature of the impurities to be removed and the required quality. It is appreciated that most treatment processes do not usually destroy the impurities, which they remove from liquid phase but simply concentrated them in a form of a sludge or effluent stream.

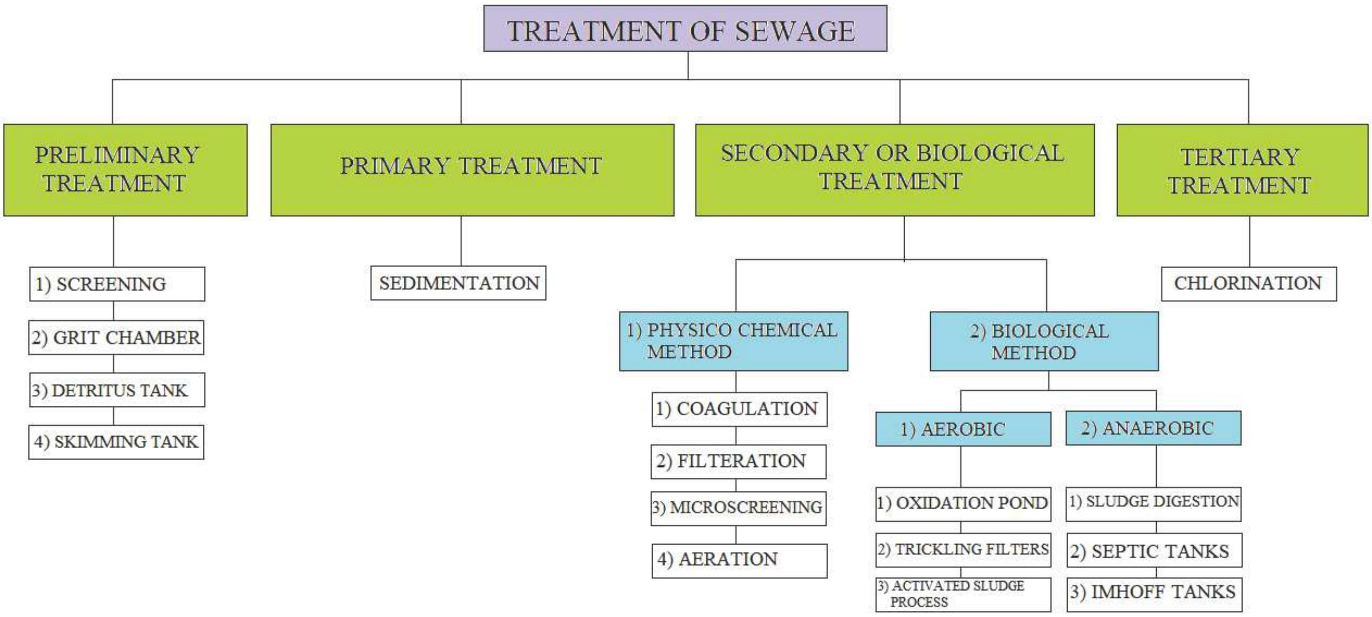

Fig 2: Flow Chart of Treatment of Sewage

Above flow chart explains 4 types of treatment stages those are Preliminary, Primary, Secondary (Biological), Tertiary Treatment.

Starting with the first stage, Screening is the first step in which floating impurities and solid material are removed such as paper, polythene bags, rag and vegetable matter, etc. Sand, grit and other materials can be removed by using grit chambers which is the second step. A detritus tank, third step in which silt and some organic matter along with grit is removed. This is attained by increasing the detention time and reducing the flow velocity through the tank. So, in this tank finer particles are removed as compared to those removed by grit chamber. When the flow enters the skimming tank, grease, oil, fats, soap are removed which is the fourth and last step of Preliminary Treatment.

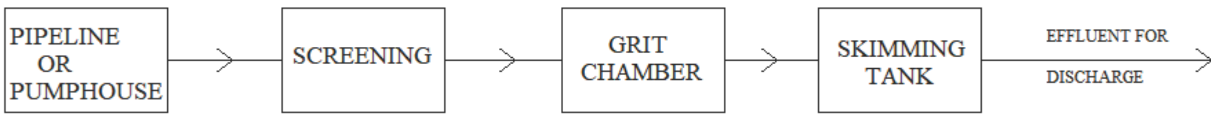

Fig 3: Flow Diagram of a Typical Preliminary Treatment System

Second stage i.e. Primary Treatment, the physical unit operation for the separation of suspended solids in which water is allowed to pass through an artificial settling chamber in which particles settle down by virtue of their self-weight and density is considered as sedimentation or clarification or settling.

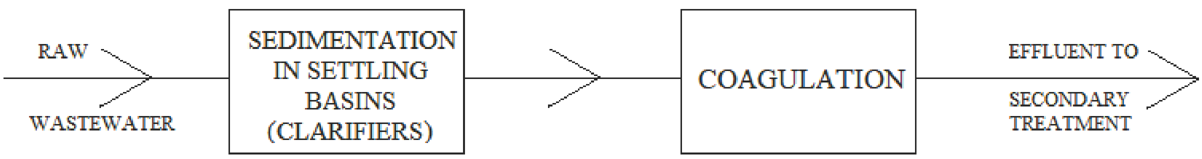

Fig 4: Flow Diagram of a Primary Treatment System

Third stage which consists 2 methods, physico-chemical and biological method. Coagulation, Filtration, Microscreening and Aeration comes under physico-chemical method. Oxidation Pond, Trickling Filters and Activated Sludge Process comes under aerobic biological method whereas sludge digestion, septic tank and Imhoff tank are under anaerobic biological method. The chemical unit process for the removal of fine suspended solids and colloids by addition of coagulants that binds with impurities resulting floc formation followed by secondary sedimentation is considered as coagulation. Then comes Filteration, the physical unit operation for the separation of dissolved solids and bacteria by passage of water through granular filter beds of sand and gravel that entrap impurities and release particle free water. Physical blockage of particles that are bigger than the size of the aperture of the filter media is the basic principle on which Microscreening works. Dissolved oxygen plays a vital role when it comes to aeration process as the levels of oxygen in the tank impact the health of the biomass breaking down the nutrients. The aeration pumps are required in order to add oxygen to the tanks so that the oxygen levels are maintained for biomass productivity. For carrying out aeration, monitoring dissolved oxygen in water ensures that pumps supply enough oxygen for microorganisms to survive. The aerobic biological treatment for raw sewage is loaded into artificially constructed earthen basin that perform degradation of organic to inorganic through symbiotic relationship between algae and bacteria is called Oxidation pond. The phenomenon of mutual benefit between any two organisms in which both the organisms help each other is called symbiosis and the relation is called symbiotic relationship. In oxidation ponds algae and bacteria mutually benefit one another and they help purification process in which algae act as a biological aerator and provides required oxygen to perform decomposition. Oxidation ponds without algae and mechanical aerator is called aerated lagoon. Treatment of sewage for effluent carrying active, unstable, harmful organic impurities in presence of oxygen and aerobic bacteria degraded into inactive, stable, harmless inorganic nitrates and sulphates is called as Trickling Filters. The next aerobic biological treatment of sludge settled in Primary Sedimentation Tank (PST) and Secondary Sedimentary tank (SST) which can undergo aeration, decomposition and settling in presence of oxygen and highly active aerobic bacteria resulting digested sludge and particularly digested effluent is called activated sludge process. Next comes the anaerobic biological treatment for the settled sludge in PST or SST in absence of oxygen in close digestor using anaerobic bacteria that perform acid fermentation, acid hydrolysis and methane formation followed by alcohol fermentation and hydrolysis, resulting degradation of organic sludge into dry powder mass of inorganic solid with the release of carbon dioxide (CO2) and methane (CH4) is the process of sludge digestion and drying. A subsurface closed horizontal rectangular impermeable chamber for treatment of sewage, sullage and any type of refuse from unsewered with population less than 300 to perform anaerobic decomposition and settling is called septic tank. Two chambered septic tanks with upper settling chamber and lower decomposition chamber for treatment of sewage from unsewered area with population greater than 300 is called Imhoff tank.

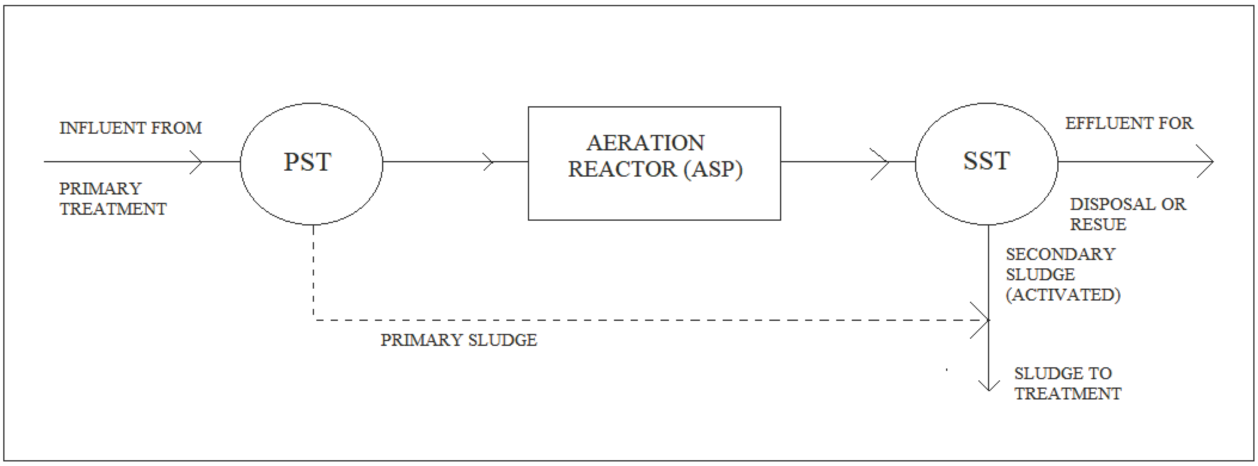

Fig 5: Flow Diagram of a Secondary Treatment System with Activated Sludge Process

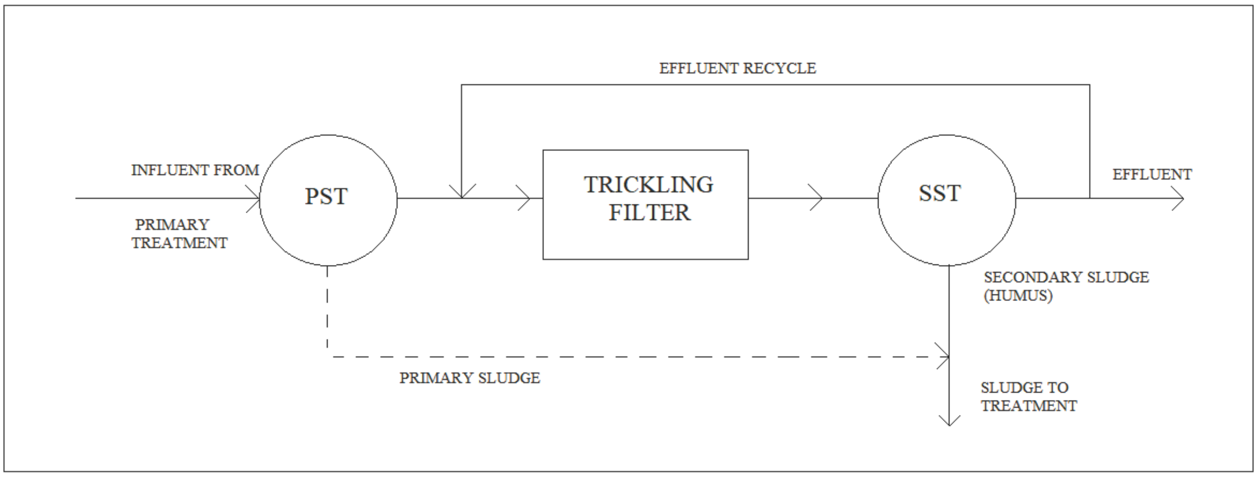

Fig 6: Flow Diagram of a Secondary Treatment System with Trickling Filter

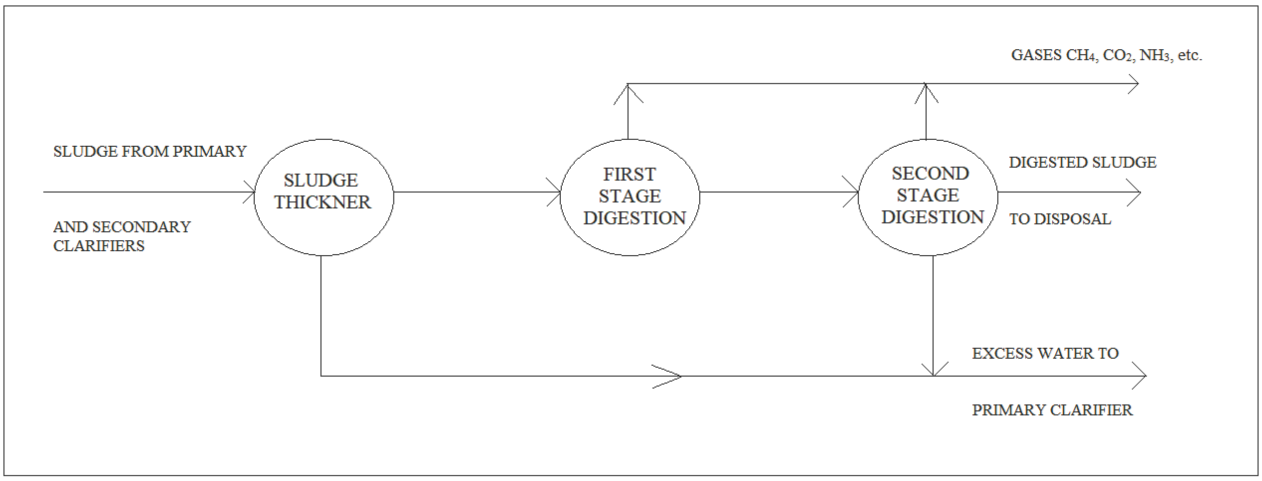

Fig 7: Flow Diagram of a Sludge Treatment System

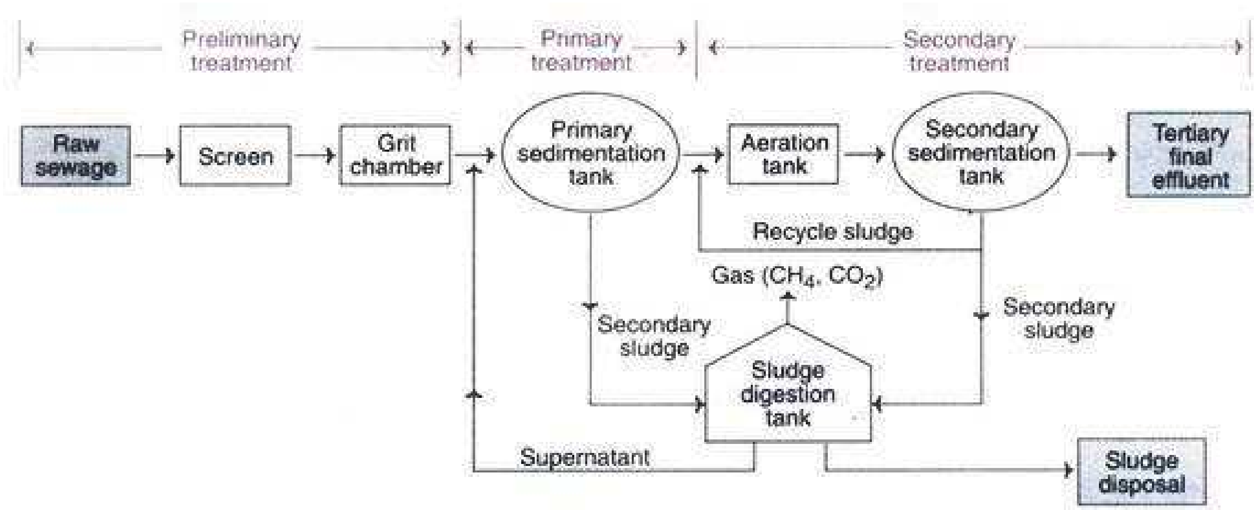

Fig 8: Flow Diagram of a conventional Sewage Treatment System [4]

After methodology, Case studies gives idea about how some residential housing societies have their own Waste Water Treatment plant and flow charts illustrates the working of those plant.

CASE STUDIES

1. Location A

This society consists of 21 towers with each of 11 floors and 4 flats on a floor.
Sewage Treatment Plant capacity: 750 KLD

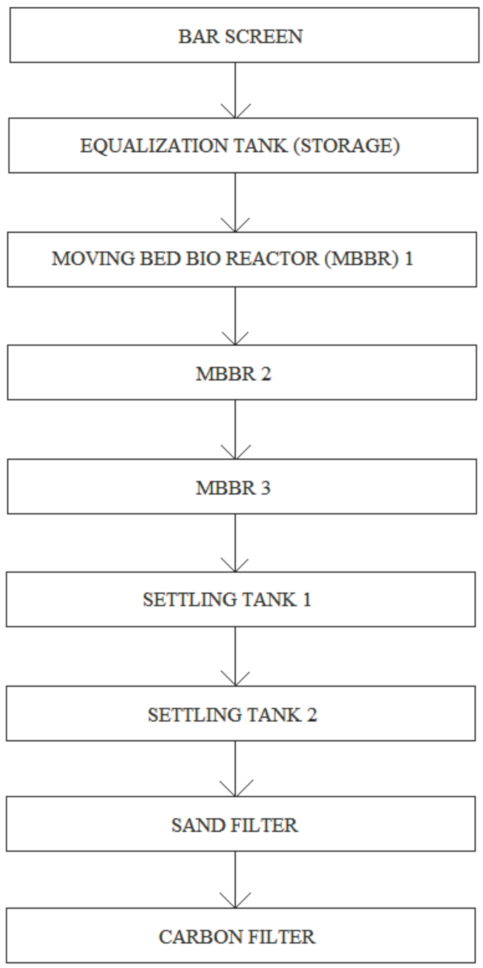

Fig 9: Flow Chart of Sewage Treatment Plant at Location A

The entrance of the STP is bar screen where the large objects are blocked. Then comes the collection tank which they named as Equalization tank in which sewage is stored. Then moving bed bio reactors (MBBR) is used which are 3 in number, provision of air blowers is done inside this and continues aeration is done. Then the water is allowed to pass through settling tank where the particles are settled by virtue of their self-weight and density, here they have 2 settling tanks. Further sand filter is used for Filteration where the fine particles are trapped and then carbon filter is used to remove odour. In this society treated water is used in flushing tank and gardening. Below shown figures are of various units in STP at this society.

Fig 10: Bar screen

Fig 11: Various tank openings

Fig 12: Aeration in MBBR

Fig 13: Air blower pump

Fig 14: Sand and carbon filter

Fig 15: Treated water

2. Location B

The Sewage Treatment Plant which was visited is for Tower-7 and 8, which has 27 floors with 4 flats on a floor.
Sewage Treatment Plant capacity (Tower-7 and 8): 175 KLD

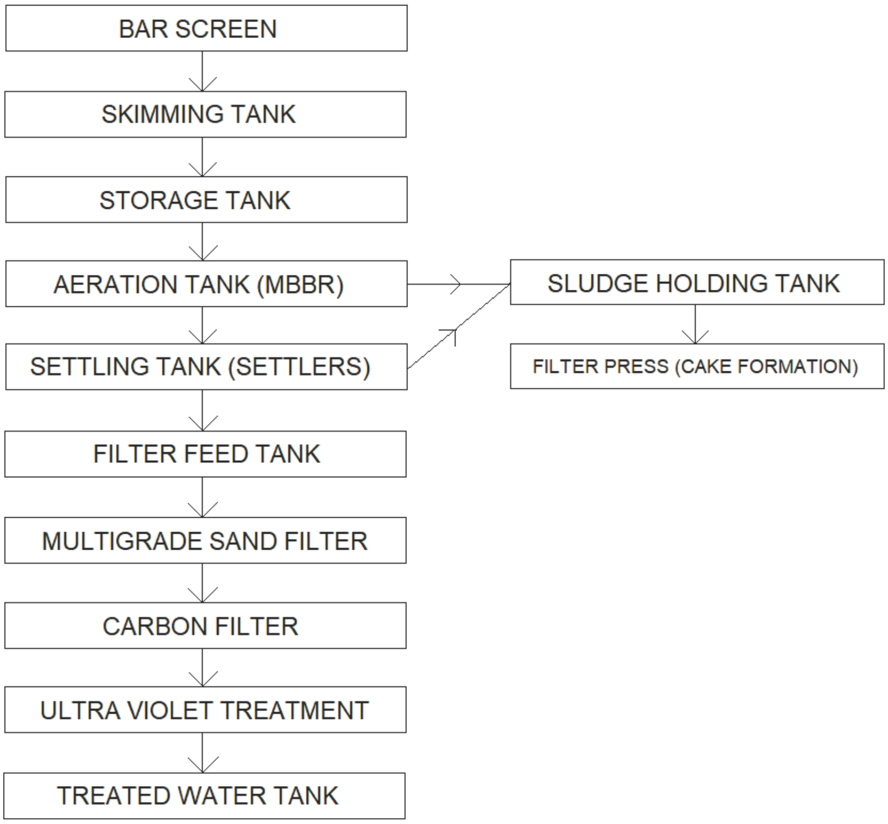

Fig 16: Flow Chart of Sewage Treatment Plant at Location B

The entrance of the STP is bar screen where the large objects are blocked. Then is skimming tank where oil is separated from sewage water. Sewage water is collected in storage tank and the next chamber is aeration tank with use of MBBR. Organic material is consumed by the microorganisms. The air blowers are used that supplies oxygen at the bottom of the aeration tank and media provides increased surface area for the microorganisms to grow and attach to in this tank. Sludge Holding Tanks provide storage and blending for the thickened waste activated sludge, primary sludge before further processing and with the help of filter press feed it is sent to filter press where cake formation of waste takes place. It is further disposed of or given to some agencies. Then Next coming to the settling tank, particles are allowed to settle with the help of settlers which are adjacently placed at some degrees to increase the settling area. The water is then passed to the filter feed tank, from here the treated water is pumped to the carbon and sand filters, where the suspended solids, colour and odour will be removed. The treated water is further passed to the Ultra violet (UV) steriliser for disinfection process. It is done to ensure the water is safe for human contact and environment and prevent infectious diseases from being spread. UV decomposes rapidly and hence leaves no harmful residual that would need to be removed from the liquid waste after treatment. After completion of the treatment process the final treated water is collected in treated water tank and in this society, this treated water is used for gardening or flushing applications.

Fig 17: Bar screen at entrance

Fig 18: Skimming tank

Fig 19: Collection tank

Fig 20: Aeration tank

Fig 21: Settlers

Fig 22: Treated water tank

3. Location C

The Sewage Treatment Plant which was visited is for two schemes.
Sewage Treatment Plant capacity: 1.61 MLD

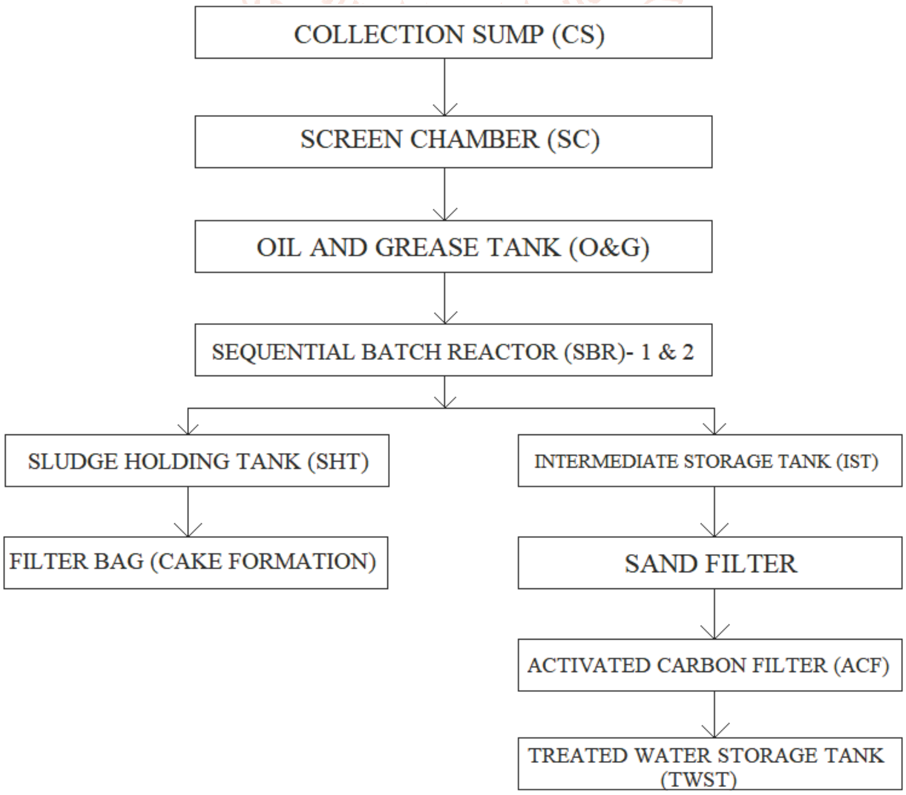

Fig 23: Flow Chart of Sewage Treatment Plant at Location C

There is an inlet pipe for domestic liquid waste, then sewage is stored in collection sump. It is allowed to pass through the screen chamber so that floating material is caught in bars. Oil and grease are removed from the sewage in oil and grease tank. Then the waste water is passed through Sequential Batch Reactor (SBR), where the settling of heavy particles takes place and oxygen supply is provided. There is provision for 2 SBR in the plant. There is a tank for holding the sludge and then the sludge is allowed to pass through Filter bags where cake formation of sludge takes place. On the other side, the water from SBR is allowed to pass into Intermediate storage tank. To remove smaller particles from the wastewater, sand filter is provided. In order to remove odour and colour, activated carbon filter is used. After undergoing purification process, the purified water is then collected in a treated water storage tank.

FUTURE SCOPE

For a new and reliable water supply, water recycling has proved to be successful and effective, without compromising public health. It is a sustainable approach and can be cost-effective. The scope for recycling of liquid waste in India is marvellous especially when we have polluted water bodies such as rivers and lakes and stressed underground sources of water like wells and infiltration gallery. Advanced technologies can be offered to users that works best for Indian conditions with the help of private sectors. By working together, water conservation and water recycling, can help us to conserve and manage our important water resources.

Since this paper work covers a detailed study of domestic liquid waste recycling and purification, this concept can be used for:

- The treated liquid waste can be used to irrigate public parks and garden, golf course irrigation, agriculture, landscape, cooling water for power plants and oil refineries, processing water for mills, plants, toilet flushing, dust control, construction activities, concrete mixing, artificial lakes.
- With tertiary treatment, water from treated sewage can be used even for air-conditioning, industrial cooling and other non-potable uses. This should be made a thrust area. Suitable fiscal concessions and subsidies may be considered by the Central and State Governments to commercial establishments or local bodies which practise waste water reuse, recycling and resource recovery. In case of big establishments like hotels, large offices and industrial complexes, community centres, etc dual piped water supply may be insisted upon. Under such an arrangement one supply may carry fresh water for drinking, bathing and other human consumptions whereas recycled supply from second line may be utilized for flushing out human solid wastes [5].
- Some projects already going on or proposed in India:

Gujarat's goal of full reuse by 2030, India

The State of Gujarat's Policy for Reuse of Treated Waste Water (May 2018) aims for full reuse of treated wastewater by 2030.

The key objectives are:

- To reach a minimum 80% coverage and collection of sewage in all municipal towns
- To reach a level of 100% treatment of collected sewage as per the prescribed standards
- To reuse at least 25% of fresh-water consumption from treated waste water (TWW) within the time limit set under policy by every municipal body
- To reuse 70% of TWW by 2025
- To reuse 100% of TWW by 2030.

- **Chennai Reuse Project, India**

A new water reuse project in the Indian city of Chennai, to supply the automotive sector with water derived from municipal sewage, highlights the contribution reuse can make to supporting industrial water security.

- **Mumbai plant, Maharashtra, India**

A 40 MLD treatment plant, being set up by the Navi Mumbai civic body, is slated to be the first such facility. The plan is to supply the treated water to MIDC areas in Vashi, Airoli, and Koparkhairane, whose fresh water reserves would be diverted for domestic uses to families belonging to 27 villages newly taken up for urbanisation in the nearby Kalyan Dombivali municipality.

- **Chandrapur Plant, Maharashtra, India**

A 70-MLD treatment plant is proposed in Solapur, which would cater to cooling water requirement of a National Thermal Power Corporation's plant. Another 40-MLD plant is being planned in Chandrapur.

- **MSPGCL Reuse project, Nagpur, India**

The primary goal of this project is to establish a wastewater recycle and reuse project in India that is both economically feasible and beneficial to the City of Nagpur as well as the Maharashtra State Power Generation Corporation (MSPGCL – a public sector unit of Govt. of Maharashtra, India). The project will also reduce the freshwater demand for non-potable applications and increasing the quantity of fresh water available for the City of Nagpur's use.

The water quality requirements, when compared with the tertiary-treated wastewater quality from the water treatment plant and existing fresh water quality from the Reservoir, indicated that the reclaimed water can be used for a number of applications at the power plant, including ash handling without further treatment, and can be used for cooling tower with the addition of a disinfectant.

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