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Original Article

SARS-COV-2 in Domestic Wastewater: A Treatment Facility Planning

R. Rajapriya[1], S. Afshana[2], M. Mahalakshmi[3]

[1,2,3]*Department of Civil Engineering, Velammal College of Engineering and Technology, India*.

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Abstract *- Mankind is battling the Outbreak of Coronavirus Disease 2019 (COVID-19) caused by the Novel Coronavirus, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2). Besides that, due to the presence of SARS-CoV-2 in sewage and stool samples, its transmission through water routes cannot be abandoned. Efficient treatment of wastewater thus becomes of the utmost importance. In preventing the spread of the virus to the environment, techniques for eliminating the virus from wastewater must be installed. The key goal of wastewater treatment is to make human and industrial effluents be disposed of with effective actions to negate health risks and threats to the environment. Even more, research is needed to investigate the survival of SARS-CoV-2 in the environment, the transferability via wastewater, and the ability to infect humans through the faecal-oral pathway.*

Keywords - *COVID-19, Extended aeration ASP, Sodium hypochlorite, Treatment units, Wastewater, Dissolved air flotation.*

1. Introduction

The Planet is Fighting the Outbreak of Coronavirus Disease in 2019 (COVID-19) caused by Novel Coronavirus, Severe Acute Respiratory Coronavirus Syndrome 2. Further, regardless of the presence of SARS-COV-2 transmission by water in waste and stool sample routes cannot be ignored. The wastewater treatment system filters the wastewater and the water so that they can be returned to the environment. These outcomes are obtained through four sets of operations: preliminary, primary, secondary, and sludge treatments. As a consequence, effective treatment of wastewater is a matter of the utmost importance. It is necessary to implement a virus removal facility to prevent a Panzootic and prevent virus dissemination into the environment. Techniques like Extended Aeration Activated Sludge Process and Disinfection by Sodium Hypochlorite are used to eliminate the virus from sewage. Eventually, faecal matter enters the sewage system, where the treatment Plants (WWTP) are potential sampling points representing the environments served by these plants.

To deter the Panzootic period of virus dissemination, Sewage treatment techniques need to be applied to keep the virus transmission in the environment. Techniques like Extended Aeration Activated Sludge Process and Disinfection by Sodium Hypochlorite are used to eliminate the virus from sewage. Sodium hypochlorite has a quite short shelf life dependent on sunlight, temperature, vibration, and the starting concentration. Increases in any of these shorten life. As we use Sanitizers and Soap in large amounts, oil and grease are secreted into sewage. In order to remove oil and grease content from wastewater using Dissolved Air Flotation, This report discusses the planning of Preliminary, Primary, Secondary, and Tertiary treatment units for a Sewage Treatment Plant. The treatment units are designed manually, and the calculation is based on the specifications as per Central Public Health and Environmental Engineering Organization (CPHEEO) manual.

2. Scope and Objective

In this period of COVID-19, the wastewater generated from Residential and Commercial Buildings contain numerous harmful microorganisms and pathogens like Coronavirus, Bacteria, etc. Some advanced techniques are used to treat sewage water to supply pure water. Treatments used in this plant remove harmful microorganisms and pathogens with the fullest efficiency. To design Primary, Secondary, and Tertiary Treatment processes for Madurai City in the Panzootic period (COVID-19). Disinfection of Sewage is done by the addition of Sodium hypochlorite. With the help of the 2011 census, the Population of Madurai city was forecasted for the year 2040 using the Geometric Increase method. Some techniques like Disinfection with Sodium hypochlorite, Extended Aeration ASP are designed for this plant.

3. Literature Review

A lot of research has been carried out to study the design of preliminary, primary, secondary, and tertiary treatment units for the treatment of sewage effluent. The following is a review of the works of various researchers who worked on various dimensions of effluent treatment.

Alain Lesimple., 2020, In order to prevent virus dissemination into the environment, there is a need to implement virus removal techniques from wastewater. Wastewater-based Epidemiology should be developed not only to localize infection clusters of the primary wave but also to detect a potential second or subsequent wave. WBE allows rapid detection of the presence of the disease in an area.SARS-CoV-2 is found living in human faeces, and it can be transmitted to animals, which also excrete it, and it can be spread to a greater extent.

C. T. Tsai S. T. Lin 2019, The presence of SARS-Cov-2 infectious agent RNA in septic tanks of the Wuchang hospital had a high level of (0.5-18.7) * 10^3 copies/L when medical care victimization whitener. The embedded virus in stool particles can be discharged in septic tanks behaving as a secondary supply of SARS-Cov-2. Effluents showed negative results for SARS-Cov-2 once overdosed with whitener (but had a high level of medical care byproduct residuals).

H. I. Nabih 2015, Oil/water emulsion is observed in wastewater streams from a number of sources, such as petroleum refineries, the discharge of maple and ballast water, workshops, gas stations, rolling mills, and edible oil and soap factories.

This research focuses on using dissolved air flotation (DAF) to recover emulsified oils from oily wastewater. The design and development of the dissolved air flotation pilot plant for handling 1,0 m3/hr of oily wastewater were carried out. The efficiency of the DAF method was studied using synthetic oil emulsions and true wastewater, where three distinct forms of oil were handled.

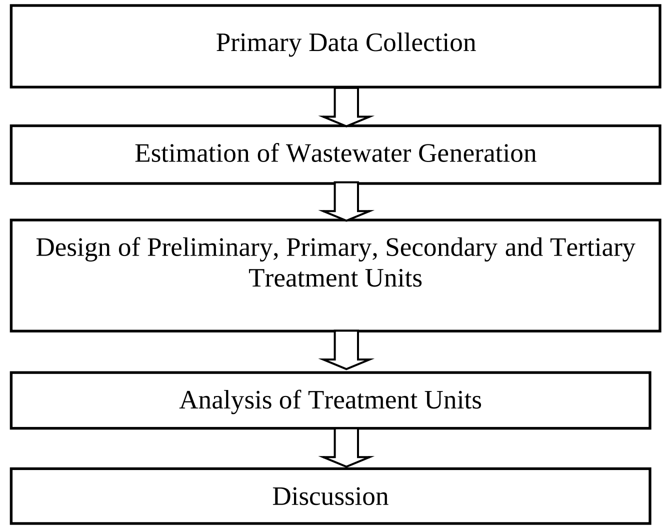
Bharati S. Shete et al., 2013, Waterborne enteric viruses are an emerging source of disease outbreaks and are a massive obstacle to global public health. Enteric viruses may emerge from human wastewater and may be transferred rapidly across marine ecosystems with minimal decay.

We conclude that viral metrics are sufficient for long-term surveillance of viral infection in freshwater and marine ecosystems and that they should be incorporated in the context of monitoring systems to provide a comprehensive evaluation of the condition of microbiological water and wastewater epidemiology, to enhance existing risk management policies and to protect public health globally.

4. Overall Process

4.1. Methodology

The process of designing a Wastewater Treatment Plant against Sars-Cov-2 seems to be an effective method to remove harmful viruses that may spread into the environment. The data collected for this project is from CPHEEO Manual. The Methodology used for this design is as follows.



4.2. Study Area

Madurai City's population is forecasted for the year 2040 using the Geometric Increase method, as Madurai is a rapidly developing city in Tamil Nadu. Moreover, Maximum Sewage discharge was calculated as per CPHEEO Manual. The population forecasted for 2040 is 4,536,934. Furthermore, per capita water supply is taken as per IS-1172. As per the IS code, the water supply is taken as 140 lpcd. The maximum discharge of sewage is calculated as 17.64 cumecs.

The city has two wastewater treatment plants, one at Vellaikkal (125 MLD) and one at Sakkimangalam (45.7 MLD). In the next three years, these plants have been designed taking into account needs. The Vellaikkal plant, which started in July 2011, was designed at the cost of 72.60 crores under the Jawaharlal Nehru National Urban Renewal Mission.

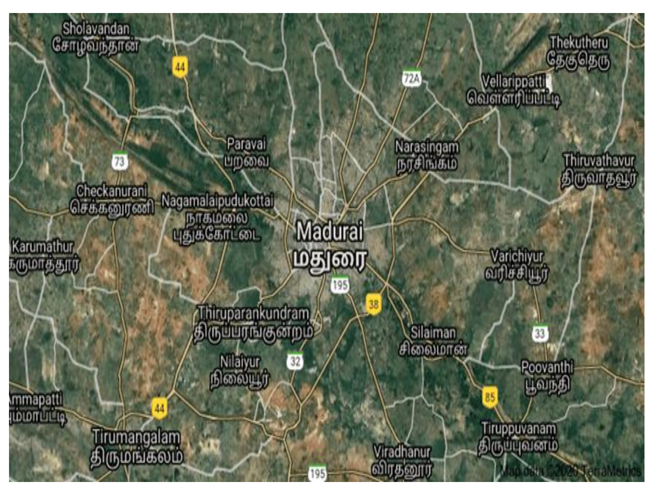


Fig. 1 Study area (Madurai, Tamil Nadu)

4.3. Overall Process

The Treatment units installed in this Treatment plant are shown below in Fig.2.

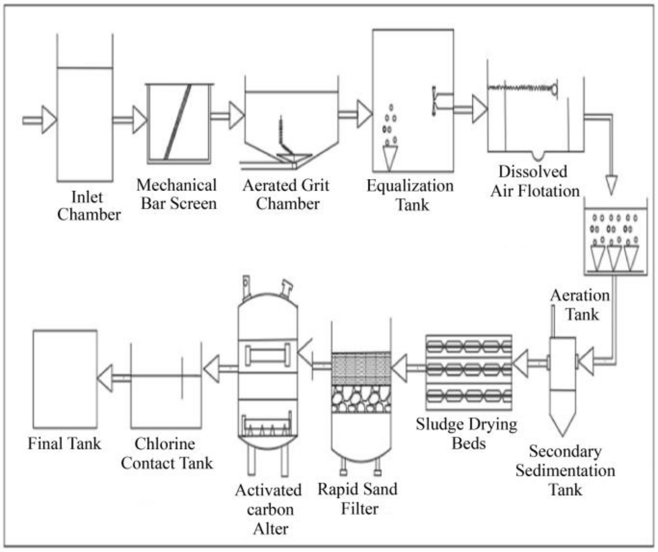


Fig. 2 Overall process of the treatment plant

5. Description of Treatment Units

5.1. Preliminary Treatment

Preliminary treatment is meant to preserve the functioning of the wastewater treatment system. This is done by eliminating all components from the wastewater that can block or damage pumps or interfere with future treatment processes. Accordingly, preliminary treatment devices are intended to eliminate or decrease the size of big, retracted, suspended, or floating solids. Effectively remove inorganic solids as well as metal or glass, such as sand and gravel. They call these objects grits. Remove excessive quantities of grease or oil. To achieve these targets, a variety of instruments or forms of equipment are used.

5.2. Primary Treatment

The primary treatment is intended to eliminate organic and inorganic solids by physical sedimentation and flotation processes. The primary treatment systems minimize the velocity of the wastewater flow and spread it. The flow rate is decreased to 1 to 2 feet per minute in primary therapy to sustain a quiescent state. Around 40% to 60% of the suspended solids are removed from the waste stream (25 - 35 percent BOD reduction). In subsequent processes for physical isolation and elimination in the final (secondary) settling tanks, the solids that remain in suspension and dissolved solids will typically be biochemically treated.

5.2.1. Screen Chamber

Screens are typically spaced from three-quarter inches to six inches of bars. Those most widely used have simple one-to-two-inch openings. While wide displays are often set vertically, screens are typically set vertically at an angle between 45 and 60 degrees. The incoming wastewater is passed through the bars or filters, and the stored content is eliminated annually. Cleaning the racks or screens manually or by fully automated rakes is possible. It is important to dispose of the solids removed by these units by burial or incineration.

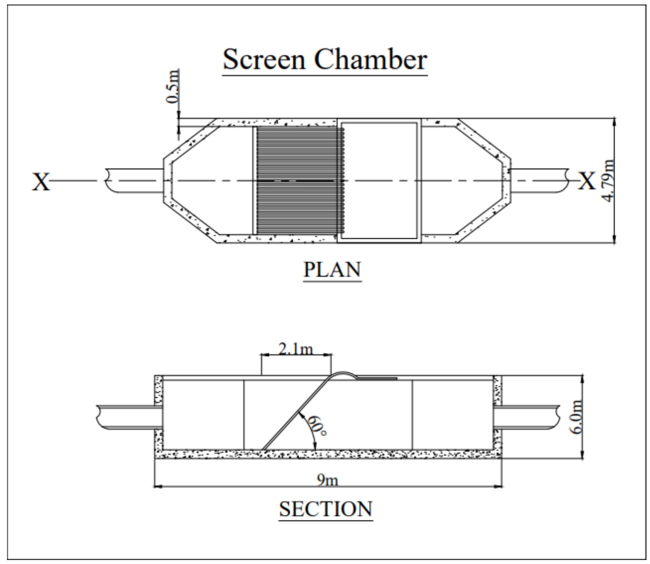


Fig. 3 Screen chamber

5.2.2. Grit Chamber

Wastewater typically includes a relatively high number of inorganic solids collectively called grit, such as sand, cinders, and gravel. If the receiving sewage system is of the sanitary or mixed form depends largely on the quantity found in the given wastewater. The time of detention is normally between 20 seconds and 1.0 minutes. The rolling velocity can be too high, caused by excessive volumes of air, resulting in inadequate removal of grit. Insufficient volumes of air result in low roll speeds, and the grit may settle with abundant organic matter. Usually, these grit chambers are called aerated grit chambers.

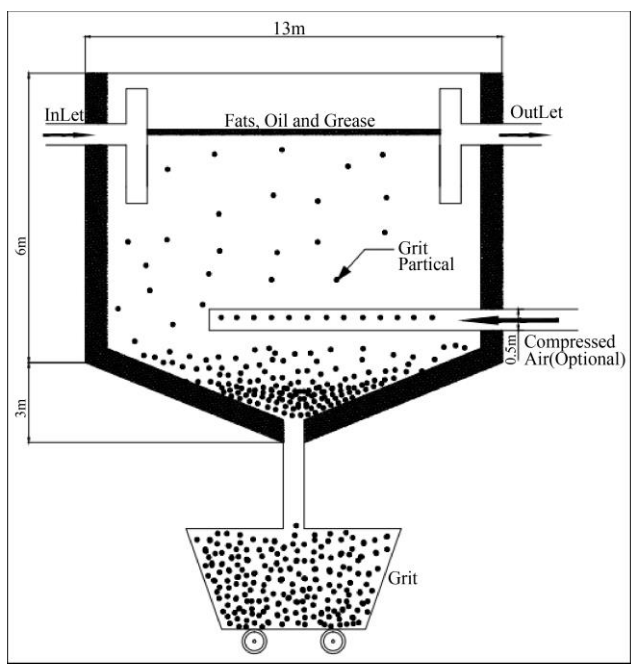


Fig. 4 Grit chamber

5.2.3. Equalization Tank

Equalization basins may be used to store diurnal or wet-weather flow peaks temporarily. Basins include a position during plant maintenance to temporarily store incoming sewage and a means of diluting and spreading batch discharges of hazardous or high-strength waste that may otherwise hinder secondary biological treatment. Flow equalization basins require monitoring of variable discharge, usually having bypass and cleaning requirements, and can also include aerators.

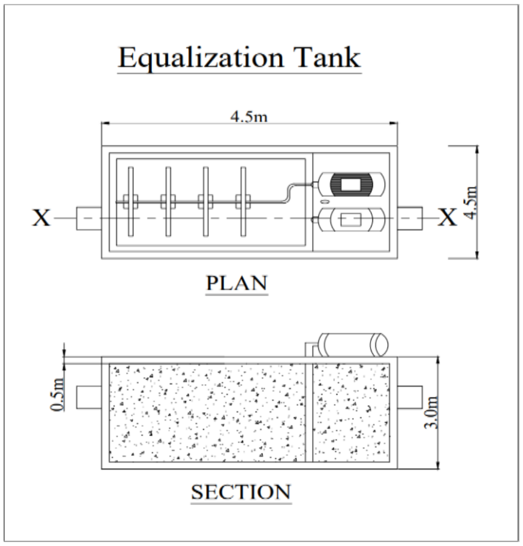


Fig. 5 Equalization Tank

5.2.4. Dissolved Air Flotation

Dissolved air flotation (DAF) is a water treatment method that clarifies wastewater by removing suspended matter such as oil or solids. The separation is done by dissolving air under pressure in the water or wastewater and then releasing the air into a flotation tank basin at ambient pressure. The released air forms small bubbles that adhere to the suspended matter, allowing the suspended matter to rise to the water's surface, where a skimming system will then extract it.

5.3. Secondary Treatment

The soluble organic matter that escapes primary treatment is eliminated through secondary treatment. It also eliminates more of the solids that are suspended. Removal is typically achieved by biological processes in which microbes eat organic impurities as food, transforming them for their growth and replication into carbon dioxide, water, and energy. The sewage treatment plant provides an adequate atmosphere for this natural biological phase, though with steel and concrete. The elimination at the treatment plant of soluble organic matter helps protect the dissolved oxygen content of a receiving stream, river, or lake.

5.3.1. Extended Aeration Activated Sludge Process

Low organic loading, long aeration time, high MLSS concentration, and low F/M are being used in the extended aeration process. The MLSS undergoes significant endogenous respiration and becomes well stabilized due to long detention in the aeration tank/oxidation ditch. No separate digestion is needed for the excess sludge, and it can be dried directly on sand beds or dewatered mechanically. Furthermore, the excess output of sludge is low. Wider approval has been seen in the traditional method and the last two modifications named above. The BOD efficiency of removal is high. The mixed liquor solids experience substantial endogenous respiration due to long preservation in the aeration tank and remain well stabilized.

5.4. Tertiary Treatment

Tertiary treatment is meant to include a final level of treatment to increase the effluent's consistency further before it is discharged into the proper location. Tertiary effluent treatment requires a number of protective measures to help eliminate organic matter, turbidity, nitrogen, ammonia, metals, and contaminants during secondary treatment. Any kind of physicochemical treatment, such as coagulation, filtration, activated organic carbon adsorption, reverse osmosis, and additional disinfection, is used in most procedures. Tertiary sewage treatment is practiced after disposal into rivers or streams for additional wildlife conservation. More often, it is carried out as excess water is reused for agriculture (e.g., food fields, golf courses), recreational uses (e.g., wetlands, estuaries), or drinking water.

5.4.1. Rapid Sand Filter

The removal of comparatively large suspended particles is provided by rapid sand filters. They reduce turbidity, iron, and manganese easily. Furthermore, they are mildly effective but have little effect on viruses, fluoride, arsenic, and salts in eliminating odor, bacteria, and organic matter. It is a reasonably complex procedure that typically includes power-operated pumps for the filter bed to be backwashed or cleaned and filter outlet flow control. When raw water with relatively low turbidity is used, a continuously working filter normally needs backwashing approximately every two days.

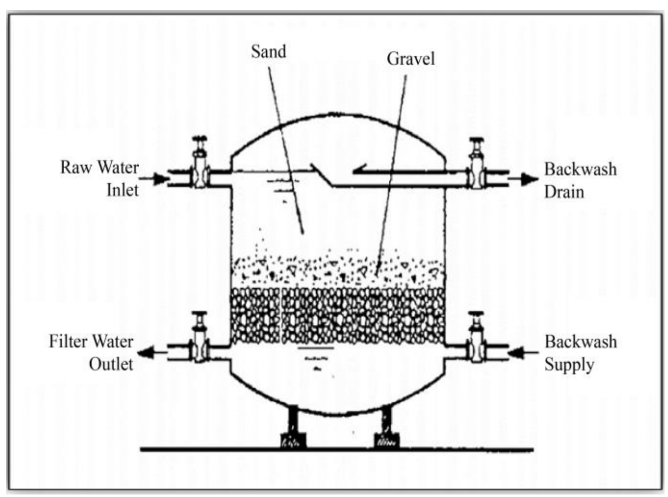


Fig. 6 Rapid sand filter

5.4.2. Activated Carbon Filter

A widely used technology is activated carbon filtration, which is based on the adsorption of pollutants to the filter surface. This approach effectively eliminates organic compounds from drinking water or wastewater (such as unwanted tastes and odors, micropollutants), ammonia, fluorine, or radon. Activated carbon filters are relatively simple to install but require resources and skilled labor, and due to frequent replacement of the filter content, they may have high costs.

5.4.3. Disinfection with Sodium Hypochlorite

Sodium hypochlorite, which relies on sunlight, temperature, vibration, and the starting concentration, has a relatively limited shelf life. Increases with each of these decrease lives. In sodium hypochlorite, the presence of caustic soda means that as the compound is applied, the pH of water increases. As sodium hypochlorite in water dissolves, two compounds are produced that play a role in oxidation and disinfection processes. Diluted cyanide wastewater, such as electroplating waste, has been treated with sodium hypochlorite solutions.

6. Conclusion

Extended Aeration ASP was found to be appropriate because treatment is extremely efficient. As per the objectives, the Primary, Secondary and Tertiary Treatment units for the estimated flow quantity have been successfully designed and analyzed. Conventional water treatment plant is constructed of great cost due to the high demands of equipment, energy, and labor. Therefore, they may not be feasible.

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