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Sewage Treatment Plant At Kayamkulam Railway Station

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***Abstract*— Kayamkulam railway station has been a developing place, which in turn resulted in the increase of sewage generated, but still there is no sewage treatment plant. So it is required to construct a sewage treatment plant with sufficient capacity to treat the generated sewage. Sewage water treatment has challenges to treat the excess sludge and disposal of sludge. Sewage/wastewater treatment operations are done by various methods in order to reduce, its water and organic content, and the ultimate goal of wastewater management is the protection of the environment in a manner commensurate with public health and socioeconomic concerns. This project focuses on the sewage generation in the Kayamkulam railway station and sewage treatment plant is designed. In one day the total sewage generated was estimated.**

The various components of sewage treatment plant are screening, grit chamber, primary sedimentation tank, biological reactor, secondary clarifier, activated sludge tank; drying beds. It is proposed to design the various components of sewage treatment plant considering the various standards and permissible limits of treated sewage water. The treated water will be supplied for irrigating the crops and the sludge which is generated after the treatment will be used as manure, so it increases the fertility of soil. Also reduce the ground water usage.

Keywords*— Sewage water, treatment plants, socio economic concerns,permissible limits, sludge.

I. INTRODUCTION

Kayamkulam Junction Railway station (Station code: KYJ) is a railway station in Kerala, located at Kayamkulam, Alappuzha District. It is an NSG 3 category station. It stands at the junction of three lines.

Pollution in its broadest sense includes all changes that curtail natural utility and exert deleterious effect on life. The crisis triggered by the rapidly growing population and industrialization with the resultant degradation of the environment causes a grave threat to the quality of life. Degradation of water quality is the unfavorable alteration of the physical, chemical and biological properties of water that prevents domestic. Commercial, industrial, agricultural, recreational and other beneficial uses of water. Sewage and sewage effluents are the major sources of water pollution. Sewage is mainly composed of human facal materials, domestic wastes including wash-water and industrial waste. The growing environmental pollution needs for decontaminating wash water result in the study of characterization of waste water, especially domestic sewage. Sewage treatment plant is a facility designed to receive the waste from domestic, commercial and industrial sources to remove materials that damage quality and compromise public health and safety when discharged into water receiving systems. It includes physical, chemical, and biological processes to remove various contaminants depending on its constituents. Using advanced technology, it is now possible to reuse sewage effluent for drinking water.

The present study comprises the study on quality of domestic waste water and industrial waste water. The study includes characterization tests for pH values, acidity, alkalinity, chloride, turbidity & BOD etc. Depending upon the values of these parameters, calculations are done for designing the different units of a 1 MLD Sewage Treatment Plant and a preliminary layout is prepared for the same.

A. Objective of the project

The objective of municipal and industrial waste water treatment is to extract pollutants, remove toxicants, neutralize coarse particles, kill pathogens so that quality of discharged water is improved to reach the permissible level of water to be discharged into water bodies or for agricultural land. Treatment of water thus aims at reduction of BOD, COD, total solids, nitrogen content etc. of receiving water bodies and prevention of bio- magnification of toxic substances in food chain. The effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. A waste water treatment system receives, stores, treats and disposes of waste water from toilets, sinks, washing machines, baths and all other water using appliances. When we talk about a waste water treatment system, we usually refer to not only a septic tank, but accompanying pipes, drains, percolation areas and fittings which ensure that the water is treated and discharged correctly.

The objective of this project can be summarized as-

- Physical, chemical and biological characterization of waste water
- Comparison with the prescribed standards
- Design of the sewage treatment plant

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B. Scope ofn the project

With the lowering of ground water level and occurrence of frequent droughts, water scarcity is being faced in many regions. Inadequate availability of water at stations and colonies water scarce areas has been impacting railway working & operations as well. Government of India in its Intended Nationally Determined Contribution INDC) submitted to UN Framework Convention on Climate Change (UNFCCC) in October 2015, has committed to improve the water use efficiency by 20%. This is a legally binding commitment on India.

Accordingly, Indian Railways, being a major consumer of water, ought to take adequate and effective measures to improve the management of demand as well as supply of water to be a part of the environmental objective as well as avoid water scarcity coming in the way of operation & maintenance of Railways. It has been decided to issue the policy instructions on water management on IR to facilitate clarity on this subject and ensure systematic approach in Water Management. Central Ground Water Authority (CGWA) guidelines for ground water abstraction issued in Nov 2015, shall be applicable for the areas as provided therein.

As per future perspective of this project, the characteristics of different units designed in this project can be compared with alternate treatments units and their treatment efficiencies can be calculated for designing of STP. For example – we choose activated sludge process in secondary treatment, but any other treatment processes like trickling filters, aerated lagoons, oxidation ponds, RBCs etc. can also be taken as secondary treatment unit and is designed. The design values and other parameters related to it are compared and the grass are plotted accordingly. The best alternative should be selected as the final one.

II. METHODOLOGY

Sewage is a water carried waste, in solution or suspension that is intended to be removed from a community. Also known as domestic or municipal wastewater, it is characterized by volume or rate of flow, physical condition, chemical and toxic constituents, and its bacteriologic status. It consists mostly of gray water, Blackwater, soaps and detergents and toilet papers, where sewer line and gray water line is not provided separately. It also contains surface runoff depends on the design of sewer system. Sewage treatment is the process of removing contaminants from wastewater, primarily from household sewage. It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safe treated wastewater (or treated effluent). A by-product of sewage treatment is usually a semisolid waste or slurry, called sewage sludge, that has to undergo further treatment before being suitable for disposal or land application.

III. PROCESS INVOLVED IN SEWAGE TREATMENT

Sewage can be treated in different ways. Treatment process are often classified as;

A. Preliminary treatment

B. Primary treatment

C. Secondary or biological treatment

D. Final treatment

A. Preliminary Treatment

Preliminary treatment consists solely in separating the floating materials (like dead animals, tree branches, papers, pieces of rags, wood, etc.), and also the heavy settle able inorganic solids. It also helps in removing the oils and greases, etc. from the sewage. This treatment reduces the BOD of the wastewater, by about 15 to 30%. The process used are screening for removing floating papers, rags, clothes, etc., Grit chambers or Detritus tanks for removing grit and sand, and skimming tanks for removing oils and greases.

B. Primary Treatment

Primary treatment consists in removing large suspended organic solids. This is usually accomplished by sedimentation in settling basins. The liquid effluent from primary treatment, often contains a large amount of suspended organic material, and has a high BOD (about 60% of original). Sometimes, the preliminary as well as primary treatments are classified together, under primary treatment. The organic solids, which are separated out in the sedimentation tanks (in primary treatment), are often stabilized by anaerobic decomposition in a digestion tank or are incinerated. The residue is used for landfills or soil conditioners. Secondary or Biological Treatment

C. Secondary or Biological Treatment

Secondary treatment involves further treatment of the effluent, coming from the primary sedimentation tank. This is generally accomplished through biological decomposition of organic matter, which can be carried out either under aerobic or anaerobic conditions. In these biological units, bacteria will decompose the fine organic matter, to produce clearer effluent. The treatment reactors, in which the organic matter is decomposed (oxidized) by aerobic bacteria are known as aerobic biological units; and may consist of Filters (intermittent sand filters as well as trickling filters), Aeration tanks, with the feed of recycled activated sludge (i.e. the sludge, which is settled in secondary sedimentation tank, receiving effluents from the aeration tank. Oxidation ponds and Aerated lagoons. Since all these aerobic units, generally make use of primary settled sewage, they are easily classified as secondary units.

D. Final Treatment

This treatment is sometimes called tertiary treatment, and consists in removing the organic load left after the secondary treatment, and particularly to kill the pathogenic bacteria. This treatment, which is normally carried out by chlorination, is generally not carried out for disposal of sewage in water, but is carried out, while using the river stream for collecting water for re-use or for water supplies. It may however, sometimes be adopted, when the outfall of sewage is very near to the water intake of some nearby town.

IV. CLASSIFICATION OF THE PROCESSES

A number of treatment processes are available depending upon method of disposal, degree of treatment,

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waste water influent quality (domestic or industrial), availability of the land etc. and requirement of recycling treated waste water. Waste Water Treatment Methodology commonly adopted for treatment of sewage waste may be any of the following:

V. BIOLOGICAL PROCESS

In these processes mixture of wastewater and microorganisms (biomass) is agitated and aerated. Certain microbes, mainly bacteria of specific kind, have the capability to oxidize the dissolved organic matter in the waste water. Microbial growth is accelerated and controlled in the process. Thus, reduction or removal of organic matter in waste is brought about by micro-organisms by oxidation. After oxidation, the sludge is separated from wastewater. These, microbial induced processes are further classified as Aerobic and Anaerobic.

Aerobic process is in the presence of oxygen and its classified into the following;

A. Activated Sludge Process

Activated sludge refers to a mass of microorganisms cultivated in the treatment process to break down organic matter into carbon dioxide, water, and other inorganic compounds. The activated sludge process has three basic components:

a) A reactor in which the microorganisms are kept in suspension, aerated, and in contact with the waste they are treating;

b) Liquid-solid separation

c) A sludge recycling system for returning activated sludge back to the beginning of the process. There are many variants of activated sludge processes, including variations in the aeration method and the way the sludge is returned to the process.

B. Trickling Filter

A trickling filter is a fixed-bed, biological reactor that operates under (mostly) aerobic conditions. Pre-settled wastewater is continuously 'trickled' or sprayed over the filter. As the water migrates through the pores of the filter, organics are degraded by the bio film covering the filter material. Trickling filter is an attached-growth type of process in which microorganisms attached to a medium are used for removing organic matter from wastewater that utilizes. This type of system is common to a number of technologies such as rotating biological contactors (RBCs) and packed bed reactors (bio towers). These reactors are also called as non- submerged fixed film biological reactors.

C. Faculative Areated Lagoons

Facultative lagoons are a type of stabilization pond used for biological treatment of industrial and domestic wastewater. Sewage or organic waste from food or fiber processing may be catabolized in a system of constructed ponds where adequate space is available to provide an average waste retention time exceeding a month. A series of ponds prevents mixing of untreated waste with treated wastewater and allows better control of waste residence time for uniform treatment efficiency.

D. Extented Areation Process

Extended aeration is a method of sewage treatment using modified activated sludge procedures. It is preferred for relatively small waste loads, where lower operating efficiency is offset by mechanical simplicity.

E. Wet Land

A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. The primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation of aquatic plants, adapted to the unique hydric soil. Wetlands play a number of roles in the environment, principally water purification, flood control, carbon sink and shoreline stability. Wetlands are also considered the most biologically diverse of all ecosystems, serving as home to a wide range of plant and aquatic life.

F. Oxidation Pond

Oxidation Ponds are also known as stabilization ponds or lagoons. They are used for simple secondary treatment of sewage effluents. Within an oxidation pond heterotrophic bacterium degrade organic matter in the sewage which results in production of cellular material and minerals.

G. Oxidation Ditches

The oxidation ditch is a variation of the activated sludge process. System consists of a closed-loop aeration channel through which mixed liquor. Anaerobic process is in the absences of oxygen these are generally classified in the following.

a) Stabilization Ponds

Stabilization ponds (also called lagoons or waste stabilization ponds) use a natural process for wastewater treatment that employs a combination of macrophysics plants, substrates and microorganisms in a more or less artificial pond to treat wastewater. The technique is frequently used to treat municipal wastewater, industrial effluent, municipal run-off or storm water. After treatment, the effluent may be returned to surface water or reused as irrigation water (or reclaimed water) if the effluent quality is high enough. Stabilization ponds are commonly used for wastewater treatment in developing countries. Types of treatment ponds include anaerobic lagoons, facultative pond and aerated lagoons.

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b) Up Flow Anaerobic Sludge Blanket(UASB)

Up flow anaerobic sludge blanket (UASB) technology, normally referred to as UASB reactor, is a form of anaerobic digester that is used for wastewater treatment. UASB uses an anaerobic process whilst forming a blanket of granular sludge which suspends in the tank. Wastewater flows upwards through the blanket and is processed (degraded) by the anaerobic microorganisms. The upward flow combined with begin to form whose surface area is covered in aggregations of bacteria. In the absence of any support matrix, the flow conditions create a selective environment in which only those microorganisms capable of attaching to each other survive and proliferate.

H. Activated Sludge Process (ASP)

Components of ASP as follows;

a) Screen Chamber

Sewage from house is collected in sump well and carried away to Sewage Treatment Plant by suitable medium (i.e. by Gravity or pumping). Screening is the very first operation carried out at a sewage treatment plant, and consists of passing the sewage through different types of screens, so as to trap and remove the floating matter, such as pieces of cloth, paper, wood, cork, hair, fiber, kitchen refuse, fecal solids, etc. present in sewage. These floating materials, if not removed, will choke the pipes, or adversely affect the working of the sewage pumps. Thus, the main idea of providing screens is to protect the pumps and other equipment from the possible damages due to the floating matter of the sewage. Screens are the devices with clear openings of uniform size used to remove floating materials and coarse (50mm opening), medium (25-50 mm opening) and fine (10- 25mm opening). Manually operated bar rack or bucket type screens can be provided which are designed by the manufacturer. The top walking platform should also be at least 60 cm wide and the operator must be able to walk safely without any fear of accidental fall.

b) Grit Chamber

Grit chambers, also called grit channels, or grit basins, are intended to remove the inorganic particles such as sand, gravel, grit, egg shells, bones, etc. of size 2mm or large to prevent damage to the pumps, and to prevent their accumulation in sludge digesters. Grit chambers are, in-fact nothing but like sedimentation tanks, designed to separate the intended heavier inorganic materials by the process of sedimentation due to gravitational forces, and to pass forward the lighter organic materials. Hence, the flow velocity should neither be too low as to cause the settling of lighter organic matter, nor should it be too high as not to cause the settlement of the silt and grit present in the sewage. A horizontal velocity of flow range of 15 to 30 cm/sec is used at peak flows. If the equalization tank is being used as collection tank, grit chamber shall be provided after equalization tank.

Fig.1. Grit Chamber

c) Equalization Tank With Provision Of Course Diffuser

It is like a storage tank in rectangular shape or circular, collecting the sewer ahead of the pumps for pumping sewer. It acts as an equalization tank during peak flow of wastewater. Pump are designed to carry waste water on the basis of the quantity of sewage likely to enter into the station. Retention time is normally taken 02 hrs. of the max. flow. Coarse bubble diffuser supply air for microbial degradation of organic matter and homogenous viscosity of sewage.

Fig.2. Equalization Tank

d) Areation Tank

From the Equalization tank/ grit chamber the sewage flows to the aeration tank by pump or gravity and is mixed with the activated sludge. The aeration tanks (or aeration chambers, as they are sometimes called) are normally rectangular tank, 3 to 4.5m deep and about 4 to 6 m wide. The length may range between 20 to 200 m, and the detention period between 4 to 8 hours for sewages depends upon the quality and quantity of raw sewage. Air is continuously introduced into these tanks by surface aerators or any suitable device.

e) Secondary Clarifer And Sludge Pit

The sewerage comes to secondary clarifier with gravity from launder of aeration tank. A secondary clarifier shall be provided for settlement of fully aerated effluent from the aeration tank. Secondary clarifier is equipped with clarifier mechanism, which move slowly and separate water from the sewage sludge. Sludge settle down in the bottom of tank. Settled sludge at the bottom of the clarifier tank will be sent to sludge pit, which is connected with bottom of secondary clarifier tank. Water comes through launder in clear water tank by gravity for further tertiary treatment. Settled sludge which is activated sent to sludge drying bed (SDB) for drying and manure and part of this activated sludge sent back to aeration tank as per requirement.

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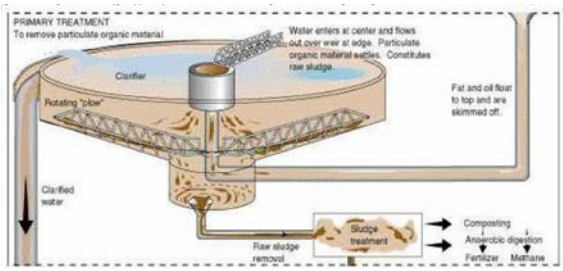

Fig.3.Secondary Clarifier

f) Sludge Drying Bed

In the extended aeration system, the sludge is sufficiently mineralized and does not need any further treatment before dewatering & disposal. sand filtration drying beds will be provided, where sludge will be dewatered by filtration through sand bed & drying of the dewatered sludge by solar radiation. Sludge drying beds are to be constructed with a sand media supported by gravel bed and suitable under drainage arrangement.

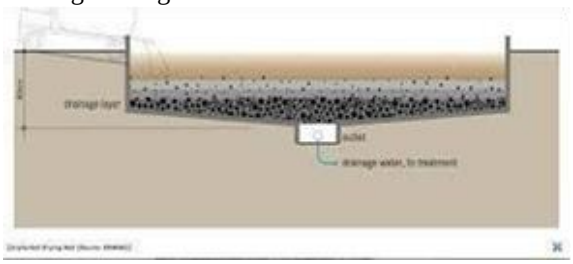

Fig.4.Sludge Drying Bed

g) Clear Water Tank

Clear Water Tank collected water from Secondary clarifier Tank by gravity. For tertiary treatment, water sent to multimedia sand filter, activated carbon filter and chlorine contact chamber.

h) Multi Grade Filter

Multi grade filter is used for filtration of water coming from clear water tank. It comprises of filter media of different grade of pebbles, gravels, anthracite.

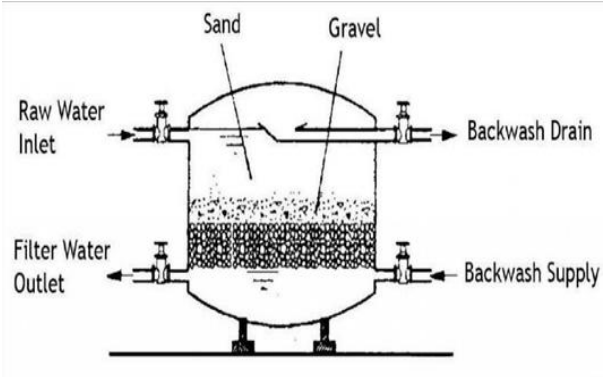

Fig.5. Multi Grade Filter

i) Activated carbon filter

Activated carbon filters are generally employed in the process of removing organic compounds and thereby making the water suitable for discharge or use in manufacturing processes.

Fig.6.Activated Carbon Filter

j) Dozer (Chlorine Contact Chamber)

Water passed from activated carbon filter sent to Chlorine Contact Chamber for disinfection. The contact time varies with chlorine concentration, the type of pathogens present, pH, and temperature of the water. Contact time must increase under conditions of low water temperature or high pH (alkalinity). Complete mixing of chlorine and water is necessary, and often a holding tank is needed to achieve appropriate contact time.

k) V-Notch

V notch is provided to check the quantity of clear treated water.

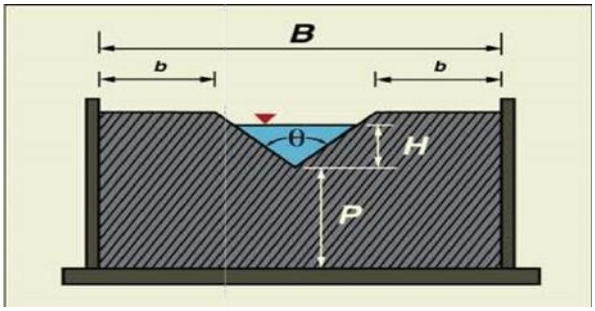

Fig.7. V-Notch

l) Treated Water Tank / Over Head Tank

Treated water stored in treated water tank / Overhead tanks for further use.

VI. CONCLUSION

In Kayamkulam Railway station there is no proper treatment plant for sewage, it is necessary to construct a Sewage Treatment Plant. The plant is designed perfectly to meet the future expansion for the 30-40 years in accordance with Indian Codal provisions. This project consists the design of the complete components of a Sewage Treatment Plant from receiving chamber, screening chamber, Grit chamber, Skimming tank, secondary clarifier and sludge drying beds for sewage.

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