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Design of Cost Effective Water Treatment Plant in Parala Maharaja Government Engineering Campus

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***Abstract*: The dirty water comes from homes due to the domestic uses is what we call as sewage or waste water. Rain water entering drains and industrial waste also appears to fits under this category.Sewage is treated by a variety of methods to make it suitable for its intended use, be it for watering crops or be it for human consumption. Sewage treatment mainly takes place in two main stage i.e. primary and secondary treatment. In arid areas where there is not enough water sewage also undergoes a tertiary treatment to meet the demands of the drinking water supply. During primary treatment the suspended solids are separated from water and BOD (Biochemical oxygen Demands) of the water is reduced. Secondary treatment can be accomplished by a wide variety means, however in our project we will only be concentrating on two of the most commonly used methods i.e. the trickling filter and activated sludge. The activated sludge method uses air and biological floc that is comprised of bacteria and protozoans. Aeration continues for 4-6 hours after which it is stopped and the contents moved into settling tanks. In settling tank flocs settles and removes much of organic matters. The process removes 75-95% of the BOD. In trickling filters 80-85% of the BOD removed. The water is then disinfected mostly by chlorination and released into flowing streams and oceans. If desired, the water can be treated in such a way to make it safe for consumption. This is where tertiary treatment appears. In other words it gives us potable water. It removes phosphorous.**

***Keywords*: Waste water, water treatment**

1. Introduction

Waste water treatment process is designed to achieve improvements in the quality of waste water. Waste water treatment is closely related to the standards and expectations on the characteristics of the sewage. Water constitutes one of the important physical environments of man and has a direct bearing on his health.

Water is absolutely essential, not only for survival of human beings but also for animals, plants and all other living beings. Water may be polluted by physical, chemical and bacterial agents. Water to be supplied for irrigation purpose must be portable i.e., satisfactory for irrigation purposes from the Standard points of its chemical, physical and biological characteristics. The objective of our water treatment is to reduce the fresh water usage and reuse the treated water for irrigation activities. Most water treatment plants (especially large plants) employ Coagulation, sedimentation, and filtration processes for water purification. The major sources of wastes are the sedimentation basins and filter Backwashes. Alum coagulation sludge, which are high in gelatinous metal Hydroxides, comprise large quantities of small particles. These are among the most difficult sludge to handle because of their low settling rate, low Permeability to water, and thixotropic characteristics. Generally, about 5% of the treated water is used for washing filters. Volume reduction of backwashes and recycling of wash water to the plant Influent can reduce waste production and cut costs. In the case of treatment plants that remove iron and manganese through Aeration or potassium permanganate oxidation, disposal of sludge to receiving waters may cause problems such as water discoloration and Destruction of aquatic life. Treatment plants that use an ion exchange. Softening process have brine wastes (high salts) which become critical Disposal problems, especially when the sludge has a high manganese content. The salts cannot readily be recovered or removed from the wastes.

Brine wastes are almost impossible to treat. Formerly, wastes from water treatment plants were returned to their Original source or discharged to nearby receiving water. Illinois laws and regulations now consider waste discharged directly from water treatment plants to receiving water as a pollutant. All wastes have to be treated to an acceptable level prior to their release into the environment, and water Treatment plant wastes are no exception. However, occasionally a Site-specific variance for direct discharge may be granted by the pollution Control authorities. In these cases, treatment of water plant wastes is not necessary before final disposal. Many water treatment plants do not have adequate facilities to investigate the quantity of waste produced, its characteristics and

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Treatability, and appropriate waste disposal practices. Very little Research has been conducted on the effects of coagulant and lime sludge's applied to farmlands. Shao-Hong (2015) provided information specifically associated with suspended growth processes including activated sludge and sequencing batch reactors. This review is a subsection of the treatment systems section of the annual literature review. The review encompasses modeling and kinetics, nutrient removal, system design and operation. Compared to past reviews, many topics show increase in activity in 2014. These include, nitrogen and phosphorus control, fate and effect of xenobiotic, industrial wastes treatment, and some new method for the determination of activated sludge. These topics are referred to the degradation of constituents in activated sludge. Other sections include population dynamics, process microbiology of activated sludge, modeling and kinetics. Many of the subsections in the industrial wastes: converting sewage sludge into fuel gases, thermos-alkali hydrolysis of Waste Activated Sludge (WAS), sludge used as H S adsorbents were also mentioned in this review.Tsagarakis(2005) had found that conditions applicable when planning wastewater treatment facilities for developing countries are not identical to those prevalent during planning in developed countries in the past. Today, technology is available for the treatment of wastewaters of any origin and strength. However, research is needed to be applied to specific country-regionconditions. The number and location of the wastewater treatment facilities in an area is a crucial factor to be determined. A combination of onsite and centralized treatment cannot be overruled. No ideal solution exists applicable to all conditions, and each sanitation project should be considered individually. Local experts should always be involved when planning new wastewater treatment projects. Historical data on the flow rate is necessary for design purposes. Daily, seasonal, and annual variations should be acquired, instead of adopting such values from text books. Low levels for effluent requirements and standards are frequently introduced in developing countries (DC), but these Levels are in reality rarely met. The abovementioned key points are among those discussed in this entry.

Sidwick(1991) published a commentary on the 'state of the art' of the pre-treatment of wastewaters with emphasis on the removal of grit and screening practices and the importance of other preliminary treatment processes as essential first stages in most wastewater treatment systems. Note is made of the lack of attention paid to preliminary treatment processes historically and on the paucity of knowledge of the mechanisms involved even today. However, there are developments and not only are conventional preliminary treatment processes reviewed, new processes are discussed and an attempt is made to forecast future trends.Kirsten (2005) investigated that coagulants and flocculants are commonly used in the destabilization and aggregation of suspended solids during water and wastewater treatment. Both inorganic salts and organic polymers may be used as coagulants, and various synthetic and natural organic polymers are applied as flocculants. Organic matter is quite well removed during coagulation, although it often requires a higher coagulant dosage. Other factors that influence the effectiveness of coagulants and flocculants are pH, temperature, mixing conditions and other ions present in the water. In order to maximize efficiency of contaminant removal while minimizing residuals, careful coagulant or flocculants dose selection and control are essential. Jayashree Dhoteet al. (2012) clarified that nowadays many water resources are polluted by anthropogenic sources including household and Agricultural waste and industrial processes. Public concern over the environmental impact of Wastewater pollution has increased. Several conventional wastewater treatment techniques, i.e. Chemical coagulation, adsorption, activated sludge, have been applied to remove the pollution, However, there are still some limitations especially that of high operation costs. The use of Aerobic waste water treatment as a reductive medium is receiving increased interest due to its Low operation and maintenance costs. In addition, it is easy-to- obtain, with good effectiveness and ability for degrading contaminants. This paper reviews the use of waste water treatment Technologies to remove contaminants from wastewater such as halogenated hydrocarbon Compounds, heavy metals, dyes, pesticides, and herbicides, which represent the main pollutants in wastewater.

Wastewater treatment, also called sewage treatment, the removal of impurities from Wastewater, or sewage, before they reach aquifers or natural bodies of water such as Rivers, lakes, estuaries, and oceans. Since pure water is not found in nature (i.e., outside Chemical laboratories), any distinction between clean water and polluted water depends on the type and concentration of impurities found in the water as well as on its intended Use. In broad terms, water is said to be polluted when it contains enough impurities to make it unfit for a particular use, such as drinking, swimming, or fishing. Although water quality is affected by natural conditions, the word pollution usually implies human activity as the source of contamination. Water pollution, therefore, is caused primarily by the drainage of contaminated wastewater into surface water or groundwater, and wastewater treatment is a major element of water pollution control.

2. Scope

1. Conduct a review of literature on water treatment plant Wastes with respect to:
   a) Defining the characteristics of wastes
   b) Assessing the environmental impacts of current Waste disposal practices
   c) Obtaining information regarding the impact of water Plant wastes on land and vegetation, if available
2. Conduct a questionnaire survey pertaining to the Characteristics, treatment, and disposal of wastes from Surface and ground-water treatment plants in Illinois, including:
   - The quantity and composition of residues produced by water treatment plants.
   - Methods of handling and treatment of all type of wastes and residues
   - The ultimate sludge disposal methods used
   - The costs of sludge treatment and disposal, if available

3. Study Area and Data Collection

1) Study area

The campus of Parala Maharaja Engineering College: (P.M.E.C), Berhampur is the first government engineering college in southern Odisha, India, came into existence in the year 2009 as a constituent college of Biju Pattnaik University of Technology (BPUT), Odisha.The silk City-Berhampur is located on the eastern coast-line of Odisha. The city is declared as a municipal corporation is well-connected by roads and rails to all parts of India. Parala Maharaja Engineering College, has an exceptionally huge campus, stretching across an area of more than 80 acres.The college population: 3000, which is mentioned in Table-1.

1.	**Faculties**	**100 NO**
2.	Girls hostel (i)	900NO
3.	Boys hostel (i) & Boys hostel (ii)	900NO
4.	Day-scholars	1000NO
5.	Others	100NO

4. Data Collection

General-Waste water treatment process is designed to achieve improvements in the quality of waste water. Waste water treatment is closely related to the standards and expectations set for the effluent quality. Sewage has to be treated to make it harmless. The degree of treatment depends on the characteristics of the sewage PMEC has a population of 3000. Water may be polluted by physical, chemical and bacterial agents. Water to be supplied for irrigation purpose must be portable i.e., satisfactory for irrigation purposes from the standard points of its chemical, physical and biological characteristics. The objective of our water treatment is to reduce the fresh water usage and reuse the treated water for irrigation activities.

1) Population forecasting

Pn=po+NX+N(N+1)/2Y

At design period of 10 years the forecast population of the PMEC is 3000.

Fig. 1. Area of PMEC Campus

5. Methodology

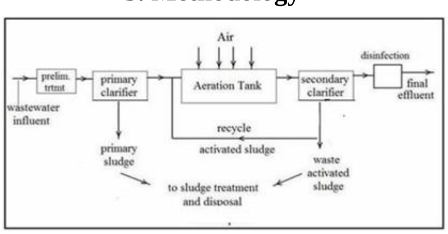

Fig. 2. Flow chart of waste water treatment process

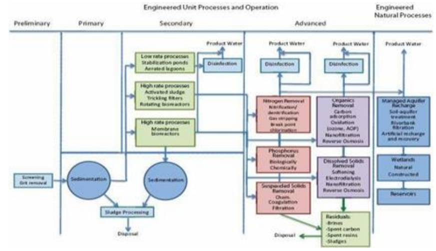

Fig. 3. Units of process and operation

- Design of coarse screen The screen bar are placed at 60O inclination to horizontal =L x B xD [1]

Where, L and B=Sides of the screen D=Depth of the screen

- Design of Grit Chamber L × B × D [2]
- Primary Treatment Primary treatment consists of in removing large suspended organic solids. This is usually accomplished by sedimentation in the settling basins. The liquid sewage from primary treatment mostly contains a huge and large amount of suspended organic and inorganic particulate materials, and has a high BOD value nearly 63% of original.

1) Design of rectangular sedimentation tank

Capacity of the tank=$sewage\ generation\ detention\ Period$ [3]

Length of the tank=Assumed velocity * Detention period [4]

Area of tank=$capacityoftank\ /lengthofthetank$ [5]

Width= $areaoftank/\ assumed\ effective\ depth$ [6]

Dimention of tank =L*B*D [7]

2) Trickling filter Design of Trickling Filter

Total bod present in the sewage to be treated per day=sewage generation per day*bod of waste water

Volume of filter media required=$total\ bod\ present\ in\ sewege\ to\ be\ treated\ per\ day\ /assumed\ organic\ loading$ [8] Area= $volume\ of\ filter\ media\ /assumed\ effective\ depth$ [9]

Required unit =π /4 ×d²

Average flow of each tank = $sewage\ generation\ per\ day/\ assumed\ velocity\ at\ peak\ flow$ [10]

Bod removed in activated plant=total bod entering STP - YE [11]. Minimum efficiency required in the activated plant=$BOD\ removed\ in\ activated\ plant\ /BOD\ of\ the\ wastewater$ *100 [12] Deisgn of Arms

The discharge per arm= $flow\ through\ each$ unit at peak time/ $assumed\ arms$ [13]

- Design of aeration tank F/M ratio=$Q/\ V$ × [Y0/XT] [14]. The length of the tank= $V/\ B*D$ [15] DIMENSION =L*B*D [16]
- Disinfection tank Volume required=flow×time [17] Area =L×B [18].

6. Result and Discussion

Sewerage Generation Ultimate design period = 30 years Forecasted population =3000. Per capita water supply =135 lpcd Avg sewage generation per day = 80% = 0.324MLD

Max discharge 3 times = 0.528 cumecs

1) Design of coarse screen

Assume the velocity at average flow is not allowed to exceed 0.8 m/s The net area screen opening required, = 0.66

Size = 10mm x 50 mm (10mm face) Clear spacing = 80mm

The screen bar are placed at 600 to horizontal L x B x D =5×2×0.4

- Design of Grit Chamber Assume avg. detention period = 180s Aeration volume = 95.04

Assume depth of 2m & width : depth = 2:1 = 5.94 Width of channel = 2x2 = 4m

Length of channel = 47.52/ (2x4) L * B * D = 7.13×4×2m

- Design of rectangular sedimentation tank Sewage generation= 0.324 MLD Detention period = 1hours

Capacity of tank 0.324/24*1=0.015MLD Assume velocity = 0.3 m/s. Length of tank = v x t =0.3 x 1x 60 = 18m Area of tank V/L=0.015/18=8.33×10-4m^2

Assume effective depth = 2m

Width = 4.168×10-4m=0.04m

Dimension L x B x D = 18m x 0.04 mx 2.5m

2) Design of Trickling Filter

Sewage generation per day = 0.324MLD BOD of the wastewater = 120 mg/l

Total BOD present in the sewage to be treated per da = 0.324 x 120=388.8 Kg

Assume, organic loading =200Kg/heater meter /day

The volume of filter media required, =(388.8/200) = 1.95m^3

Assume effective depth = 2m

Area =1.95/2=0.98m^2

Required units Assume d= 10m,

Therefore required units = 1units

Design of rotary distributors peak sewage flow per day = 0.528m^3 /sec Assume that the velocity at the peak flow is 2m/sec through the central column of distributer, Average flow to each tank =0.324/2=0.162m^3/day The total BOD entering STP = 120 mg/l

Assuming that negligible BOD is removed in screening and grid chamber i.e YE = 20mg/l

BOD removed activated plant = 120-20 =100 mg/l Minimum efficiency required in the activated plant =100/120×100=83.33=84%

Since the adopted extended aeration process can be remove up to 95 – 98%

3) Design of Arms

Now let as use rotary reaction spray type distributor with 2 arms. The discharge per arm = 0 .264/2=0.132m^3/sec

Arm length = 19m

4) Design of aeration tank

Number of tanks = 2 MLS=3000mg/l F/M ratio=0.2 F/M=Q/V*[YO/XT] V=7600×120/0.12×3000=2533.33m^3

Let us adopt an aeration tank of liquid depth 4m and width 10m. Then, The length of the tank = v/b*d

L = 118m

Therefore dimension of the aeration tank is 118x10x4

5) Design of Disinfection tank Design flow = 0.528 Detention time = 60 sec

Volume required = flow x time = 31.68 Provide depth = 3m

Area = 10.56 L: B = 2:1

SB^2 = 10.56

B = 2.296 ≈ 2.3m L=4.6cm

The dia of central column assume= $=\sqrt{\frac{0.264}{2} \times \frac{1}{\square}/4}=0.4m$

Provide a central column of 0.4m in dia find the velocity through the column at average flow, as it should not be less than 1m/sec.

7. Conclusion

The design of waste water treatment plant is not only limited to duty of residential or industrial plants but is also a environment friendly. Waste water treatment is an initiative which has to be taken more seriously for the betterment of the environment. Proper design, engineering, operation and maintenance are absolutely imperative for successful and satisfactory performance of treatment plant in a long way. Our design of the plant has sufficient capacity to treat the projected flows and loads throughout the planning period. The plant is capable of meeting current effluent permit conditions and no charges are required through the next permit cycle. Each and every unit of the designed plant would perform at its optimal and most efficient design level for overall satisfactory performance of the plant. Each and every unit in a treatment plant is directly or indirectly impacts performance of other units in a treatment plant.

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