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# Proposal of activated sludge process with extended aeration at Yadagirigutta

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***Abstract***

*The discharge of untreated waste water to the environment causes adverse environmental problems. In this regard feasible wastewater treatment system must be designed and operated to reduce the pollutant load and to safeguard the public health in that region. We are designing waste water treatment plant for approximately 4 MLD of waste water collected by various sources in Yadagirigutta region We have opted activated sludge process with extended aeration technique to treat waste water. Activated Sludge Treatment is a biological wastewater treatment process which speeds up waste decomposition by adding Activated sludge into waste water. The basic principle behind all activated sludge processes is that as microorganisms grow, they form particles that clump together. These particles (floc) are allowed to settle to the bottom of the tank, leaving a relatively clear liquid free of organic material and suspended solids. The treated wastewater is used for agricultural purposes, landscaping and street gardening. The sludge which is obtained is used as manure for the crops which yields the growth of the crops.*

***Keywords:*** *Waste Water, Activated Sludge Process, Extended Sludge Process*

## 1. Introduction

In society every community consumes water for various domestic, industry, agricultural activities etc., and produces both liquid and solid wastes and air emissions. In the past, more money has been spent for the research and development of sewage treatment process and sludge management, which resulted in a rapid growth in technology for improved process design. Laboratory and pilot plant studies are utilized to develop process design parameters and kinetic coefficients. Now, great emphasis is given to energy conservation, operation and maintenance of treatment plants to optimize the treatment costs. The aim of the project is to study and compare two different technologies such as Activated sludge process (ASP) & Extended Aeration Sludge process (EASP) in wastewater treatment by analyzing the performance in the removal of Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), the main constituents that are to be controlled before discharging the effluent into the environment by testing the raw sewage and treated waste water at frequent intervals [1-4]. The Activated Sludge Process (ASP) is a type of wastewater treatment process for treating sewage or industrial wastewaters using aeration and a biological floc composed of bacteria and protozoa.

The general arrangement of an activated sludge process for removing carbonaceous pollution includes the following items: An aeration tank where air (or oxygen) is injected in the mixed liquor. This is followed by a settling tank (usually referred to as "final clarifier" or "secondary settling tank") to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.

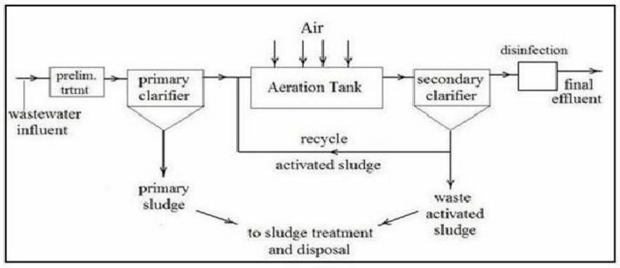
### Study area

Yadagirigutta, Telangana

## 2.Literature review

[1] Metcalf and Eddy, Inc. “Wastewater Engineering, Treatment and Reuse, Tata McGraw-Hill Publication,2010.
[2] “Evaluation of Operation and maintenance of sewage Treatment Plants inIndia-2007”,www.cpcb.nic.in.
[3] “Sewage Treatment Plants and Wastewater Treatment Plants”,www.ecowatersolution.com.
[4] Kerri., and D Kenneth., Operation of Wastewater Treatment Plants. 1990; California State University, Sacramento, Vol.I

## 3.Methodology




Activated Sludge Wastewater Treatment Flow Diagram

Wastewater collected from municipalities, communities and industries contains a wide range of pollutants. The treatment train normally adopted includes physical, chemical, and biological methods. WWTP is divided into four major treatment groups:

- Preliminary
- Primary
- Secondary and
- Tertiary advanced treatment.

Preliminary treatment of wastewater removes coarse and readily settleable inorganic solids with the size range of more than 0.01 mm, such as sand and grit particles. The removal is carried out using screens and grit chambers, respectively. After coarse and floating solids are removed in preliminary treatment

Primary treatment removes the bulk of suspended solids through sedimentation tanks or clarifiers. During sedimentation, particles from 0.1 mm to 35 μm including both organic and inorganic matter are removed. Of the 70-90 percent of suspended solid removed by sedimentation, 30-40 percent of this reduction is oxygen-demanding suspended solids (Tchobanoglous and Burton, 1991).

Secondary treatment is employed to remove oxygen-demanding organic pollutants which are present mostly in the dissolved form. This process utilizes bacterial biological degradation to remove the dissolved pollutants. However, these microbes will produce SMPs and extracellular polymeric substances (EPSs), which can be toxic and inhibit nitrification.

Tertiary treatment removes part of the remaining organic pollutants through a filtration process. Final disinfection is often utilized to reduce the bacterial count, particularly pathogenic microbes. This is mainly adopted to avoid poorly treated effluent quality and to protect the receiving water.

The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. It is also called "effluent polishing."

"Tertiary Filtration" systems must include a physical filtration process designed to achieve an effluent quality of 10 parts per million biological oxygen demand and 10 parts per million suspended solids.

The use of filtration systems for waste water systems is relatively recent development. Concept of utilizing filtration in waste water treatment came into practice due to stringent requirements for secondary reuse. The low levels of SS & BOD were difficult to meet with conventional secondary treatment. Tertiary filtration is aimed at removing the fine suspended solids that are carried over with effluent in secondary clarifier. The BOD associated with the suspended solids also automatically gets removed during filtration resulting into low SS/BOD effluent.

**Scope of activated sludge process:**

The activated sludge process is a multi-chamber reactor unit that uses highly concentrated microorganisms to degrade organics and remove nutrients from wastewater, producing quality effluent. The goal is to maintain aerobic conditions and to keep the activated sludge suspended

To reduce the organic matter present in the sewage and waste water

Oxidizing carbonaceous biological matter

To extract pollutants, Removing toxicants,

To improve the quality of the discharged water

| | | After filtration(0.75mm) &cyclone | | After filtration cyclone, CAS | | After filtration cyclone, CAS, MBR | |
|---|---|---|---|---|---|---|---|
| No. of available samples | | 21 | | 21 | | 21 | |
| | | Average | Std.dve | Average | Std.dve | Average | Std.dve |
| TURBIDITY | NTU | 516 | 273 | 402 | 213 | 1.2 | 0.7 |
| pH | l | 5.8 | 0.7 | 7.5 | 0.5 | 7.9 | 0.3 |
| Electroconductibility | uS/cm | 2177 | 889 | 1722 | 651 | 1294 | 315 |
| Alkalinity | mg/l | 830 | 246 | 838 | 329 | 487 | 124 |
| COD | mg/l | 2471 | 1512 | 595 | 192 | 73 | 20 |
| BOD5 | mg/l | 1882 | 1129 | 247 | 189 | 11 | 5 |
| Ammonium-N | mg/l | 38.9 | 16.9 | 17 | 20 | 1 | 0.9 |
| Nitrate-N | mg/l | 4.7 | 4.6 | 7.5 | 16 | 1.2 | 0.7 |
| Total nitrogen | mg/l | 75.2 | 27 | 61.1 | 30.6 | 5 | 2.2 |
| Total phosphorous | mg/l | 6.1 | 2.6 | 6 | 2.5 | 4.9 | 2.8 |
| Chlorides | mg/l | 114 | 54 | 89 | 24 | 74 | 20 |
| Active surfactants | mg/lDBS | 1.1 | 1.2 | - | - | 0.2 | 0.1 |
| Hydraulic residence time | h | - | - | 45.7 | 3.4 | 45.7 | 3.4 |
| MLSS | g/l | - | - | 4.9 | 2.4 | 16.2 | 4.4 |
| Temperature | C | - | - | 18.2 | 3.8 | 17.7 | 3.9 |
| Dissolved oxygen | mg/l | - | - | 5.9 | 1.9 | 6.6 | 1.6 |
| F/M | l/d | - | - | 0.0296 | 0.0201 | 0.0004 | 0.0002 |

Future population:

The future population in the Yadagirigutta region can be calculated by population forecasting methods
They are

1. Arithmetic Progression.
2. Geometric Progression.

3. Incremental increase Method.
4. Graphical method

Arithmetical increase method
This method is suitable for large and old city with considerable development. If it is used for small, average or comparatively new cities, it will give low result than actual value. In this method the average increase in population per decade is calculated from the past census reports. This increase is added to the present population to find out the population of the next decade. Thus, it is assumed that the population is increasing at constant rate. Hence, dP/dt = C i.e., rate of change of population with respect to time is constant.
Therefore, Population after nth decade will be Pn= P + n.C

Where, Pn is the population after n decades
P is present population.

| Sl.no | Year | population | Increase in population |
|---|---|---|---|
| 1 | 2001 | 13,267 | |
| 2 | 2011 | 15,232 | 1965 |
| 3 | 2021 | 17,252 | 2020 |

The population in Yadagirigutta town after 20 years (2041) will be approximately **=**21,237
The various unit operations for chemical clarification are as follows,

- Coagulation
- Flocculation
- Sedimentation.

**Coagulation**

Coagulation is the method of mixing chemicals to waste water in order to decrease the forces which tend to preserve suspended particles apart. In this method mixing is achieved in rapid or flash mixing unit developed to generate velocity gradientsof300sormorewithdetentionperiodof15to50sec.Thepaddlesofmixingunitarepreparedonverticalshaft and operate by a constant speed motor through reductiongear.

Thesizeandspeedofthepaddleissochosenthatthecapacityofpaddleistwicethemaximumflowofthetank.Thespeed of shaft should be in between 100 – 200 r.p.m and power of about 0.1 kw/mid is required.

**Flocculation**

Flocculationprocessiscarriedoutaftermixingthecoagulantswithwastewater.Inthismethodflocisdevelopedthroughslowstirringmechanisms.Flocculationcomprisesofpaddleswhichrotatesonvertical (onhorizontalshaftwithalowspeed about2 3r.p.m(runperminute).Forcompleteformationofflocflocculatorsallownumberofgentlecontactsbetweenthe flocculatingparticles.Inmechanicalfocculators number ofcompartmentsarefixedalongwithrotatingpaddlesand waterflowsthroughtheinletandremovedfromtheoutlet.Inflocculationthedetentionperiodshouldbeinbetween30 –60minutestoobtainbestfloc.

**Sedimentation**

Theprocessinwhichthesuspendedparticlesareremoved withthehelpofgravitationalsettlingistermedassedimentation.
Insedimentationtank,solidsofflocculatedsewagearesettled.Normally2hoursofdetentiontimeandanoverflowrates for average flows of $50 m^3/d/m^2$ is assumed in sedimentation tankdesign.

**Primary Sedimentation Tank**

Thesuspendedimpuritiesinwatervaryinthecomposition ,charge,size,shapeanddensity.Thedifferenttypesofphysical forces that enable the particles to be held in suspension in waterinclude: The turbulence or currents maintained in thewater.
Repulsion forces: The suspended solids in water are generally negatively charged. When the particles come closer, they repel each other. However, when the turbulence reduces, the larger particles settle to the bottom of the tank/ water body under the influence ofgravity.
Thesedimentationtanks(alsoknownaswastewaterclarifier,primarytanks,primaryclarifiers,primarysettlingtanks and)aremeanttoremoveheavysolidsfromthesewageby meansofsettlingandseparationofsuspendedparticlesfromtheliquidphasebyplainsedimentation.Inthismethod,waterisallowedtoremainstillormoveveryslowlythroughtheartificialbasinssothatthesuspendedimpuritiessettletothebottomandrelativelyclearwaterflowsfromthetopportion.Thefloatingmaterial(orscum)likeoilandgreaseareskimmedoffwhilethesludgesettledatthebottomofthetankiscontinuously removed for further processing.The factors affecting the sedimentation process in sedimentation tanks include,Characteristics of solid particles, such as size and specificgravity.Characteristics of liquid in the waste water, such as temperature, viscosity,etc.

Characteristics of the artificial tanks, such as shape, velocity of flow of liquid,etc.
Sludge digestion tank. The tanks which stores the sludge formed in the wastewater treatmentplant is called sludge digestion tanks.
Sludge is the solid part (in the form of slurry) removed or separated from the wastewater. Sludge digestion is defined as the process of biochemicaldecomposition (aerobic or anaerobic)oforganicmatterinsludgesuchthatitisprevented from dewatering process over mechanical filters or sand beds before it is disposed to land orsea.
Sludge drying beds Sludge drying beds are used for the purpose of dewatering the digested sludge. Disposal of digested sludge takes place on greve bed and sand bed which are drained well. Generally, sludge layer thickness lies in between 150 mm – 200 mm. Sludge dryinggravelbedsfacilitateforthereductioninthesludge watercontentbyabout70%.Morethan60%ofvolumeofsludgecan be minimized in the sludge dryingbeds.

**Extended aeration**

It 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. Extended aeration is typically used in prefabricated package plants intended to minimize design costs for waste disposal from small communities, tourist facilities, or schools. In comparison to traditional activated sludge, longer mixing time with aged sludge offers a stable biological ecosystem better adapted for effectively treating waste load fluctuations from variable occupancy situations. Supplemental feeding with something like sugar is sometimes used to sustain sludge microbial populations during periods of low occupancy; but population response to variable food characteristics is unpredictable, and supplemental feeding increases waste sludge volumes. Sludge may be periodically removed by septic tank pumping trucks as sludge volume approaches storage capacity.

## 4.Results

**Design of Screens**

Waste water produced (discharge) Q = 4MLD
Number of openings = 5
Number of bars = (6 + 2 end bars) = 8 bars
Diameter of bars = 2cm
Spacing of bars = 8cm
Width of screening = 0.057m
Depth of screening = 0.9m
Area of screening = 0.0513 sq.m

**Design of grit chamber**

Waste water produced (discharge) Q=4MLD
Surface loading rate (SLR)= 555.56 m/day
Peak factor (P.F) = 2.5
Detention time = 1 min
Length of grit chamber = 25.2 m
Width of grit chamber = 1.4 m
Depth of grit chamber = 0.69 m
Area of grit chamber = 0.39 sq.m
provide grit chamber size; 25.2*1.4*0.69

**Design of sedimentaion tank**

Waste water produced (discharge)Q= 4MLD
Volume of sedimentation tank = 500 cum
Length of sedimentation tank = 31m
Width of sedimentation tank = 7m
Height of sedimentation tank = 5.2m
Dimensions of rectangular sedimentation tank is; 31m*7m*5.2m

**Design of cascade aeration**

Diameter of aeration fountain=3m
Total no. of steps=4
Height of each step=0.55m
Total contact time=0.8sec
Section of collection channel = 0.6 m wide and 0.95m deep

**Conclusion**

From the present investigations, the following points can be considered

1. The treatment of Domestic sewage with Extended Aeration Sludge Process (EASP) is an effective and economicaltechnology.
2. The land area required is minimum and installation cost, operation and maintenance cost is minimum. Since the primary settling tank, sludge digester etc., are not required in thisprocess.
3. Treated waste water is generally of poor quality than portable water, so the treated waste water that obtained from the extended aeration is used for maintenance of city garden and also used in irrigation.
4. In this treatment the waste in waste water is removed and the disease caused bacteria and virus are neutralized by exposing to air. The sludge which is formed in the treatment process can further used in agriculture field as manures.
5. The treated waste water can be obtained of any quality and this allows the water agency to satisfy short term needs as well as to increase water supply reliability
6. For that it is recommended to utilize EASP technology for the treatment of domestic sewage in the industrial areasalso.