IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Enhancing Agricultural Methods Through Artificial Intelligence And The Internet Of Things

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Abstract:

Water stands as one of the most crucial and indispensable resources for all life on Earth, including humans. However, the rampant spread of pollution and contamination poses a severe threat to its quality and availability. A significant contributor to this crisis is the unchecked disposal of untreated industrial waste into nearby bodies of water like lakes, ponds, and rivers. It's imperative that educational institutions prioritize the establishment of efficient sewage treatment facilities to manage the wastewater generated on their premises. Before constructing such a facility, a comprehensive analysis of the wastewater's characteristics is essential. Parameters such as pH level, total solids, suspended particles, hardness, alkalinity, fluoride, iron, ammonia, nitrate, and phosphate require thorough examination. The primary goal of a sewage treatment plant is to receive and process wastewater from various sources like hostels, colleges, and canteens, eliminating any harmful substances that could endanger the surrounding environment. The ultimate aim of sewage treatment is twofold: to produce a treated effluent that meets environmental safety standards and to generate treated sludge suitable for disposal or potential reuse, typically as fertilizer in agriculture. This process involves the removal of diverse pollutants including solids, organic matter, nutrients, salts, metals, and pathogens. Effective wastewater management is paramount for safeguarding both environmental integrity and public health. Various methods are employed for sewage/wastewater treatment, all aimed at reducing water and organic content. The overarching objective of wastewater management is to ensure environmental protection while addressing public health and socioeconomic considerations. This project focuses on the meticulous design of a comprehensive sewage treatment system, encompassing key components such as storage tanks, screen chambers, primary sedimentation tanks, the activated sludge process (ASP), and secondary sedimentation tanks.

Keywords: sewage, BOD, Solids, ASP, public health. Sewage

Introduction

Sewage and its effluents stand as primary contributors to water pollution, comprising human fecal matter, household wastewater, and industrial discharges. Addressing the escalating environmental concerns necessitates a comprehensive understanding of wastewater characteristics, particularly domestic sewage. While historical focus rested on organic carbon elimination in domestic wastewater treatment, the surge in pollution levels mandates the adoption of novel techniques targeting nitrogen and other critical pollutants.

A Sewage Treatment Plant (STP) serves as a crucial facility for receiving and treating waste from residential, commercial, and industrial sources. Its primary aim is to eliminate substances detrimental to water quality and public health when discharged into water bodies. Employing a combination of physical, chemical, and biological processes, the STP targets diverse contaminants based on their composition.

Advancements in technology now enable the potential reuse of treated sewage effluent for potable water purposes.

DEFINITIONS

Sewerage: The system by which waste matter is carriedaway in sewers and made harmless.

1. Sewage: waste matter such as faces or dirtywater from homes and factories, which flowsaway through sewers.
2. Storm water: water that comes from precipitationand ice/snow melt – it either soaks into exposed soil or remains on top of impervious surfaces, likepavement or rooftops.
3. Activated sludge: the type of wastewater treatment process for treating sewage or industrial wastewatersusing aeration and a biological floc composed of bacteria and protozoa.
4. MLSS: the amount of suspended solids in themix of raw water and activated sludge.
5. Sludge age: the average residence time ofbiological solids in the system. It can be defined as the average life span of bacteria in the system.
6. Over flow rate: the discharge per unit of plan area
7. Food to Micro-organisms ratio: the ratio betweendaily BOD loads applied to aerator system and total microbial mass in the system.

OBJECTIVES OF THE STUDY

1. To design the sewage treatment plant in PERIEDUCATION.
2. To characteristics the sewage wastewater comingfrom hostel, college and canteen for physic-chemical parameters and then comparison with the prescribed standard.

Literature

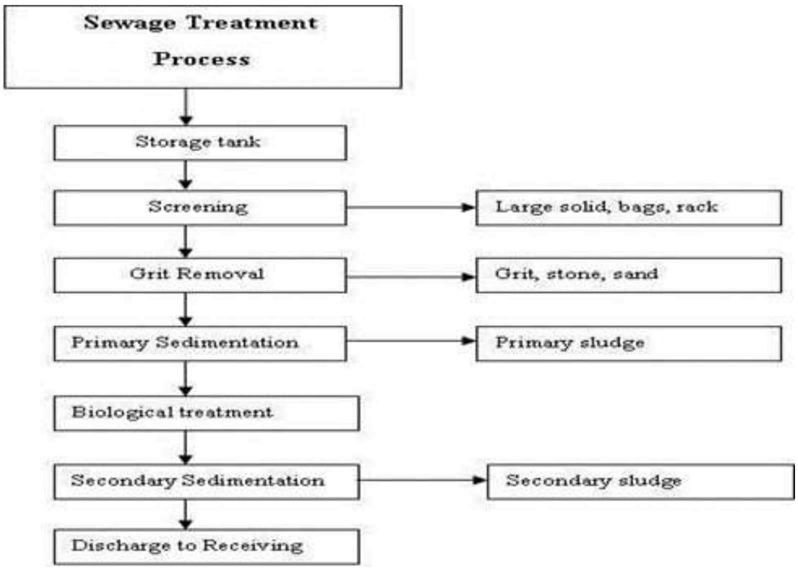
Puspalatha et.al (2016) reviewed on design approach for sewage treatment plant. A case study of Srikakulam greater municipality; the present study involves the analysis of parameters like BOD, raw sewage, effluent. The construction of sewage treatment plant will prevent the direct disposal ofsewage in Nagavali River and the use of treated water will reduce the surface water and contaminated ground water.

Chakar bhushan et al. (2017) reviewed about design of sewage treatment plant for lohegaon village, Pune. This project studied that social and environmental pollution issue due to sewage is disposed in some part of village and directly sewage drain in open land. It is used for recharging sub surfacewater level at lohegaon and used for irrigation purpose.

M. Aswathy et al. (2017) studied on analysis and design of sewage treatment plant of apartment in Chennai. This project is studied that domestic and commercial waste and removes the material with possess harm from generated public. To produce an environmental sewage fluid waste stream and solid waste suitable from disposal of use.

S. Ramya et al. (2015) reviewed on design ofsewage treatment plant and characteristics of sewage. The growing environmental pollution need for decontaminating water results in the study of characterization of waste water especially domestic sewage. The waste water leads to developing and implementing new treatment techniques to controlnitrogen and other priority pollutants.

METHODOLOGY



CHARACTERSITICS OF WASTEWATER

4.1. INITIAL CHARACTERISTICS OF WASTEWATER

Table 4.1 Initial characteristics of wastewater

COLLEGE POPULATION	NUMBER OF THE POPULATION
Total students	1671
Total staff workers(teaching staff and Non-teaching staff)	**142**
Total Workers	**103**
Total Population	1916- 450 [1466]
Per capita demand	45 per head
Water demand	65970 l/ day + 60750 l/day 126720l/day
Sewage demand	101376 L/day
Peak factor, Q max	= 0.0012*3 = .0036m^3/s

Quantity of sewage generation from hostel andcollege

Table 4.2 Quantity of sewage generation from hostel and college

S.No.	PARAMETERS	UNITS	RESULTS	PERMISSI BLE LIMIT
1	pH	-	6.8	6.5-8.5
2	Total dissolved solid	mg/L	1458	500
3	Total solid	mg/L	3108	1000
4	Total alkalinity	mg/L	439	200
5	Total hardness	mg/L	940	300
6	Fluoride	mg/L	0.34	1
7	Iron	mg/L	8.6	1
8	Ammonia	mg/L	104	1.5
9	Nitrate	mg/L	0.18	45
10	Phosphate	mg/L	9.2	1
11	Free residual chlorine	mg/L	0.1(lower)	0.2
12	BOD	mg/L	480	30
13	COD	mg/L	1460	250

DESIGNING

DESIGN OF STORAGE TANK

Maximum Quantity of sewage produced/day =0.0036X (24X 60 X 60) = 31m^3 Volume / day = 311m^3

Since volume of tank is large. Tanks are divided intotwo tanks. Volume = 311/2

= 156 m^3

Hence provide two as a volume from IS 3370 Part4 Depth of the inlet tank (2 to 4m) In Rectangular tank, the water is only stored for 12 hrVolume of tank = 156 / 12

= 13 m^3

Area of the tank = volume/depth

= 13/2

=6.5 m^2

Assume L:B=1.5 :1

Area of tank = 6.5

LX B =6.5

1.5 B^2 =6.5

Breadth = 2m

Length =3m

Hence provide 2 tank of rectangular storage tank withlength and breadth 3 X 2 (m)

Velocity of flow in the storage tank = Vol./surface

Area = 13/6

= 2 m/s

Assume inlet and outlet diameter of pipe = 0.15m

SCREENING

The first unit operation generally encountered in wastewater treatment plants is screening. A screen is a device with openings, generally of uniform size, that is used to retain solids found in the influent waste water to the treatment plant.

The principal role of screening is to remove course materials from the flow stream that could: 1. Damage subsequent process equipment. 2. Reduce overall treatment process reliability & effectiveness, 3.Contaminate waste way.

There are two types of screening processes 1.Manually operated. 2. Automatically

1. Coarse screens (Bar Racks)
2. Fine screens
3. Micro screens.

DESIGN CRITERIA:

- Screen chamber is designed for peak flow.
- Area of screen opening=2 to 2.5 times the area ofincoming pipe
- Depth of submergence over the crown of thepipe=75 to 100cm.
- Detention time=2 to 5 minutes
- Width of chamber=2 times width of the screen.
- Size of bars

' Width = 25 to 50mm

' Thickness = 10 to 20mm

' Width of bars is placed parallel to the flow

- Clear opening = 25 to 50mm
- Width of end clearance = same as opening
- Angle of screen = 45° to 60°.
- Shape and material of the bar = M.S. Flats
- Inclination of bars with horizontal = 800(cleaning manually)

2 numbers of screen chambers/ channels shall beprovided as per sound engineering practice.

The Flow from the inlet chamber to screen channelsshall be controlled by C.I. penstock gates.

DESIGN OF SCREENING

Peak discharge of storage = 0.0036 m3/s

The velocity at average flow is not allowed to exceed 0.9 m/s Vertical projected area of screen,

A = (0.0036 / 0.9)

Thickness = 10 mm

Width = 25 mm

Clear spacing = 30 mm

Total area

=0.004(25+10/30)

= 0.0065 m^2

The screen is inclined @ 45 degree Horizontal gross sectional area of screen

= area / sin 45

= 0.0065/sin45

= 0.01m2

If 20 no of bars are provided, then no of openings = 21

Width of screen = (no of bars * thickness) + (no. of opening * spacing)

=0.83 m

Assuming depth as 0.9m including free board. Coarsescreen channel is designed for the size of 0.83m X 0.9m

Provide 20 bars of 10mm X 25 mm at 30mm clear spacing Screen chamber shall be 83 cm wide.

Assumption:

U/S of screens, 2 Nos. C.I. penstock gates shall beprovided (one for each channel). Min. drop of 150 mm shall be provided in the bed ofscreen channel.

The size of the penstock gates: 2Nos. of 350X450 mmsize be provided.

Table No.5.1: Results of screen chamber

S. No	Design parameters	value
1	Peak flow through coarse screen	0.0036 m^3/s
2	Velocity through the screen	0.9 m/s
3	Clear opening area	0.01 m^2
4	Clear opening between bars	0.03 m
5	No of clear opening in coarse screen	21
6	Width of channel for coarse screen	0.83
7	Depth of channel for coarse screen	0.9

DESIGN OF GRIT CHAMBER

Grit chamber are basin to remove the inorganic particles to prevent damage to the pump and to prevent their accumulation in sludge digesters.

Grit chamber are nothing but like to sedimentation and grit presence in the sewage. This velocity is called differential sedimentation and differential scouring velocity. The scouring velocity determines the optimum flow through velocity.

DESIGN OF GRIT CHAMBER

Flow from screen chamber shall be taken into grit chamber, provided in duplicate. 2Nos. C.I. gates, oneeach at inlet and outlet, are provided for each grit chambers. One more C.I. The gate shall be provided atthe inlet to bye-pass channel in between two gritchambers.

Design flow = 311 m^3/day

Assume Surface loading = 500-1100 m^3 /m^2 /day

To account for turbulence and short circuiting, reducethe surface loading to about 500m^3 /m^2 /day Area required = 311/ 500 = 0.622 m^2

Provide 1 m dia. chamber (if circular), or 1X 1 m. Square chamber (if square). Detention time = 60sec Volume = (311X 60) / (24 X 3600) = 0.35m^3

Depth = .35m^3 / 0.622m^2 = 0.6 m

Size of the Grit chamber = 1.0m X 1.0m (dia. or side)X 0.6 m (i.e. 0.6 + 0.5 F.B. =1.1 m)

Check for Horizontal Velocity Velocity = 311 / (1 X 0.6 X 24 X 3600) = 0.006 = 0.6 cm / sec < 18cm / sec.Hence Ok

Grit generation = 0.05 m3 per 1000m3 of sewage flow(Assume)

Even though Grit is continuously raked, still 8 hours of grit storage is provided for average flow. Storage Volume required = (311 X 8 / 24) X (0.05 / 1000) =0.005184 m^3

Grit Storage area = (π/4) X 1 = 0.785 m^2

Grit Storage depth = 0.028 /0.785 = 0.035 m^2Total liquid depth = 0.6 + 0.035 = 0.64

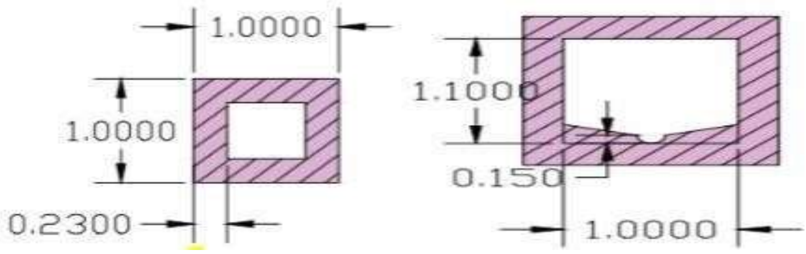
= 0.65m

Provide grit chamber of size = 1.0 X 1.0 X 1.15 (depth). Assume inlet and outlet pipe diameter as 0.15 m and wall thickness 230mm

Note: Parshall Flume and measuring arrangement hasnot been proposed for two reasons viz:

a) The measuring instruments are rarely workingsatisfactorily at any plant.

b) The plant is very small, to seconomize the cost.



SKIMMING TANK

It is generally the standard parameters of skimming tank are length should be in between 0.6m to 1m, width should be in between 0.5m to 1m, depth shouldbe in between 1m to 1.5m. After designing the skimming tank obtained values are length is 0.83m, width is 0.8m, and depth is 1m.

4.8 DESIGN OF SKIMMINGTANK Surface area of tank A= 0.00622 X q / Vr

q= rate of flow sewage (m^3/day)

Vr = min rising velocity of the oilymaterial to be removed in m/min q= 0.0036 * 60*60*24

= 311m^3/day

Vr = 0.25 m/min

= 0.25 *60*24

= 360 m/day

Area (A) = 0.00622 *311/360

= 0.0054 m^2

Provide the depth of the skimming tank (1 to 3 m) =2m The length breadth ratio is 1.5:1

Area = L *B 0.0054= 1.5 B2 B= 0.06 m

L =0.12 m

Skimming tank is designed for the size of 0.12m*0.06 m*2m

4.10 DESIGN OF PRIMARY SEDIMENTAIONTANK

Total amount of water to be treated =0.0036 m^3/s

Total amount of water to be treated =0.0036 m^3/s Quantity of sewage to be treated for 3 hr (2 to 3hr)

Volume = discharge * detention time

= 0.0036 * 3 * 3600

=40 m^3

Provide depth = 2 to 4 (3m)

Surface area = volume/ depth

Volume = discharge * detention time

= 0.0036 * 3 * 3600

=40 m^3

Provide depth = 2 to 4 (3m)

Surface area = volume/ depth

= 40/3

= 15 m^2 Diameter of tank = 4.5 m Free board = 0.5 m

Hence actual depth = 3+0.5 = 3.5 m

Primary sedimentation tank is designed for thedimension of 3.5 m * 4.5 m

4.11 DESIGN OF ACTIVATED SLUDGEPROCESS

Quantity of sewage = 0.0036m3/s

=311m3/day

We know that ASP unit

Initial BOD = 480 mg/L

Final BOD = 30 mg/L

Efficiency (η) = [initial BOD- final BOD/ initialBOD] *100 = (480-30)480 *100

= 93.75%

Therefore for η range 82-92we have,

F/M = 0.3

MLSS = 2000 mg/L

Now,

F/M = (Q * Y0)/V * Xt 0.3= (311*480)/V *2000 V=

250 m3

Check for HRT,

t = v/Q

= 250*24/311

=19 hr

Check for volumetric loading rateVLR = .311 * .480/.250

= 0.6 Kg/day/m^3 (within the limit less than

0.8 Kg/day/m^3) Tank dimensionsDepth = 3m Breadth = 3 m

Total length of aeration tank = V/bd = 40 /(3*3.5)

= 3.8 m

Provide 2 baffles gives 3 sections

Length of each tank = 3.8/3= 1.3 mProviding, Thickness of baffle = 0.2 m

Total width = (3*1.3) + (3*0.2) =4.5 m Over all dimensions= 1.3 m* 4.5m * 3.5m Air requirement

Assuming air= 100 m3/day/Kg of BOD removal Airrequired = 0 .311 *(480-30) *100= 5.76 m^3/min

4.12 DESIGN OF SECONDRAY SEDIEMNATIONTANK

Average flow, Q = 0.0036 m^3/s

= 311m^3/day Recalculated

flow = 53 % of Q

Re-circulated flow = 163 m^3/day

Detention period = 2 hours

Total in flow = 311+ 163

= 480m^3/day

Volume of tank = 480*(2/24)

= 40 m^3

Providing liquid depth = 3.5 mSurface loading rate= 30m^3/day/m^2 Area of tank = 311/3.5= 88 m^2 Diameter = 10m

Secondary sedimentation tank = 10 m* 3.5m

VII. CONCLUSION

1. This project focuses on establishing the design parameters for a sewage treatment plant.
2. The design considerations extend to a projected population spanning 12 years, from 2023 to 2035.
3. The insights garnered from this project and its data are instrumental in shaping future sewage treatment plant designs.
4. The plant's design is meticulously tailored to cater to the anticipated needs of a population of approximately 7200 over an extensive timeframe.
5. The reclaimed sewage water undergoes further treatment for various uses including irrigation, fire suppression, and sanitary facilities in public, commercial, and industrial settings. Additionally, if the water meets cleanliness standards, it can contribute to replenishing groundwater levels.

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