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Design of Integration of Waste Water Treatment Plant with Existing Biogas Plant in an Institution

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ABSTRACT: The management of wastewater poses global environmental and economic challenges, demanding innovative solutions. This paper explores integrating biogas production with wastewater treatment to tackle pollution and energy needs concurrently. Anaerobic digestion extracts organic matter to produce valuable biogas, offering renewable energy. Environmental benefits, such as reduced greenhouse gas emissions and improved water quality, are meticulously evaluated. Real-world applications highlight successes and challenges in implementation. The potential scalability of these integrated systems is analyzed to meet growing demands sustainably. In summary, merging wastewater treatment with biogas production offers a compelling path to address pollution and generate renewable energy. This approach promotes environmental sustainability and offers economic benefits, paving the way for a cleaner, greener future.

KEYWORDS: Wastewater Treatment, Biogas Production, Renewable Energy.

I. INTRODUCTION

Waste water treatment is a critical aspect of environmental conservation and sustainability, especially in institutions where significant amounts of wastewater are generated on a daily basis. In order to address this issue and make the most of the resources available, the design of a waste water treatment plant integrated with an existing biogas system is proposed. By combining these two processes, we can effectively treat the wastewater generated by the institution while also harnessing the energy potential of the biogas for various purposes. This integrated system not only helps in reducing the environmental impact of the institution but also provides a sustainable source of energy that can be used for heating, electricity generation, or even as a fuel source. With the right design and implementation, this integrated waste water treatment plant can help the institution become more self-sufficient, reduce its carbon footprint, and contribute to a cleaner and healthier environment for all. Let's explore the possibilities and benefits of this innovative approach to waste water treatment.

1.1 OBJECTIVES

The main objective of this paper is to maximize the utilization of organic waste and waste water resources, to create plan, elevation and 3D model of water treatment plant using AutoCAD and Revit software and to integrate the waste water treatment plant with existing biogas plant



II. TESTING OF WASTE WATER FROM AN INSTITUTION`

SL.NO	PARAMETERS	RESULT	P ERMISSIBLE LIMIT	REMARKS
1.	PH	6.97	7-8.5	Slightly acidic
2.	TOTAL SUSPENDED SOLIDS	208 mg/l	30 mg/l	High levels of particles and organic matter
3.	COD	220 mg/l	250-500 mg/l	High amount of organic pollutants
4.	BOD (3 DAYS AT 27°C)	101.92 mg/l	30 mg/l	
5.	TURBIDITY	80 NTU	5NTU	water-cloudy, high amount of suspended particles
6.	CHLORIDE AS CL ⁻	25.62 mg/l	600 mg/l	Low amount of chloride
7.	DISSOLVED OXYGEN	nil		Oxygen deprived
8.	TOTAL NITROGEN AS 'N'	12.6 mg/l	2-6 mg/l	Nitrogen compound leads to eutrophication

III. DESIGN PARAMETERS

3.1. Design population

For the waste water treatment plant design a population for institution

Total population of institution = 3810

Per capita demand = 45litre/person/day, Sewage demand = 80%

Water demand = 0.002015cubic metre & peak factor = 3

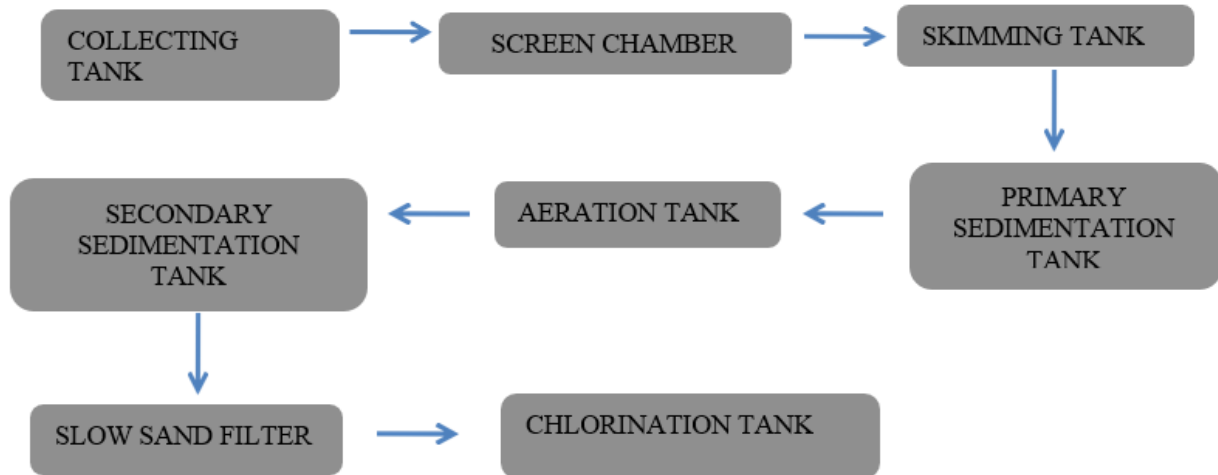
Maximum Discharge = 417960 Litre/day

3.2. Calculation for Diameter of Inlet and Outlet Pipe

Design consideration

SL NO	DESIGN PARAMETERS	VALUES	UNIT
1	Discharge	417960	Litre/day
2	Velocity of inlet pipe	2	m/sec
3	Velocity of outlet pipe	3	m/sec
4	Volume of efficiency	94	%
5	Diameter of inlet pipe	0.150	m
6	Diameter of Inlet pipe	0.180	m
7	Actual Discharge	0.0522	m/sec

IV. DESIGN OF WASTE WATER TREATMENT PLANT



4.1. DESIGN FOR COMPARTMENT OF WASTE WATER TREATMENT PLANT

4.1.1 Screening: Screening is the very first operation carried out waste water treatment plant and consist of passing the waste water through different types of screens. The screening usually contains some quantity of organic materials, which may purify and become offensive, and must , therefore be disposed of by incineration. The screen is needed to trap the floating matters like sachets, plastic, milk packets, groceries bags etc. Coarse screen is made of steel bars, fixed parallel to one another at desired spacing on rectangular steel frame and are called as bar screen.

Design consideration

SL NO	DESIGN PARAMETERS	VALUE	UNITS
1	Peak discharge of sewage	0.0048375	m ³ /sec
2	Velocity	0.8	m/sec
3	Vertical projected area of screen	0.0060	m ²
4	Thickness	10	Mm
5	Clear spacing	20	mm
6	Area	0.009	m ²
7	Horizontal gross sectional area of screen	0.0127	m ²
8	Width of screens	0.62	m
9	Assuming depth	0.9	m

4.1.2. Skimming Tank: Skimming tanks are provided for removing oils and grease from the sewage constructed before the sedimentation tanks.. In skimming tank air is blown along with chlorine gas by air diffuser placed at the bottom of the tank. The rising air tends to coagulate and solidify the grease and cause it to rise to the top of the tank whereas chlorine destroys the protective colloidal effect of protein, which holds the grease in emulsified form. The greasy materials are collected from the top of the tank and the collected are skimmed of by specially designed mechanical equipment.



Design consideration

SL NO	DESIGN PARAMETERS	VALUE	UNIT
1	Rate of flow	417960	Litre/day
2	Rising velocity	360	m/day
3	Breadth	0.5	m
4	Length	0.6	m
5	Velocity	0.671	m/sec
6	Area	0.072	m ²
7	Depth	1	m

4.1.3 Sedimentation Tank: Sedimentation or setting tank that receive raw waste water prior to biological treatment. The objective of primary sedimentation tank is to remove readily settleable organic solids and floating material and thus reduce the suspended solid content efficiently designed and operated sedimentation tank should remove from 50 to 70 % the suspended solids and 25 to 40% of the BOD.

Design consideration

SL NO	DESIGN PARAMETERS	VALUE	UNIT
1	Diameter	5	m
2	Depth	3.5	m
3	Hydraulic detention time	2	hr
4	Volume of tank	17.41	m ³
5	Surface loading rate of average flow	25	m ³ /m ² /day
6	Surface area to be provided	16.71	m ²
7	Actual area provided	19.63	m ²
8	Weir loading	26.41	m ³ /day/m
9	MLSS	3000	mg/l
10	Total solids in flow	1880.88	kg/day
11	Solid loading	112.5	kg/day/m ²
12	Average flow	417.96	m ³ /day

4.1.4. Aeration tank: Aeration tank is the mixing and diffusing structure in the activated sludge plant.. Air is introduced continuously to the tank. Combined Aeration type aerators having the diffused air aeration as well as mechanical aeration together in a single unit are used

Design consideration

SL NO	DESIGN PARAMETERS	VALUE	UNIT
1	Discharge	417.96	m/day
2	Min efficiency required	90	%
3	Total length	8.1	m
4	Breadth	5	m
5	No of divisions	2	Nos
6	Aeration period	7	Hour
7	Return sludge ratio	0.50	-
8	Oxygen applied in tank	3	-
9	Generator	1	5Hp
10	Hp required	2.3	KW
11	Volume	118.329	m ³
12	Motor	1 Hp	Nos



4.1.5. Slow Sand Filter: Slow sand filters are used in water purification for treating raw water to produce a portable product.

Design Consideration

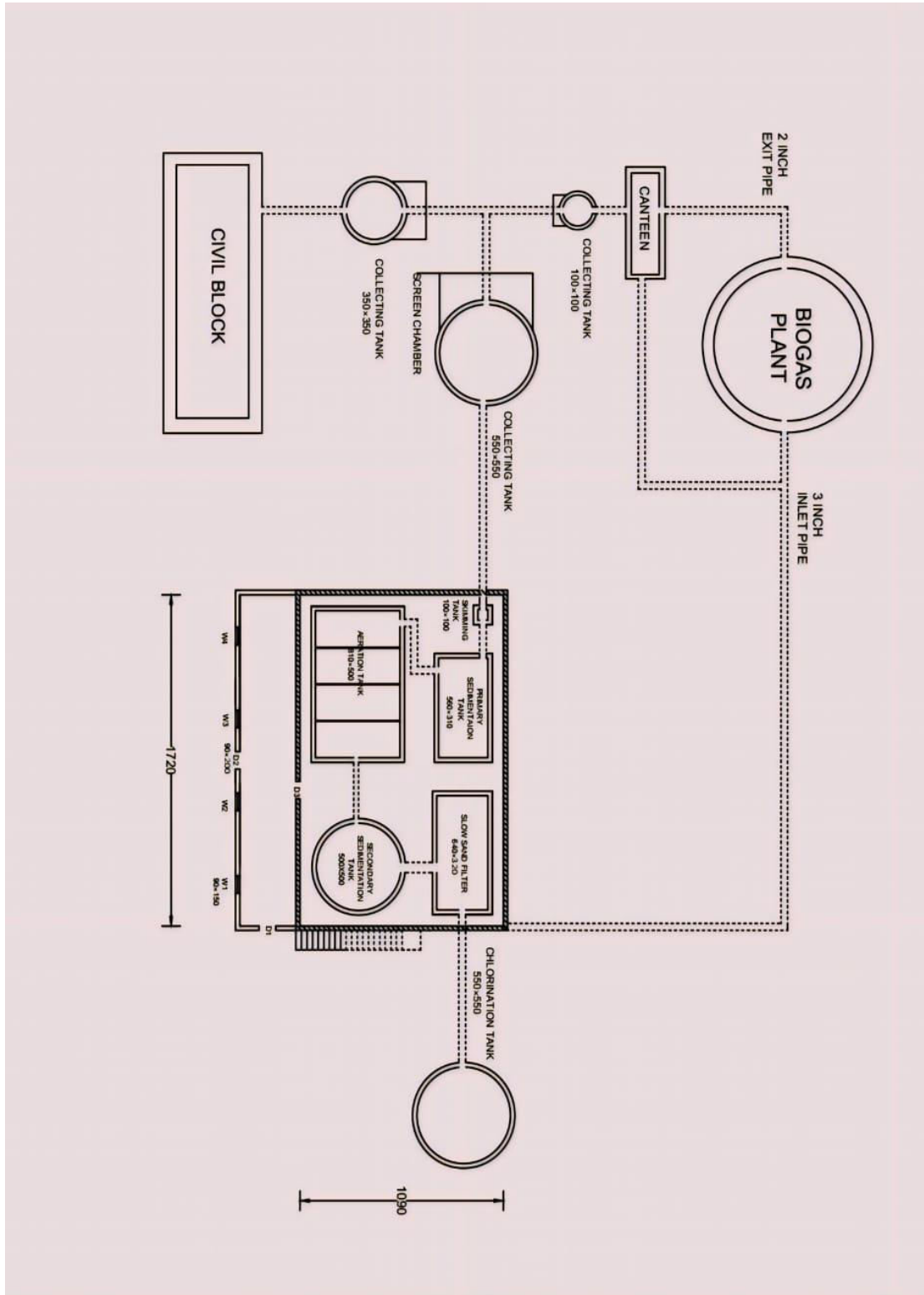
SL NO	DESIGN PARAMETERS	VALUE	UNIT
1	Discharge	417.96	m/day
2	Breadth	3.2	m
3	Length	6.4	m
4	Area of each filter unit	20.5	m ²
5	Rate of filtration	170	l/m/hr
6	Total surface area of filter required	120.5	m
7	depth	5	m ²

4.1.6. Chlorination Tank: Microorganisms can be found in raw water from rivers, lakes and groundwater. While not all microorganisms are harmful to human health, there are some that may cause diseases in humans. These are called pathogens. Pathogens present in water can be transmitted through a drinking water distribution system, causing waterborne disease in those who consume it. In order to combat waterborne diseases, different disinfection methods are used to inactivate pathogens. Chlorine is an efficient chemical liquid that destroys bacteria and is added to public water supplies to kill disease causing pathogens such as bacteria, viruses that commonly grow in water supply reservoirs and in storage tanks.

Design Consideration

SLNO	DESIGN PARAMETERS	VALUE	UNIT
1	Discharge	17.415	m ² /hr
2	Volume	69.66	m ²
3	Diameter	5.5	m
4	Area	23.75	m ²
5	Desired chlorine concentration	0.2	ppm
6	Contact time	2	hrs
7	Dosage rate	6.996	mg/m ³

V. PLAN & 3D DRAWING OF STRUCTURE



AutoCAD drawing of waste water plant

This drawing shows the integration of existing biogas plant with the water treatment plant .The biogas plant is used for the generation of cooking gas in the institution



3D drawing of waste water treatment plant using Revit

VI. CONCLUSION

The wastewater treatment plant has seamlessly integrated various environmental engineering principles to develop a solution for managing campus wastewater. Through field visits, experimental analyses, and advanced design software, a comprehensive plan has been tailored to the institutions infrastructure needs while promoting environmental stewardship. Notably, the exploration of biogas technology adds a renewable energy component to the plant, contributing to a circular economy on campus. This paper not only reduces our environmental impact but also serves as a model for other institutions seeking \ water management solutions..

VII. FUTURE SCOPE

The spent sand which is contaminated and scooped out from the slow sand filter can be reconditioned and reused after using advanced methods so we can make the project sustainable.

REFERENCES

1. Shubham singh, shubh Kant Yadav “Study and Analysis of Biogas Production from Sewage Treatment Plant and Design Anaerobic Digester” (2022).
2. Jayalekshmi S J, Minnu Biju, Jithin Somarajan, PE Muhammad Ajas “ Wastewater Treatment Technologies: A Review” (2021).
3. Zahra Aghalari, Hans- Uwe Dahmas, Mika Sillanpaa Juan Eduardo Sosa- Hernandez, Roberto Parra- Saldivar . “Effectiveness of waste water treatment in removing microbial agents: a systemic review” (2020).
4. Akash Deep Singh, Apporva Upadhyay, Sandeep Shrivastava, Vivekanad Vivekanand “Life-cycle assessment of sewage sludge-based large-scale biogas plan”(2022)
5. Andersson, K., Rosemarin, A., Lamizana, B., Kvarnström, E., McConville, J., Seidu, R., Dickin, S., Trimmer, C., . “Sanitation, Wastewater Management and Sustainability: from Waste Disposal to Resource Recovery. Nairobi and Stockholm” (2016)
6. Guest, J.S., Skerlos, S.J., Barnard, J.L., Beck, M.B., Daigger, G.T., Hilger, H., Jackson, S.J., Karvazy, K., Kelly, L., Macpherson, L., Mihelcic, J.R., Pramanik, A., Raskin, L., Van Loosdrecht, M.C.M., Yeh, D., Love, N.G., “A new planning and design paradigm to achieve sustainable resource recovery from wastewater. Environ. Sci. Technol. 43, 6126– 6130. <https://doi.org/10.1021/es9010515> 60. ” (2019)
7. Gurieff, N., Bruus, J., Nielsen, B., Nawawi-Lansade, D., Cantegril, M., “Moving towards an energy neutral WWTP –

- the positive impact of Exelys™ continuous thermal hydrolysis in achieving this goal. *Water Pract. Technol.* 7. <https://doi.org/10.2166/wpt.2012.03461>” (2012)
8. Gurung, K., Tang, W.Z., Sillanpää, M., “Unit Energy Consumption as Benchmark to Select Energy Positive Retrofitting Strategies for Finnish Wastewater Treatment Plants (WWTPs): a Case Study of Mikkeli WWTP. *Environ. Process.* 5, 931.” (2012)
9. Puyol, D., Batstone, D.J., Hülsen, T., Astals, S., Peces, M., Krömer, J.O., Arora, P.K., Singhal, N., Kumar, S., “Resource Recovery from Wastewater by Biological Technologies: Opportunities, Challenges, and Prospects. *Front. Microbiol.*” (2017)
10. Raheem, A., Sikarwar, V.S., He, J., Dastyar, W., Dionysiou, D.D., Wang, W., Zhao, M., “Opportunities and challenges in sustainable treatment and resource reuse of sewage sludge: A review. *Chem. Eng. J.* 337, 616–641” (2018)
11. Jaffar Abdul Khaliq S, Ahmed M, Al-Wardy M, Al-Busaidi A, Choudri BS. “Wastewater and sludge management and research in Oman: an overview” (2017).



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