

A System Design for Solid Waste Management and Cogeneration of Gas with Waste Activated Sludge

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Abstract: Disposal of biodegradable waste has become a stringent waste management and environmental issue. As a result, anaerobic digestion, has become one of the best alternative technologies to treat the municipal solid wastes and can be an important source of bio energy. This study focuses on the design various set up required for treating solid waste using waste activated sludge. The evaluation of biogas and methane yield from the digestion and co-digestion of mixtures of Waste Activated Sludge and Solid Waste is a dual advantage in this treatment process. An alternative treatment strategy for solid waste is anaerobic biological treatment, either in anaerobic digesters or in landfill bioreactors. Anaerobic biological treatment can be a sustainable alternative to current disposal strategies because it reduces the volume of Solid Waste, stabilizes it, produces a residue that can be used for soil conditioning, and recovers energy from Solid Waste in the form of methane.

Keywords: Disposal, Solid Waste, Activated Sludge, Sewage, Digestion, Anaerobic Digestion.

I. INTRODUCTION

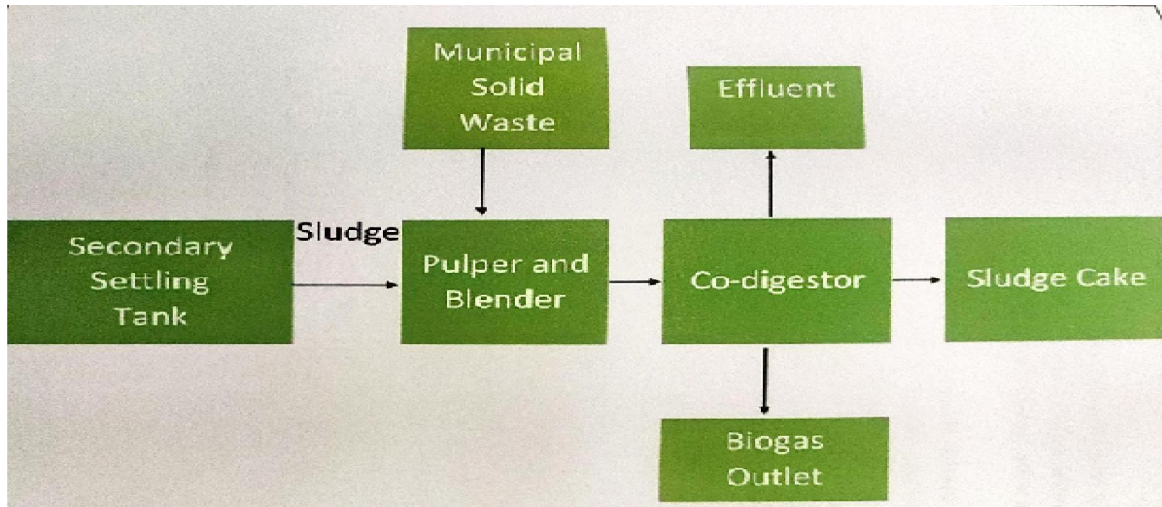
The Activated Sludge is generated in huge amount from the secondary settling tank. Only of it is 20-30 % reused for Activated Sludge Process. The unused sludge is sent to the digester for its anaerobic digestion which liberates energy in the form of methane. The sludge from the digester is then dried and sent to solid waste incineration sites. This Waste activated sludge contains active micro-organisms. It has the efficiency to digest any type of waste with the help of active microorganisms. The solid waste on the other side is disposed of by different methods of land filling, incineration and composting. Land filling and composting require more space whereas land filling and incineration require more energy for the disposal of the solid waste.

All the processes are having certain disadvantages to the environmental and human health. Modern land filling methods may not ensure proper protection to the groundwater always. Thus, a new environment friendly method should be used for the treatment of the solid waste.

II. METHODOLOGY

If solid waste is mixed with waste activated sludge and kept for digestion under anaerobic conditions, the active micro-organisms will digest the solid waste liberating high amount of energy in the form of methane. This AD process of digestion of waste activated sludge with solid waste can prove to be very beneficial as it will reduce the waste and gain energy from it. Waste activated sludge is almost liquid of the total volume and the total solid contains the sediments of various waste coming from domestic areas. The sediments are form by settling tanks of vast size. It can be continuing type of settling tank or fill and draw type of settling tanks.

The Main function of this settling tanks to separate the semimetal sludge from the overall liquid waste. Thus, the modify the design of STP for the proper digestion process of both wastes activated sludge and SW. The SW will be crushed and mixed with the waste activated sludge to obtain a waste mixture liquor A huge mixer is designed for this cutting and mixing process. The waste mixture from the mixer is conveyed to sludge digestion tank further digestion. All processes carried out are anaerobic in nature. The energy through the digestion of these wastes liberates in the form of CO₂ and CH₄



Design of Treatment Process and its Components:

Following is the working mechanism of the system



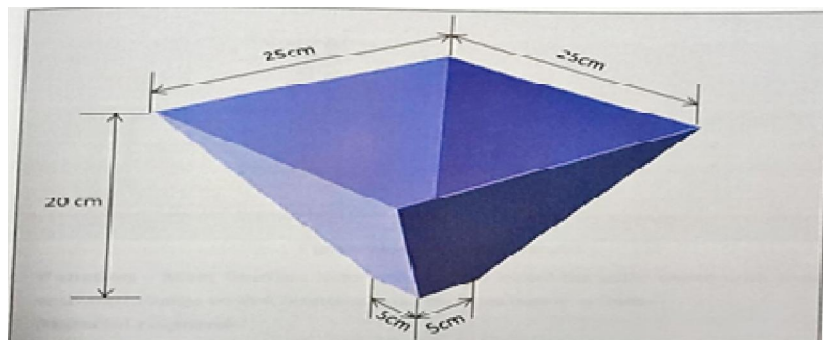
The above picture shows that final design after the completion of all trial-and-error experimentation and sampling of material such as waste activated sludge and various types of solid waste. The overall model is painted with pure black colour. The intension of putting black colour on the model is to make the optimum temperature within the co-digester. Hence, the increase in temperature will occur with time and the reduction in volume of waste will be caused. The waste mixture of solid waste such as onion waste, decayed tomatoes, brinjal and small amount of cow dung with 20% waste activated sludge of total volume is then filled into the sludge digestion tank for further digestion. All the processes carried out are anaerobic in nature.

The energy through the digestion of these wastes liberates in the form of C02 and CH4 The waste is initially digested and the mixture in the form of liquor is transferred to the co digester. Due to the application of black coat on the Co digester the increase in temperature slowly occur, at a certain time the temperature causes the generation of thermophile bacteria and other considerable anaerobic bacteria which will sustain daily digestion process. The tyre tube which is used for gas collection is provided with gas regulatory valve. In this case, after this process the action of micro-organisms like protozoa; algae, fungi, etc are finished out.

The waste activated sludge from the secondary settling tank has to be mixed with biodegradable solid waste for the digestion process. Thus, a blending unit is established for crushing and mixing the solid waste with the waste activated sludge. After mixing the sludge and solid waste, the mixture is conveyed to co digester for anaerobic treatment of mixture. The solid waste will be crushed and mixed with waste activated sludge to obtain waste mixture liquor. A sizable mixer is designed for the cutting and mixing process. The activated sludge process of digestion of waste sludge with solid waste can prove to be very beneficial and it will reduce the waste and also, we can gain energy from it. It digests the waste and liberates bio energy which results in advantageous disposal of it.

III. SYSTEM COMPONENTS

A) Funnel:



The funnel in the model represents the secondary settling tank which stores the activated sludge and conveys it forward for further treatment. This rectangular section will be decreased in size to the lower circular section this help to form a conical shape this funnel. A funnel is a tube or pipe that is wide at the top and narrow at the bottom, used for guiding liquid or powder into a small opening. Funnels are usually made Of stainless steel

Function - Storing Waste Activated Sludge

Material required - MS Sheet

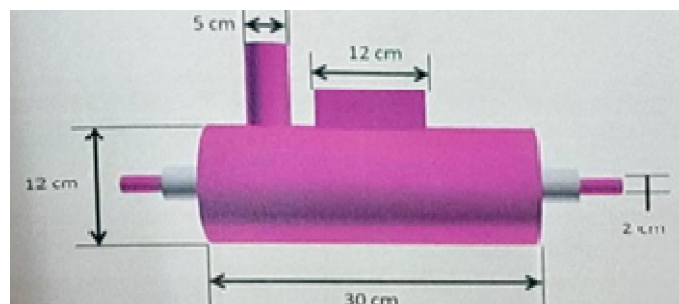
Sub-Components - The funnel is provided with valve to regulate the flow of waste activated sludge.

Capacity - 3 liters

Dimension - Upper Size - 25cm x 25 cm, Lower size-5 cm x 5cm

b) Pulper and Blender:

A unit is established for the crushing of solid waste and mixing it with waste activated sludge. This unit helps reducing size of the solid waste and help gaining efficiency in liberation of energy. Blender is a laboratory appliance used to mix, purée, or emulsify food and other substances. A stationary blender consists or a blender jar with a rotating metal blade at the bottom powered by an electric motor in the base. Function - Main function is to crushed and blends the solid waste with waste activated sludge so that homogeneous mixture liquor is form. Material required - MS Sheet, MS Blades, Single Phase Motor, MS Shaft, Bearings, Sub-Components - The blender is provided with solid waste inlet and the main outlet for mixture liquor. Capacity - 4 litres, Dimension - Diameter - 12cm, Length - 30cm.

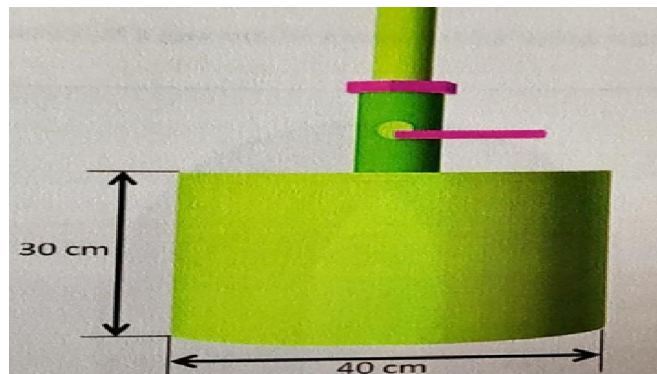


c) Co-Digester:

The digester is the unit where anaerobic reactions take place and digest the waste activated sludge in normal sewage treatment plants. The same process is required for the digestion of mixture of waste activated sludge and solid waste. As both of these wastes are to be digested together in a single container, it is called co-digester. A digester is a huge vessel where chemical or biological reactions are carried out.

Function-The main function of co digester is to carryout anaerobic digestion of mixture of liquor and liberates energy in the form of useful gases. These gas compounds are generally collected under the dome of digester and then filtered and supplied.

Material required-MS Sheet, Sub Components-Outlet for effluent and dry sludge are provided, Capacity-10 litres, Dimensions-diameter-40 cm, Height-30 cm.



d) Gas Collector:

The characterization gas collecting tube describes an oblong container with one valve at either end-Gas collecting tubes are for science-related purpose, for taking samples of gases. The mass density of a gas can be measured by using a gas collecting tube. The Gas collecting tube describes an oblong gas-tight container with one valve at either end-The Capacity of gas collecting 150, 250, 350, 500 and 1000 ml-usually such container has a gauged volume and a cylindrical shape made up of glass The characterization gas collecting tube describes an oblong container with one valve at either end-Gas collecting tubes are for science-related proposes for taking samples of gases. The mass density of a gas can be measured by using a gas collecting tube

Function - To collect the bio-gas Material - Rubber Tyre Tube

Capacity - 30 psi

Dimension - Diameter - 2 inches



e) Gas Burner:

A gas burner is a device that produces a controlled flame by mixing a fuel gas such as acetylene, natural gas, or propane with an oxidizer such as the ambient air or supplied oxygen, and allowing for ignition and combustion.

The flame is generally used for the heat, infrared radiation, or visible light it produces. Some burners, such as gas flares, dispose of unwanted or uncontainable flammable gases. Gas burner is a device to generate a flame to heat up products using a gaseous fuel such as acetylene, natural gas or propane. The gas burner has many applications such as soldering, brazing, and welding, the latter using oxygen instead of air for producing a hotter flame, which is required for melting steel. Methane flame temperature in air 1950 oc

Function – To ensure the generation of gas in co-digester Sub-Components—Gas pipe

f) Flow Meter:

A flow meter is a device used to measure the volume or mass of a gas or liquid. Flow meters are referred to many names such as flow gauge, flow indicator, liquid meter, flow rate sensor etc. depending on the particular industry manufacturing. However, they all measure now, Open channel, like river or streams, and may be measured with flow meters. More frequently the flow meters are used to measure gases and liquid in the pipe. Improving the precision, accuracy, and resolution of fluid measurement ore the greatest benefits of the best now meters, there are three main meter styles for now measurement: Positive displacement meters collect a fixed volume of fluid, then release and refill the fluid, then tally how many times the volume is filled to determine flow. A gas meter is a specialized flow meter, used to measure the volume of fuel gases such as and liquefied petroleum gas. Gas meters are used at residential, commercial, and industrial buildings.



IV. CARE & MAINTENANCE OF THE SYSTEM

Care and maintenance is important at the point of fabrication work and during operation of the system. If there is no use of care more accidents will occur and efficiency of the system will be reduced due to loss of power.

Following care should be taken while doing the work-

First set the proper sequence of assembly. Before starting the machine, we must check the fitting of nut, bolts of whole machine to avoid maximum vibration. Gearing, oiling of bearing & rotating part should be done weekly, Tension in the belt should be checked monthly. The insulation of wire electric motor should be checked periodically.

V. COST ESTIMATION OF SYSTEM

Material

Sr.No	Name of component	Material	Quantity	Cost in RS
1	MS Angle Frame	MS	50 Kg	600
2	MS Sheet Metal	MS	1 Sheet	400
3	Shaft 20 mm Diameter	MS	1 set	350

4	Single Phase Motor	STD	1 sct	4500
5	Ball Valve	STD	2 Nos.	800
6	Pipe 2.5" Diameter	GI	1 No.	200
7	Belt	STD	1 No.	50
8	Bearing	CI	2 Nos.	200
9	Pulley	CI	2 Nos.	150
10	Nut Bolt Washer M 10	MS	20 Nos.	60
11	Cutter	MS	1 Nos.	200
			Total	7510

Labours:

Sr.No	Operation	Hours	Rate/labour	Amount
1.	Turning		1	250
2	Drilling	1	1	200
3	Welding	2	2	200
4	Grinding	1	1	100
5	Tapping	2	2	100
6	Gas cutting	2	2	200
7	Assembly	1	1	200
8	Painting	1	100	250
			Total	1500/-

Grand Total cost=Rs.9010/

VI. COMPARISON BETWEEN NANO BIOGAS AND MODIFIED SOLID WASTE MANAGEMENT SYSTEM

Sr.No	Parameters	Domestic biogas plant	Modified system
1	Average capacity	10 liters	10 liters
2	Efficiency	Less	More
3	Cost	35000/-	9010/-

4	Handling	Depends on handling of people	Easy
5	Maintenance cost	More	Less
6	Type of waste required	All organic Biodegradable	All organic Biodegradable and activated sludge

VII. CONCLUSION

In this paper, a novel treatment method of disposal of solid waste and waste activated sludge is designed for the community. This modified management system has become a necessity for the urban community. The modified treatment plant becomes an easy provision of manure for agriculture and CH₄ for domestic and industrial purpose. The co-digestion concept involves the treatment of several types of waste in a single treatment facility. The mixing of several waste types has positive effects both on the anaerobic digestion process itself and on the treatment economy. The profit of co digestion in the anaerobic degradation process is mainly due to the increased methane yield and improved process stability. Co-digestion of the Solid Waste and sludge from a sewage treatment plant (STP) suggests an integrated waste and waste-water treatment. Sludge is one of the most appropriate co-substrates for co-digestion with Solid Waste. In this way, co-digestion can be applied at existing treatment facilities without great investment and by use of simple and cost-effective components.

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