TECHNICAL DETAILS & WORKING OF BIOGAS PLANT

BIOWASTE TO BIO ENERGY PROJECT

CAPACITY: 2-3 Kg waste per day

Client :

Design, Engineering, Manufacture and Supply By

Yadi Infra Works Pvt Ltd

स्वच्छ भारत

एक कदम स्वच्छता की ओर

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Client:

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1. PROJECT BACKGROUND

Solid Waste management is a process of treating biological waste and to produce liquid waste suitable for discharge to the environment or for reuse with some bi-products. The process of biological treatment can be done either by aerobic fermentation or by anaerobic fermentation. Due to high running cost for aerobic treatment anaerobic treatment is usually promoted which can produce Biogas and manure which can be used as fertilizer.

Biogas is produced by anaerobic digestion or fermentation of biodegradable materials such as biomass, manures, sewage, municipal waste, green waste, and plant material and energy crops. This type of biogas comprises primarily methane and carbon dioxide. Anaerobic digesters also function as a waste disposal system, even for human waste, and can, therefore, prevent potential sources of environmental contamination and the spread of pathogens. Industries and institutions are also made possible, from the sale of surplus gas to the provision of power for industry; therefore, biogas may also provide the user with income generating opportunities.

The true degree of effectiveness of biogas plants and consequently their profitability is in the maximum possible utilization of annual hours of full capacity use. Procurement of highest-quality components reduces downtime to a minimum. Profitable biogas plants provide additional yield from constant full capacity running with cost savings achieved from a low degree of downtime. In this way, it is possible to achieve a working life of 10 years or more with a biogas plant.

The proposal for 2-3 kg solid bio waste treatment plant has been designed based on the biowaste characteristics provided by the client.

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2. DESIGN BASIS

The Waste Treatment

Waste Type	: Food waste
Waste generated from	: Hostel
Waste generated/ day	: 2-3 kg waste /day

Plant has been designed based on the following parameters.

1. **Technical details of biogas**

1.	1 cum Bio Gas is	=	0.5 kg LPG (Approximate)
2.	"	=	Firewood 3.5 kg
3.	"	=	Cow dung cake 12.3 kg
4.	"	=	Diesel 0.5 liter

2) TECHNICAL DETAILS OF THE PROPOSED TREATMENT PLANT

a.	Process	: Anaerobic Digester
b.	Reactor	: Vertical Reactor prefabricated portable
c.	Reactor Type	: Stirred type
	Land required for the Plan	:1.2 Sq. meters
d	Design	: Floating drum
e	Extraction System	: Flooding Type Automatic with Respect to Fresh Feed
f	Digester Capacity	:1 Cum
g	Treatment Capacity per Day	2-3 kg Biowaste

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i.	Gas Production	: 0.25 LPG equivalent gas
j.	Structure	: Digester above ground
k.	Holder Movements	: Horizontal Type
l.	Moisture Trap	: Inline – 1
m.	Feed	: Food waste
n.	Output	: Biogas (Ch4+C02) + Slurry With >95% Water and Very

Small Suspended Undigested Particles. - Provision For Outlet of the Treated Waste (Liquid Slurry) From the Outlet Be Connected To Drainage

o.	Digester Wall Thickness	: 1.6 mm
p.	Gas Holder	: FRP made
q.	Inlet Pipe & Outlet Pipe	: Sudhakar Make PVC Pipe
r.	Gas Line Trap	:flexible PVC Pipe Channelled Connection With Moisture
s.	Scum Breaker	: MS Made Coated With FRP coated

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Specifications/Standards:

1. Treatment Capacity - 2-3kg of bio waste per day
2. Inlet devices food waste with PVC pipe 4" 6 Gauge
3. Rubber hose, stove and control valve with ISI mark
4. Gas holder 4 layered fiber reinforced plastic

Chemical Coating

1. Polyester ISO Resin
2. Polyester ISO Resin Gelcoat
3. Glass fiber mat 600E
4. G.I pipe with Gas holder B-CLASS 3" pipe

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3.TECHNOLOGY

Anaerobic fermentation is the technology used in this treatment plant.The anaerobic fermentation technology has been used for years for the production of biogas plant. The technology may be used for industrial as well as municipal wastewaters. Different models have been developed by different countries on the basis of their requirement. **We** adopt KVIC floating drum model which has been developed by Khadi and Village Industries Commission and it's an approved model of Ministry of New & Renewable Energy, Government of India. The advantage of this model is its low construction cost, high efficiency and can be used for wide range of waste.

The process

There are a number of microorganisms that are involved in the process of anaerobic digestion including acetic acid-forming bacteria and methane-forming methanogens. These organisms feed upon the initial feedstock(cow dung and previous slurry), which undergoes a number of different processes converting it to intermediate molecules including sugars, hydrogen, and acetic acid, before finally being converted to biogas.

Different species of bacteria are able to survive at different temperature ranges. Ones living optimally at temperatures between 35–40 °C are called mesophiles or mesophilic bacteria. Some of the bacteria can survive at the hotter and more hostile conditions of 55–60 °C, these are called thermophiles or thermophilic bacteria. Methanogens come from the domain of archaea. This family includes species that can grow in the hostile conditions of hydrothermal vents. These species are

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resistant to heat and can therefore operate at high temperatures, a property that is unique to thermophiles.

As with aerobic systems the bacteria in anaerobic systems the growing and reproducing microorganisms within them require a source of elemental oxygen to survive. In an anaerobic system there is an absence of gaseous oxygen. Gaseous oxygen is prevented from entering the system through physical containment in sealed tanks. Anaerobes access oxygen from sources other than the surrounding air. The oxygen source for these microorganisms can be the organic material itself or alternatively may be supplied by inorganic oxides from within the input material. When the oxygen source in an anaerobic system is derived from the organic material itself, then the 'intermediate' end products are primarily alcohols, aldehydes, and organic acids plus carbon dioxide. In the presence of specialized methanogens, the intermediates are converted to the 'final' end products of methane, carbon dioxide with trace levels of hydrogen sulfide.In an anaerobic system the majority of the chemical energy contained within the starting material is released by methanogenic bacteria as methane.

Populations of anaerobic microorganisms typically take a significant period of time to establish themselves to be fully effective. It is therefore common practice to introduce anaerobic microorganisms from materials with existing populations, a process known as "seeding" the digesters, and typically takes place with the addition of sewage sludge or cattle slurry.

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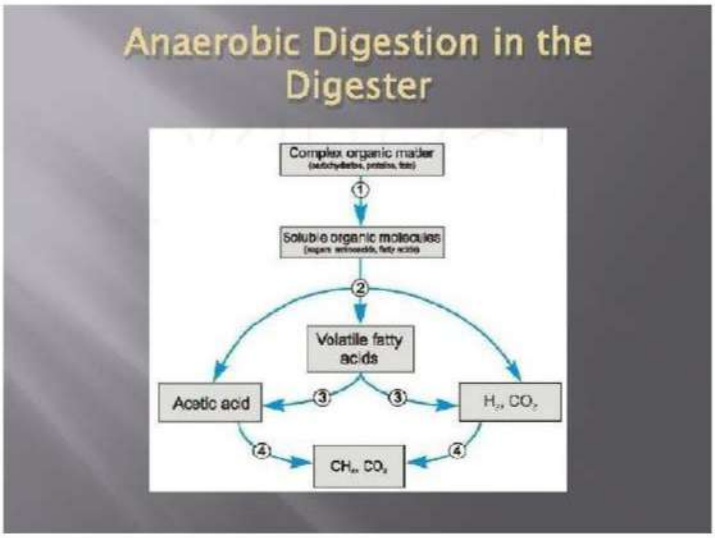

The key process stages of anaerobic digestion

There are four key biological and chemical stages of anaerobic digestion:

1. Hydrolysis
2. Acidogenesis
3. Acetogenesis
4. Methanogenesis

In most cases biomass is made up of large organic polymers. In order for the bacteria in anaerobic digesters to access the energy potential of the material, these chains must first be broken down into their smaller constituent parts. These constituent parts or monomers such as sugars are readily available by other bacteria. The process of breaking these chains and dissolving the smaller molecules into solution is called hydrolysis. Therefore hydrolysis of these high molecular weight polymeric components is the necessary first step in anaerobic digestion. Through hydrolysis the complex organic molecules are broken down into simple sugars, amino acids, and fatty acids.

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Acetate and hydrogen produced in the first stages can be used directly by methanogens. Other molecules such as volatile fatty acids (VFA's) with a chain length that is greater than acetate must first be catabolised into compounds that can be directly utilised by methanogens.

The biological process of acidogenesis is where there is further breakdown of the remaining components by acidogenic (fermentative) bacteria. Here VFAs are created along with ammonia, carbon dioxide and hydrogen sulfide as well as other by-products. The process of acidogenesis is similar to the way that milk sours.

The third stage anaerobic digestion is acetogenesis. Here simple molecules created through the acidogenesis phase are further digested by acetogens to produce largely acetic acid as well as carbon dioxide and hydrogen

The terminal stage of anaerobic digestion is the biological process of methanogenesis. Here methanogens utilise the intermediate products of the preceding stages and convert them into methane, carbon dioxide and water. It is these components that makes up the majority of the biogas emitted from the system. Methanogenesis is sensitive to both high and low pHs and occurs between pH 6.5 and pH 8. The remaining, non-digestible material which the microbes cannot feed upon, along with any dead bacterial remains constitutes the digestate.

Biogas is the ultimate waste product of the bacteria feeding off the input biodegradable feedstock, and is mostly methane and carbon dioxide, with a small amount hydrogen and trace hydrogen sulphide. (As-produced, biogas also contains water vapor, with the fractional water vapor volume a function of biogas temperature).[Most of the biogas is produced during the middle of the digestion, after the bacterial population has grown, and tapers off as the putrescible material is exhausted. The gas is normally stored on top of the digester in an inflatable gas bubble or extracted and stored next to the facility in a gas holder.

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Typical composition of biogas	
Matter	%
Methane, CH_4	50–75
Carbon dioxide, CO_2	25–50
Nitrogen, N_2	0–10
Hydrogen, H_2	0–1
Hydrogen sulfide, H_2S	0–3
Oxygen, O_2	0–2

4. ADVANTAGES OF KVIC Model

ROBUSTNESS AND OPERATIONAL RELIABILTY

1. Stable under large load variations
2. Tolerant to disturbances
3. Recovery very quickly after major upsets
4. No Clogging of reactors
5. No risk of Sludge Bulking
6. Excellent Strength to retain high pressure of Gas
7. Expert Fabrication
8. Customized Design & Fabrication
9. Long Life
10. Cost Effective
11. Easy Maintenance

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5. PROCESS DESCRIPTION

The proposed system consists of following stages:

Feeding at the Inlet tank

Inlet tank is connected to the digester. The feeding process is carried out through inlet. This feed directly enters to the digester where the anaerobic digestion takes place.The feed and water need to mixed in 1:1 proportion and then feed into the Digester Inlet .

Treatment inside the Digestion chamber

The digester mainly consists of a digestion chamber and a gas holder. The feed directly enters the digester where the reaction carried out is an anaerobic digestion (in the absence of oxygen). The size of the digester is designed on the basis of kitchen waste and quantity of waste. Only the waste which completes its HRT (Hydraulic Retention Time) will be coming out of the digester as slurry. As the part of digestion methane gas will be formed which will be collected in the gas holder.

Slurry pumping at the Outlet tank

Digester is connected to an outlet tank in which slurry can be collected. This slurry can be directly used as fertilizer or can be connected to drainage.

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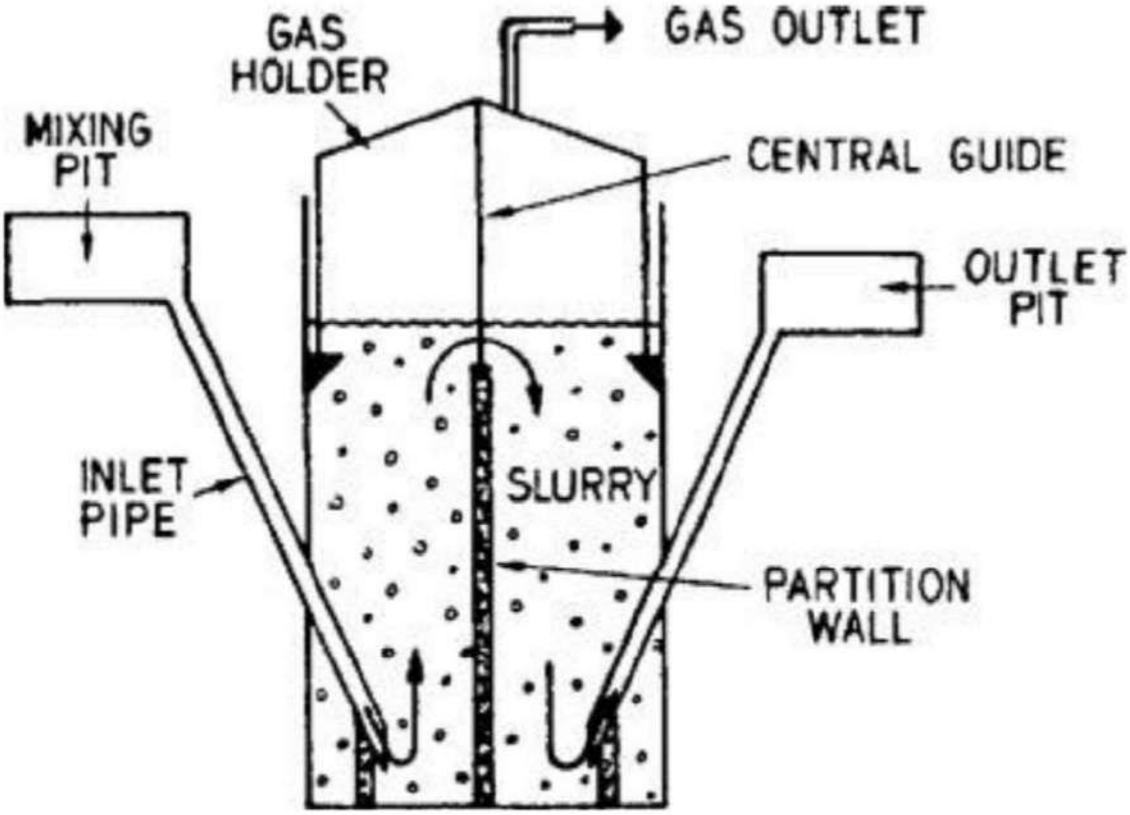
Floating Drum Biogas Plant Working Diagram



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DO's and DON'Ts in Operating Biogas Plant:

Do's:-

- Biogas plant/ Bio-Digester should be placed in open area of smooth & even surface to avoid any physical damage.
- Biogas plant must be filled with cow dung as inoculum for initial start-up only.
- Biogas plant should be fed daily without fail for the proper operation of the plant.
- Solid organic wastes such as vegetable waste, food waste, fruit peels must be mixed with water in a ratio of 1:1 before feeding into the biogas plant.
- The particle size of the solid waste should be below 25 mm.
- The liquid organic wastes like leftover milk, curd, rice wash water, dhal wash water, kanji waste water etc can be directly fed into the digester.
- The gas hose piping from the biogas plant to the kitchen biogas stove is recommended to be in a tapered position.
- Slurry from the biogas plant should be diluted with water before using it as fertilizer.
- Water in the outer water jacket portion must be checked at regular time intervals in order to make sure that the water level is not falling down.
- Proper amount of waste must be fed into the biogas plant as recommended.

Don'ts:-

- Do not over feed the biogas plant as it creates acidity & reduction in microbial population.
- Avoid feeding chemicals, acid (avoid acidic substances like tamarind & Citrus fruit wastes), plastics, papers, glass & rubber into the biogas plant which will affect the biogas plant functioning by killing methanogenic microbes.
- Avoid feeding more waste into the biogas plant if the previously generated biogas is not used and is stored in the gas holder.

Regards

Udaykiran

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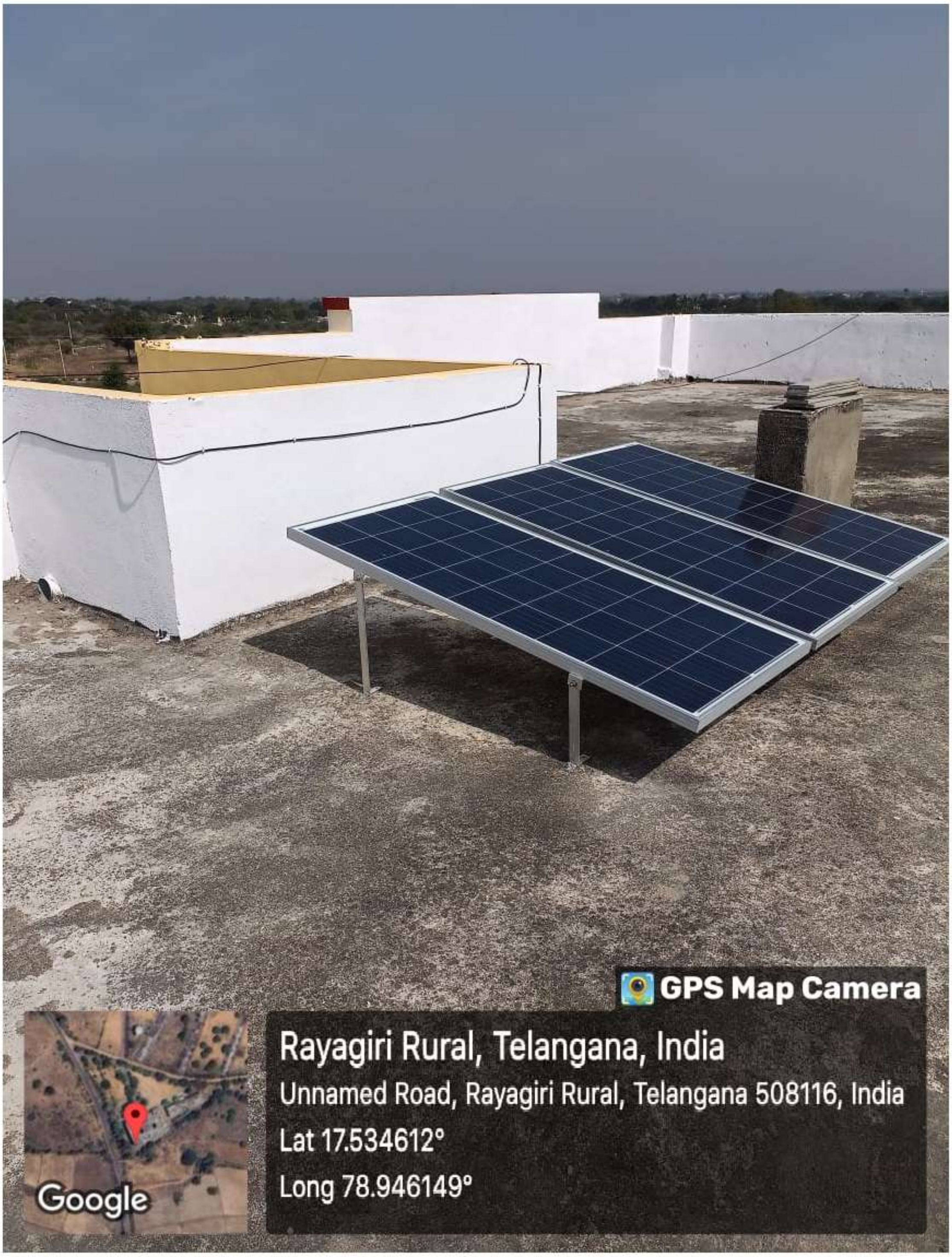

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Solar Energy:

7.1.2.1 Table of Solar Power Plant Specifications and Energy Consumption

No of Photo Voltaic Cells	Each Cell Energy Produced	Total Power Produced	Inverter Specifications
138 (300 WP) 17 (500WP)	P mp = 300 WP P mp = 500 WP V mp = 36.45 V I sc = 8.85 A	P= (300*138) + (17 * 500) = 49.9 KW 50 KW / 62.5 KVA	DC – AC Converter 50KW
Transformer	Technical Specifications	Standard Value	Difference
100KVA	HV 11KV LV 440V HV 5.248A LV 133.34A	Power Factor = 0.8	Transformer KVA – PV KVA 100KVA – 62.5KVA = 37.5 KVA/30KW
			Total Full Load Power Saved = 30KW

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