Indian Institute of Information Technology Design and Manufacturing Kancheepuram.

Product Design Practice

Group No. : B1-18

Team Members:

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PROBLEM STATEMENT

Extraction of biogas from the kitchen waste which can be used for cooking. The kitchen waste is transported to landfills where released methane gas is being captured by the atmosphere which is harmful for the environment. The main aim of this product is to capture this methane gas and to use it for cooking purposes.

PROBLEM DESCRIPTION

The demand of energy has been increased over the years as the sequence by increasing of the world population .Fossil fuels are exhausting and the emission products of these fuels have been causing some damages to the environment.

Bioenergy is an energy obtained from any fuel that is originated from biomass, which includes recently living organisms and their metabolic by-products.

Biofuels are eco-friendly and renewable resources of energy. Biogas technology is used to convert organic waste into energy. The use of energy and manure can lead to social economic benefits, green environment, and also contributes towards sustainable development Biogas technology is also a source of nutrient-rich organic fertiliser

Biogas generation serves three important functions: waste removal, environmental management, and energy production .The first and most direct use of biogas is for heating and domestic purposes .

There are several studies made on the availability of the LPG gas and the results turned out that it would get exhausted completely within 50 years, hence we should act as soon as possible and should search for the alternatives available. One of the best alternatives is the biogas.

SOLUTION

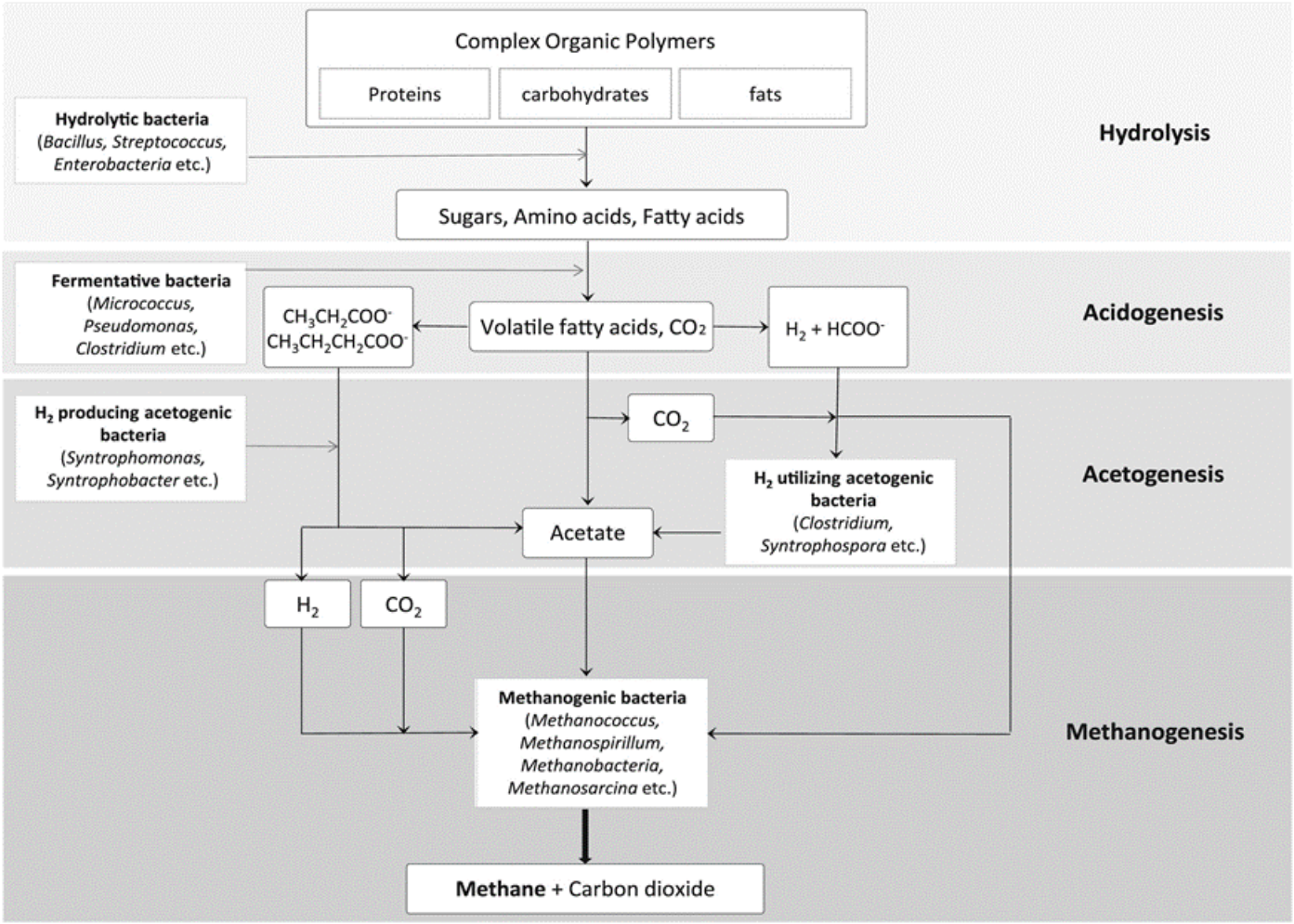
Biogas digesters are the systems that process waste into methane gas by undergoing anaerobic digestion inside the chamber, and then channel that biogas so that the energy production can be utilised productively. Each model differs depending on input, output, size, and types of wastes , customer demand, available size, operational simplicity. Biological process that converts organic waste into biogas is uniform. Biogas digesters receive organic matter, which decomposes in a digestion chamber. The digestion chamber is fully submerged in water, making it an anaerobic (oxygen-free) environment. The anaerobic environment allows for microorganisms to break down the organic material, and convert it into biogas.

Why kitchen waste?

We saw that typical biogas digesters till now only use cow dung that is the livestock waste. But livestock waste is something that is already digested. Usually the gas that is produced while digestion is more efficient. When we compare this logic to kitchen waste, usually the kitchen waste produced starts decomposing after a day by helping us to get more gas. As per the records it is said

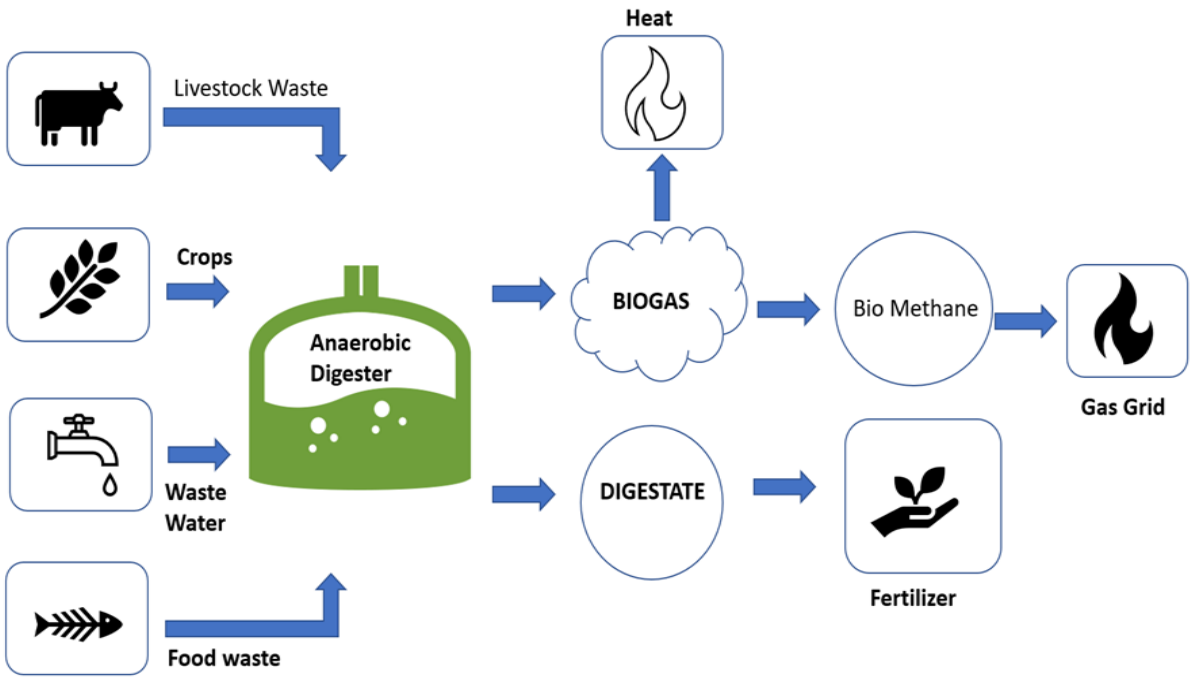
that the gas production is 400% more efficient using kitchen waste than with the livestock feed. There is a drawback by using kitchen waste that it smells a lot. But we have come up with the idea that reuses the smell that a typical biogas digester produces. The carbon filters can be used to capture the smell produced in the process. Mostly the smelling part of the gas is sulphur content in it which can be captured by carbon filters.

WORKING PRINCIPLE



To put it simply ,
We can see the flow as Waste(saccharides, amino acids, fatty acids) -----> **volatile acids+H2+CO2 ----->acetic acid+CO2+H2+(acetogenic bacteria)----->Methane+CO2**

WORKING PROCESS



WORK DISTRIBUTION

1) CED19I056
   - Research
   - Testing
   - Components finalising
   - Prototyping
2) EDM19B005
   - Research
   - Documentation
   - Prototyping of electrical components
3) MDM19B007
   - Research
   - 3D Modelling
   - Documentation
   - Prototyping
4) MDM19B034
   - Research
   - Observations and calculations
   - Prototyping

PROJECT PLAN

PROJECT PLAN					
Project title	Biogas Digester product				
Project Objective	To make a working model of the original biogas digester within 2.5 months at cost not to exceed ₹3000.				
Project Scope	A Biogas digester that gives out methane gas by taking in the kitchen waste produced in house				
In Scope	An Indicator can be fitted to the container which tracks the amount of methane gas.				
Out of Scope	1.Gas produced is not the same as the amount of LPG we usually use in a household .It is only a substitute to LPG. 2.Cannot have a complete automated product.				
Project deliverables	A working MVP of the original Biogas digester product which is scaled down in volume and size than that of the original product.				
Project Constraints	The pressure of the released methane gas from feed tank is yet to be brought under consideration				
Start Date	11-Jan-2022	**End Date**	12-Apr-2022	**Overall Progress**	95%

GANTT CHART

D	Task Name	Progress	Jan			February				March				
			W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W5
1	Research on how to implement the Solution	100%												
2	Doing analysis on whether the solution is viable	100%												
3	Working on the design of the product	100%												
4	Building the fusion 360 Model	100%												
5	Research on the application part of our product	100%												
6	Deciding the required parts and quantities for MVP	100%												
7	Finding suppliers and ordering components	100%												
8	Assembly and building prototype	90%												
9	Overall review and final testing of MVP	90%												

FINAL PRODUCT BILL OF MATERIALS:

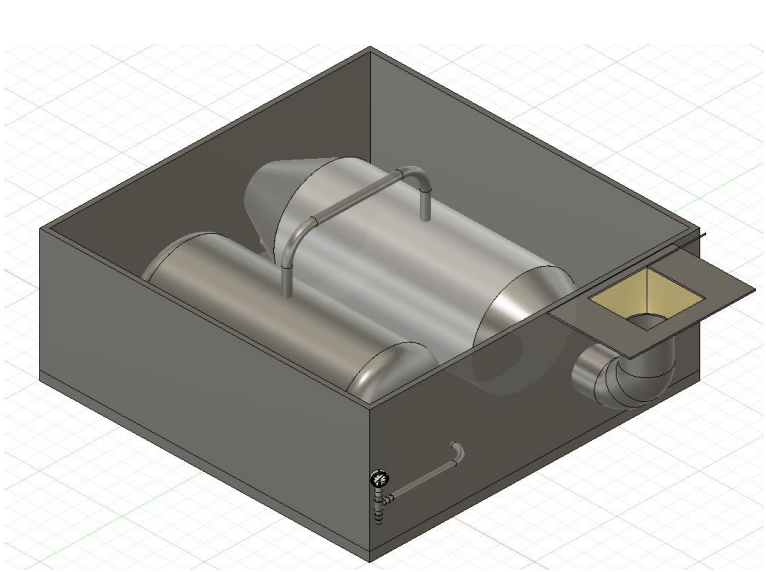
Part No.	Component	Part Description/ Purpose	Supplier	Measuring unit	Quantity	Price(INR)
1	Heater	To maintain the temperature of the container within a specific range	AVIGNA	Number	1	270
2	Pressure gauge	To keep track of the pressure contained in the methane storage container	TECHNO	Number	1	350
3	Gas Pressure Booster Pump	To pump the released methane gas into storage tank at a higher pressure.		Number	1	
4	Pressure Regulator	For controlled outflow of the gas from the storage container.				
5	RTD sensors	To sense the temperature	GENERIC	Number	1	182
6	Steel Pipe	To channel the methane gas released from digester to the storage container and then to stove.	INDIA MART	Feet	20 ft	200
7	PVC pipes	Can be used to transport the kitchen waste and also water to the digester.	INDIA MART	Feet	20 ft	200
8	Glass-fibre reinforced plastic	Can be used to manufacture the feed tank i.e., the main digester in which anaerobic digestion takes place.			1	
9	Mild Steel	For the gas storage tank			1	
10	Plastics	For the external body				
11	Electric wires	For connecting electric components				

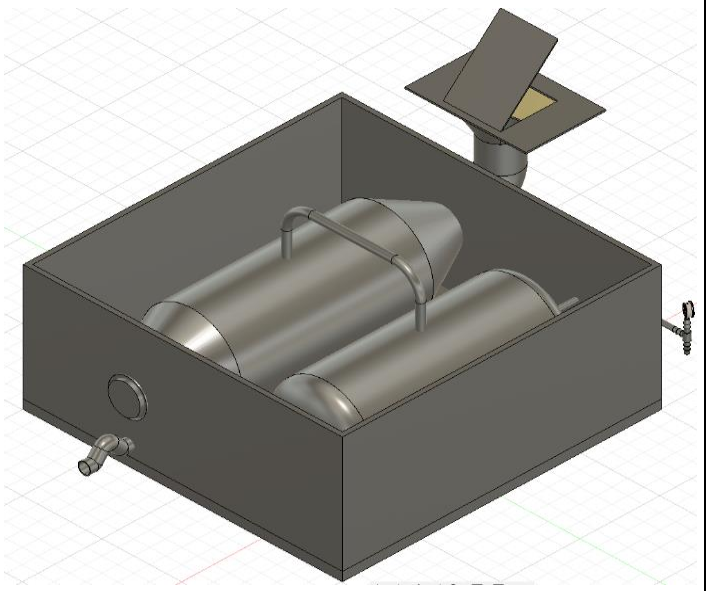
This is the BOM created for the final product which we've designed and modelled in the fusion 360.

PRODUCT SPECIFICATIONS

PRODUCT INFO			
PRODUCT NAME	**PORTABLE BIOGAS DIGESTER**	**ITEM NUMBER**	1
PHYSICAL QUANTITIES			
Digester		**Gas Storage Cylinder**	
Height	652mm	**Height**	650mm
Diameter	326mm	**Diameter**	326mm
Weight	25kg	**Weight**	1kg
Thickness	4mm	**Thickness**	2.25mm

CAD MODE



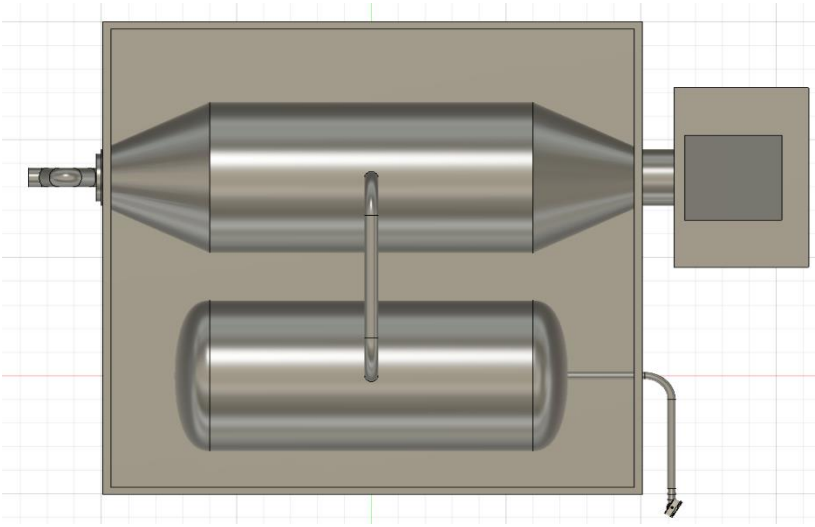


PROTOTYPE:

Minimum viable biogas digester

We used a feed tank which collects the waste before which we fill 60% of the container with water. Now the waste which is getting collected will go into the digester directly from the pipe that is fitted to the side of the container. We pour water after each loading to make sure that waste is not getting stuck. We also connected pipes to the other side of the container to maintain the level of water. If a user unknowingly puts in more water then this excess water is collected into the bucket from outside. This water has many nutrients in it so that it can be used as fertiliser to plants.

The slurry collection process is manual where the customer needs to replace the garbage bags with a new one when the slurry is filled in it.



The amount of water to be added in correspondence with the amount of waste is to be done or estimated manually by the customer.

PRODUCT SPECIFICATIONS

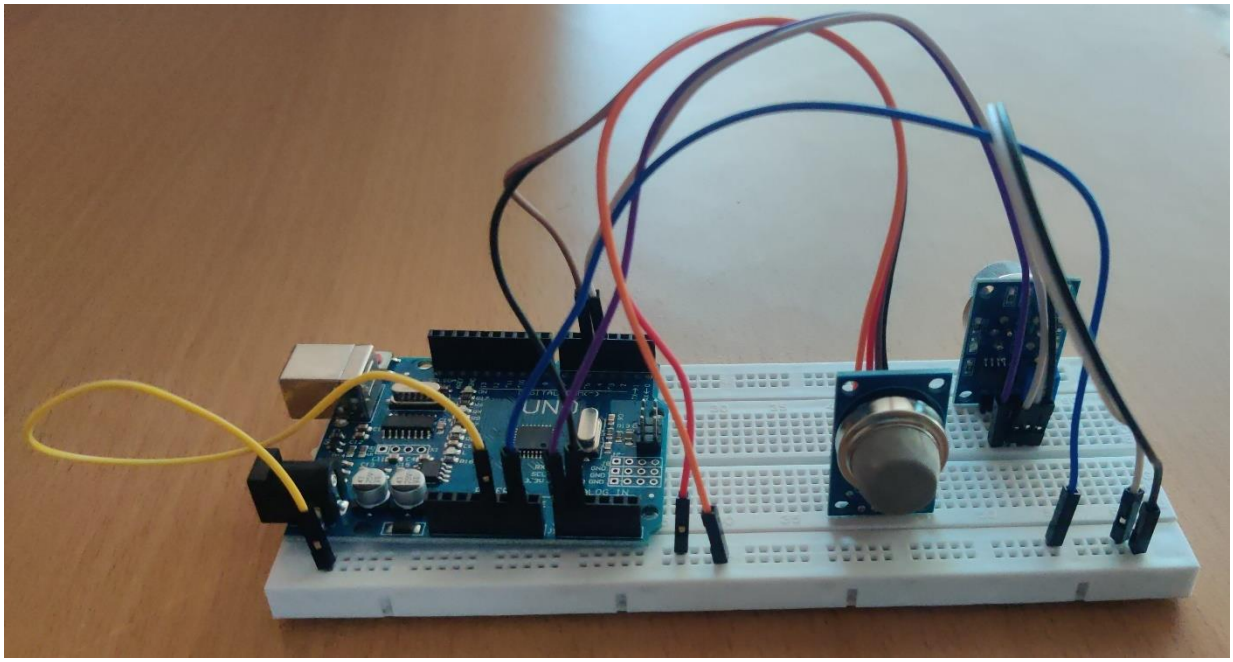
PRODUCT INFO			
PRODUCT NAME	**PORTABLE BIOGAS DIGESTER(MVP)**	**ITEM NUMBER**	1
PHYSICAL QUANTITIES			
Digester			
Height		200mm	
Diameter		120mm	
Weight		0.5kg	
Thickness		2mm	

BILL OF MATERIALS (Prototype)

Part No.	Component	Part Description/ Purpose	Quantity	Price(INR)
1	RTD sensors	To sense the temperature	1	182
2	PVC pipes	Can be used to transport the kitchen waste and also water to the digester.		200
3	Ball valve (plastic)	For the gas storage tank	1	50

4	Ball valve (Brass)	For the external body	1	150
5	Gas pipe	For transporting gas from tank		30
7	Aurdino-Uno-R3	Interface with sensors	1	750
8	Breadboard	Base	1	75
9	Connecting Wires	Connecting	1	55
10	LCD	To check the amount of pressure released	1	135
11	LPG-Sensor	Check for Methane gas	1	90
12	Smoke Sensor	Check for Methane gas	1	90

IMAGES



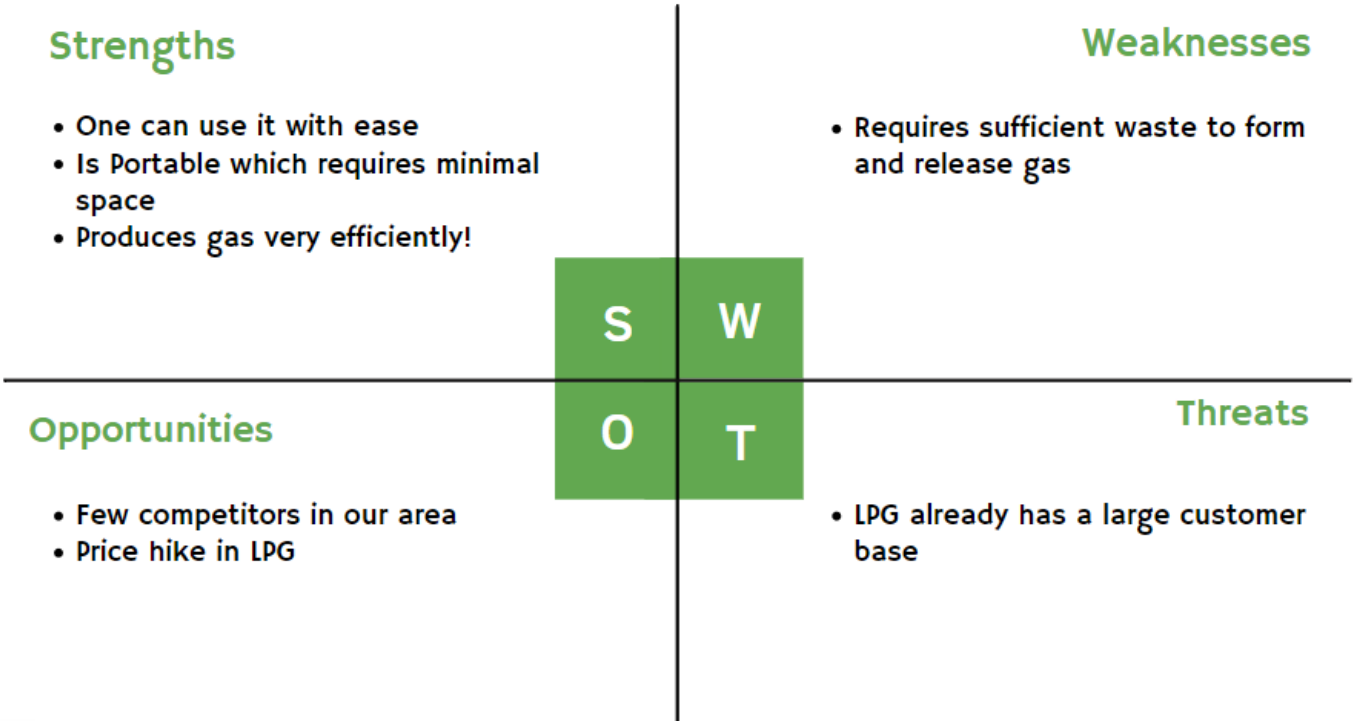
RESULTS AND CONCLUSION

1 L LPG = 1.05 m3 of biogas.
1 kg LPG = 2.1 m3 of biogas.

LPG to Biogas Comparison

•1kg if well digested, it yields 0.3m^3
•1 cylinder(14.2kg of LPG) can be used for 1.16months.
•We produce 0.887kg of waste per day which equals 0.887*0.3= 0.2661m^3 of biogas.
•Therefore to satisfy this we need to produce 14.2*2.1 m^3 biogas=29.82m^3 Per 1.16 months to get uninterrupted gas.
•This means we can produce 3.201 times less biogas than required with waste generated per day.
29.82m^3/35days = 0.852m^3/day has to be produced.
•So we can use our biogas digester 11 days 1.16 months.
So we concluded that our product can only be used as an add on to the existing LPG gas system which we are using for now. We can use this biogas digester along with normal lpg subsidy.

SWOT ANALYSIS



FUTURE ENHANCEMENTS

- Use of Solar Panel for maintaining the temperature of the digester
    - We can use solar panel for all the energy requirements of the digester
- Producing enough gas for 1month requirement
- App dedicated for monitoring the Gas available
    - Here the user can make use of the app for knowing the how many days the gas will last for approximately.
- Automation of manual processes of filling water and calculate the time required to digest the waste
- The double locking mechanisms like using butterfly valve technique can be used at the inlet to reduce the release of the bad smell from the inlet opening.