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ECO HEARTH

A biogas-based solution at a household level that'll utilize the daily organic waste of the household and convert it into biogas and a fertilizer as a by-product

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In the name of Allah,

The Most Beneficent, The Most Merciful

Acknowledgements

All praises to Almighty Allah, the authority of knowledge and creator of resources, skills, and opportunities. It is only HE who guided me through all circumstances and with HIS blessings was I able to accomplish this work.

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I would especially like to thank my parents without the prayers and constant support of whom in every possible way it would never have been possible for me to be successful in my work especially for my father who has always been a source of tremendous inspiration and motivation for me.

In the end, I would like to thank my brother Bilal and best friend for the endless support; since alone I would have done very little, but together we have accomplished greater.

Saadia Anjum

Contents

List of Acronyms

AD	Anaerobic Digestion

List of Figures

List of Tables

Abstract

A research into one of the main problem faced by the Pakistani women due to the unexpected gas load shedding, the activity of cooking taking a hit due to a shortage of natural gas that also adversely affects the economy of the country. The shortage of natural gas in Pakistan has pushed the locals to shift to fuel wood or fossil fuels combustion for extraction of energy; an alternative that is not only time consuming and costlier but is also unhygienic and harmful for human health.

The project involves the developing and analysis of a bio digester tank that mainly concentrates on the design and structure strength, durability, ergonomics, convenience and flexibility of usage in different conditions. Such a solution offers a time and cost efficient alternative to the natural gas with added benefits of protecting both the human health as well as the environment. All the specifications must be verified to avoid materials and fund wasting.

The proposed product, therefore, suggests realization of miniaturized biogas-based solution at a household level that'll utilize the daily organic waste of the household and convert it into biogas and a fertilizer as a by-product.

Keywords

Biogas; Natural gas; Sustainable; Energy; Fuel; Cooking; Environment; Appliance

Research Question

How can the unavailability of natural gas and unexpected load shedding which is troublesome at the household level can be solved by a single compact unit catering to the domestic needs of an individual, without compromising the health and hygiene of those individuals?

CHAPTER 1

Biogas

Biogas

Biogas comprises of several different gases and is produced when a certain biodegradable material is anaerobically fermented by the microorganisms. As the name suggests, anaerobic fermentation occurs in an absolute absence of oxygen. It is a biochemical process that uses bacteria to digest the biomass and produce CO2, CH4, H2 along with various other gases in a fraction.

Properties of Biogas

Biogas comprises of various components and the exact composition is varied and dependent on the amount of degradation that occurred in the digester, the fundamental features of the feed materials used, etc. While other gases are in trace amounts, Methane and Carbon Dioxide take up a major portion of the Biogas composition amounting to 50-70% for Methane and 30-40% for carbon dioxide. Since methane is the major component of combustion in the composition of biogas, it is the amount of methane that determines the energy content of the produced Biogas.

Table 1.1 and 1.2 accentuate the composition along with the primary properties of Biogas.

Table 1.1 Composition of biogas

Name of the gas	Composition in biogas (%)
Methane (CH_4)	50-70
Carbon dioxide (CO_2)	30-40
Hydrogen (H_2)	5-10

Nitrogen (N_2)	1-2
Water vapour (H_2O)	0.3
Hydrogen sulphide (H_2S)	Traces

Table 1.2 Properties of biogas

Properties	Range
Net calorific value (MJ/m^3)	20
Air required for combustion (m^3/m^3)	5.7
Ignition temperature (^0C)	700
Density (kg/m^3)	0.94

Classification of biogas plants

Biogas plants can be classified into three major types on the basis of nature of feeding. These types are as follows:

I. **Batch Type:** The organic waste material is only added to the digester once which is then digested by the microorganisms without the utilization of oxygen. Feeding is done at intervals. Once the entire process has been carried out, the plant is then thoroughly emptied. Retention time varies between 30 to up to 50 days. Production of gas is achieved intermittently. Such plants are highly suitable if fibrous materials are being used. A few of the drawbacks include the requirement of adding fermented slurry in order to begin the process of digestion. This is what makes it uneconomical.

II. **Semi-continuous:** Feed materials, in a quantity that is determined beforehand, is added to a certain amount of water. The mixture is then added to the digester via the inlet after a particular interval of time; (for instance, once a day) and the effluent or the digested material that is equivalent to the feed volume, comes out of the outlet or the other side of the digester.

III. **Continuous type:** As the name suggests, the feed is consistently added to the tank while the effluent flows out of the other side simultaneously. The benefits of such plants include the requirement of a small digestion area, continuous gas production, the lesser time required for digestion, and minimal maintenance, etc.

The types of plants used in villages are commonly the semi-continuous kind that makes use of biomass including animal dung as feedstock for the purpose of producing biogas. The semi-continuous plant can further be divided into the following types:

I. Fixed dome type model– It consists of an enclosed digester that has a non-movable space for gas. The upper portion of the digester stores the gas.

II Floating drum type- It comprises of a dedicated digester and moving holder for gas. The gas holder is capable of floating either directly on the slurry fermentation or on a built-in water jacket. Once the gas drum is accumulated with the gas, it automatically moves up and once it has been drawn out, it automatically goes down.

III. Balloon type: It makes use of a rubber or plastic digester bag. The upper part of the bag is where the gas storage occurs. The balloon skin is directly in

contact with the inlet and outlet. Once the gas space has been filled, the plant starts to act more like a fixed dome kind.

Uses of biogas

Biogas fills in as a reasonable replacement of current fuel sources which fulfills the energy requirements for the society. Biogas as a source of fuel can be used for cooking, lighting and a wide range of other personal or commercial uses. The figure clarifies further about various utilizations of biogas.

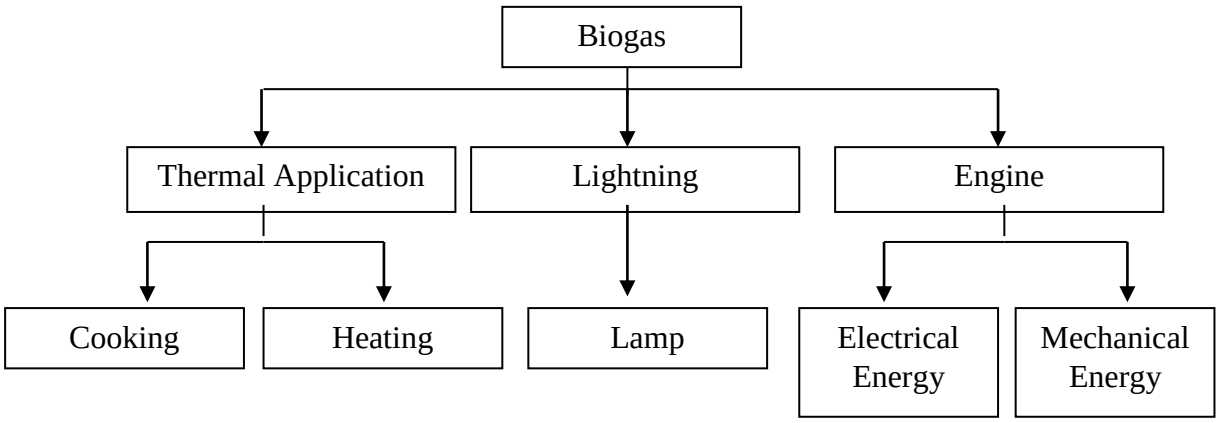


Fig 1.1. Applications of Biogas

Cooking are lighting are the primary domestic uses of biogas, as mentioned earlier. The essential household needs biogas caters are cooking and lighting. Since biogas has unique properties as compared to a range of other commonly utilized gasses including butane and propane, and is made available at significantly reduced pressure of 4 - 8 cm water, the requirement of stoves which are specifically designed for the purpose of burning biogas in an efficient fashion is indispensable. Drawing a comparison cow dung cake, firewood, or other such sources of fuel, Biogas has an added benefit of being odorless. It gives out a blue flame but with no amount of ash that further adds to the list of its advantages.

Anaerobic Digestion

Anaerobic digestion is a process in which controlled degradation of biological components takes place which permits the powerful utilization of biogas, the composition of which is 60% methane and 40% carbon dioxide. Anaerobic digestion of food is also possible, however, different kinds of food waste is known to produce different amounts of methane upon AD which is why it is recommended to make use of a mixture of food waste, the proportion of which is identified on case to case basis.

Anaerobic digestion (AD) is a favorable technique for treating kitchen waste. While rural parts of a wide a range of developing countries are known to use AD for treatment of animal dung, the operational feasibility or technical information regarding organic solid waste treatment is remarkably limited in such areas. There is a wide range of elements which have an impact on the overall performance of AD as well as its design. A few of such features include the design as well as the conditions in which the reactor is expected to work in real-time. The feedstock characteristics do also influence the performance and design of the reactor. Physical as well as the chemical properties that the organic substrate of choice has to offer must be considered while designing or operating a digester since it casts an impact on the entire process of biogas production as well as its stability. Therefore, properties including volatility, moisture content, nutrient content, size of the particles and biodegradability must not be ignored. It is primarily the biodegradability of the organic substrate and the concentration of volatile solids in it which governs the production of biogas and the subsequent yield of methane. In our case, the overall yield of biogas is only measured in terms of the amount that can actually be produced and also collected in the floater gas tank.

A wide range of technological advancements has made it more convenient and achievable to produce biogas in a more cost-effective fashion. A few of such improvements which have been introduced include the factors which increase the overall speed of bacterial operations within the reactor for the purpose of achieving fermentation efficiently, making the reactor smaller, utilization of organic substrate rich in sugar or starch for biogas production, altering the composition of feeding material which will be subject to fermentation, and finally ensuring a dedicated exit for effluent that improves the employment of the biogas. Making the entire equipment more compact than before enables the entire process to be carried out within a small tank which can conveniently be placed in the backyard.

Owing to the rapid and consistent increase in the price of traditional fuel sources along with the improving demand of fertilizers as well as an alternative fuel source, such a solution seems promising for the future.

Anaerobic Digesters provide numerous advantages, including:

- Offering an alternative to fossil fuels.
- Getting rid of the energy footprint associated with the waste treatment plants.
- Minimizing methane emissions.
- Producing premium quality chemical fertilizer to be used in industry as a by-product.
- Minimizing emissions related to trucking etc.
- Minimizing the solid waste disposal in terms of its volume and curtailing the overall cost.
- Offering a simpler yet reliable solution.
- Minimizing the odor by containing and then eliminating it.
- Minimizing the overall cost of operation.

A biogas plant is much like anaerobic digesters that is capable of making use of the animal dung or food waste and use its organic component for the process of AD and production of biogas as an alternative source of fuel along with a premium quality fertilizer which can be used in the agriculture industry. Therefore, the proposed biogas system must be highly effective, affordable, long lasting, eco-friendly, and durable.

In order to build a system that incorporates all of the aforementioned features, it is imperative that a thorough analysis followed by evaluation of the entire process of biogas production is performed for better understanding. Only then, an efficient, reliable, and portable solution can be developed which can be conveniently used in a common household.

Extensive research has been performed to identify the manure that ensures production of premium quality biogas with optimum quantities of methane production that governs not only the quality but also the burning efficiency of the biogas that has been produced. Since the ordinary kitchen waste is rich in nutrients or calories in general for the microbes to feed on, the quantity of methane production can conveniently by increased multiple folds. The utilization of Biogas is not confined by the geographical location neither does it require advanced technology for its production.

Kitchen wastes are mainly constituted of:

- Cooked Rice
- Cooked Vegetables
- Uncooked Vegetables and Fruits
- Cooked eggs and meat

Purpose Statement

Development of a system/appliance for household that uses the daily organic waste of a household and converts it into biogas for meeting the daily energy requirements of the house for cooking. The biogas-based system will be efficient, cost effective, and safer both for the environment as well as the human health.

CHAPTER 2

Introduction

It is known that energy is a fundamental requirement to the quality of our daily lives. The economic outlook of the country, as well as the modern national life, is directly affected by the availability and accessibility of energy. Pakistan has been fortunate to be blessed with the largest natural gas reserves located at Sui, Baluchistan, however, years of mismanagement, lack of strategic vision, inadequate exploration of the aforementioned reserves, perhaps due to lack of funding and investments has engendered an acute shortage of natural gas in Pakistan. (Jamil 368-374)

The challenge of unscheduled gas load shedding specifically during the winters in Pakistan is intolerable not only for a layman to address his/her daily chores like cooking, washing, and bathing, but it does also jeopardize the industrial and commercial activities on a national level that threatens to hurt the economy adversely. It is only fair to deem gas load shedding as a major reason that disrupts the daily routine of a common man and brings the business as well as the human productivity in general to an impasse. (Shahbaz, Lean and Farooq 87-94)

As per the recent report of SNGPL, 4.7 million consumers range from domestic to commercial and CNG to industrial are being fed through a common distribution network. On average, the gas demand rises by 40 – 50 million meter cubic feet per day (mmcfd) during the summer season while the winter season experiences a rise of 80 – 100 (mmcfd) each year (Mahmud 641-648). (Malik and Sukhera 1282-1290)

During the study driven by the problem stated a rudimentary idea for the identified problem which was informing was a cost-effective and environmentally

friendly alternative that is likely to enable the consumer to cook meals and address the daily requirements without any hassle.

It is possible to produce biogas not only at a large-scale but also at the household level (Kurchania, Panwar and Pagar 99-103). The operation of biomass for household is the anaerobic digestion of organic material that may include the animal dung or perhaps the waste that produced on a daily basis at home like the food leftovers. Instead of throwing all of this waste away that contributes towards attracting insects and pests, a biogas reactor usually converts it into energy which can be used as a safer, more cost-effective source of fuel that doesn't produce harmful gasses or chemicals which hurt the environment. A small-scale biogas reactor offers a cheaper, more sustainable source of fuel for lighting, cooking, and electricity. (Bajet, Jr. et al.)

The unavailability of Sui gas in the northern and rural areas of Pakistan impels the locals to make use of Timber or charcoal as a primary source of fuel for cooking. Being a remarkably environmental-friendly alternative, biogas enables a family to reduce their utilization of timber, firewood, or charcoal by at least 60%. Not only does it militate deforestation, but it also helps a great deal in addressing a global challenge of reducing greenhouse gas emissions. A mass utilization of biogas, therefore, holds a propitious impact on climate change and the environment in general. (Khan 1145-1159)

A number of countries have made sustainable waste management including prevention and reduction of waste as their prominent political priority. Such an agenda has been inspired in the name of putting an effort into reducing the environmental pollution in order to minimize the emissions of greenhouse gases and consequently counter the changes that it threatens to bring in the global climate. There is no room for uncontrolled waste dumping in the world of today. As a matter of fact, incineration of organic waste or controlled landfill disposal has also been identified as a non-optimal practice with environmental standards getting stricter than ever before and emphasizing the recycling of organic matter including the nutrients and recovery of energy. A few of the prominent substrates

which can be used for the production of biogas include animal manure, slurries, and digestible organic wastes.

Anaerobic Digestion (AD) of such substrates results in the production of renewable energy along with a premium quality, highly useful fertilizer which can directly be used in agriculture. In the meantime, such a process does also help a great deal in cleaning the waste streams off organic fraction ultimately improving the overall efficiency of the process of energy conversion. Since the remaining waste is incinerated, the landfill sites can be further improved in terms of biochemical stability. AD is a process that utilizes microbes for the purpose of decomposing the organic matter. As the name suggests, the decomposition occurs without the utilization of oxygen. It is a process that is widely witnessed in a range of natural environments. It is turning into a common industrial practice to utilize the same process in an airproof reactor for the purpose of biogas production. The airproof reactors are commonly referred to as the digesters. A fairly large variety of microorganisms can be put to use for the aforementioned process that produces two end products namely the biogas and the digestate. Comprising of carbon dioxide, methane, trace elements, and a few other gases in small fractions, Biogas is highly combustible in nature. Digestate is primarily the decomposed form of the used substrate. It is rich in not only the macro, but the micronutrients as well, which make it a perfect candidate for the purpose of plant fertilizer. The first documentation of biogas product and its subsequent collection occurred in the United Kingdom in the year 1895 (Metcalf & Eddy 1979).

Since then, the same process has also been put to use in various other industrial processes including sludge stabilization and wastewater treatment. The early 70s energy crisis served to bring awareness about the utilization of renewable fuels for energy purposes that included Biogas as well. Today, Biogas relishes a global interest that is deeper than ever before as part of a global effort to find an alternative to fossil fuels for extraction of energy and an indispensable necessity to recycle or treat the animal manure as well as various other forms of organic wastes, with a solution that is environmentally sustainable.

Objectives of the Study

Following are the accentuated objectives of this project:

- Designing a biogas solution that is portable enough to be utilized in a common household.
- Developing an understanding of how it works and what is the principle of the biogas system.
- Performing a thorough analysis of the biogas system in terms of its various operational parameters.

CHAPTER 3

Literature Review

The anaerobic digestion of organic matter that produces biogas has far and wide applications in meeting the energy requirements of various sectors including household, bakeries, and restaurants. While the initiative of utilizing the home biogas is primarily destined to serve the developing world, where the daily waste production is sufficient to be converted into a form of fuel that is clean-burning and adequate for the purpose of cooking, heating, and lighting (Bond and Templeton 347-354), the provision of renewable local energy source as proposed in this project can also be useful for the suburban market. It has a capacity to serve the role of an imperative home energy network's component, either as an accessory that is off-grid or even as a grid-based system in the form of an adjunct.

It is preferable for the majority of the users to make use of biogas since the ease of turning it on and off makes it a convenient option as compared to coal or wood. Biogas further helps prevent indoor air pollution by minimizing the production of smoke inside the kitchen facility of the house. The purpose is to turn waste into gas and fertilizer, creating an in-house cycle of energy. The proposed product is a family-sized affordable biogas system. It converts any organic waste into clean cooking gas and a high quality liquid fertilizer for the garden.

The kitchen leftovers of a household can efficiently be converted into a source of energy that supports cooking for a few hours every day. This is what offers an additional benefit of maintaining the closed-loop eco-cycle: the organic waste gets converted into a useful source of energy and a byproduct of a liquid fertilizer that enhances the production of food and contributes in keeping the indispensable cycle of life intact. While most if not all of us are concerned with the maintenance of this planet and try to play their role for the purpose, it is nothing but a drop in the bucket unless the major issues are not addressed with

dire seriousness. The proposed product may be small, but it has a potential to generate a gigantic impact. By ensuring a reduction in the untreated organic waste and the damage that it causes including water contamination, air pollution, and utilization of fossil fuels to extract energy, these systems respond to some of our most pressing environmental challenges today (Martins das Neves, Converti and Vessoni Penna 1147-1153). The main vision is to make a biogas system accessible and affordable for everyone.

The utilization of biogas has remarkable potential in the sector of sustainable development. It can essentially serve as a sustainable sour of energy all over the globe. Making use of biogas in the household for cooking purposes has a potential of enhancing the supply of energy for the poor i.e. around 2.7 billion populations from all over the world that has to depend on combustion of biomass in order to obtain energy, a mode that is both unhealthy and inefficient. The solutions premised on biogas, therefore, offer a convenient, an efficient, and a cleaner cooking facility for the people of rural areas of Pakistan. (Kalia 67-76)

The utilization of biogas is being deemed appropriate for sustainable development since methane holds a stronger greenhouse effect as compared to carbon dioxide. Therefore, the effect of carbon dioxide on climate change is negligible as compared to methane. Since biogas-based solutions are primarily focused on capturing methane that is produced as a result of natural processes and converting it into biogas which can be used for the purpose of combustion, such solutions have a proclivity towards contributing to the reduction of methane that is openly released in the environment. In the case of properly combusted biogas, the emission of greenhouse gasses in the environment is minimal compared to any other technology that makes an extensive use of fuel combustion, for instance, fossil fuels or perhaps biomass. Development of such miniaturized solutions which can be used indoors at a household level can, therefore, significantly contribute towards the battle against climate change. (Keleş and Bilgen 5199-5206)

The use of biogas for extraction of energy is remarkably cost efficient in itself since it makes use of the daily organic waste of the household including the

kitchen leftovers etc. Furthermore, since the waste material is being recycled to produce energy, it further saves the cost of waste removal in order to prevent its negative impact on the environment and human life. (Hamburg 31-32)

CHAPTER 4

Case Studies & Analyses

HomeBiogas Team, Beit Yannay, Israel

Websites:

Facebook: facebook.com/homebiogas/?fref=ts

Twitter: twitter.com/Home_Biogas?lang=he

Youtube: youtube.com/channel/UC_2lbLBOxZpEDHLEzd1z9vQ

Homepage: homebiogas.com/

Biogas is a renewable fuel that is produced by the decomposition of organic matter in an environment absent of oxygen. Biogas is made up of several gasses, primarily methane (CH4) and carbon dioxide (CO2), which can be stored and directed for cooking for up to 6 liters a day of any food waste, including meat and dairy. These amounts are the maximum per day, but even one-third of the quantity is enough to produce your daily gas consumption (Raven and Gregersen 116-132).

On average, 1 Kg of food waste produces about 200 liters or 7 Cubic feet of gas, which generates around one hour of cooking over a high flame. Therefore, at 6 liters / in 1.58 gallons of food scraps, one can generate 1-3 hours of cooking gas each day - the perfect amount for three meals. This proves that each year that you use it, you eliminate one ton of organic waste, and reduce harmful emissions equivalent to six tons of carbon dioxide (CO2). The accurately-named Home Biogas device could herald a new dawn for full-circle local waste recovery for both on- and off-grid homes, because it has the ability to take in up to 6 liters per day of any food waste (including both meat and dairy, which are often not recommended for home composting) or up to 15 liters per day of animal manure (including pet waste, which is also considered a no-no in home composting), and

turn that into enough fuel to cook several meals per day, while also producing a rich organic fertilizer that can boost soil fertility and garden yields. (Amjid et al. 2833-2837)

The product hence is a kitchen appliance which looks into one of the main problem faced by the Pakistani women due to the unexpected gas load shedding, the activity of cooking taking a hit due to a shortage of natural gas that also adversely affects the economy of the country. The shortage of natural gas in rural and northern areas of Pakistan has pushed the locals to shift to fuelwood or fossil fuels combustion for extraction of energy; an alternative that is not only time consuming and costlier but is also unhygienic and harmful for human health.
The proposed product, therefore, suggests realization of miniaturized biogas-based solution at a household level that'll utilize the daily organic waste of the household and convert it into biogas and a fertilizer as a by-product. Such a solution offers a time and cost efficient alternative to the natural gas with added benefits of protecting both the human health as well as the environment.

The case study hence chosen is called the "Home Biogas" formed by the industrial designers of Israel. Energy demand is increasing with every passing minute due to the population explosion. With the alarming increase in Global Warming scale and depleting Natural Resources, something needs to be done to save the planet and provide us fuel at the same time.

HomeBioGas gives the most reliable and sustainable solution to this rapidly spreading hazardous problem. This technology similarly to my appliance uses kitchen waste and converts it into combustible fuel in a very short time preventing depletion of a significant amount of natural resources i.e. natural gas hence proving to be an exemplary ECO-FRIENDLY and efficient technology. Along with the biogas, it also provides us with a liquid fertilizer for our backyard & kitchen gardens completely taking over the artificial chemical fertilizers and pesticides and saving us from consuming thousands of toxins in the form of packet vegetables & fruits.

Biogas is a non-toxic eco-friendly gas produced by the natural decomposition of organic substances found in our everyday kitchen wastes. 1 kg

of food waste produces about 200 liters of gas on an average, this much amount of gas can be used for 1-hour high flame cooking. As the daily kitchen waste of almost 6 kg can generate 1-3 hours of cooking gas every day.

With this much amount of biogas, it not only provides fuel but also reduces a significant amount of land waste being generated every signal day. By this green technology, you are also reducing the total amount of harmful gasses specifically carbon dioxide in the air and actually reversing the amount of carbon emission.

Home biogas is easy to assemble and is perfectly designed for a home application. This device weighing less than 40kg contains a Built-in filter for the removal of Hydrogen Sulphide, and a fertilizer chlorinator with a nominal pressure of 15 millibars Irrespective of the family-size it is the perfect natural gas replacement and fulfills the same functions without any significant difference yet having a huge environmental impact.

Not recommended for restaurants and huge hotels, it is an ideal environmental education tool using the précised basis of permaculture. HomeBioGas unit is ideal for animal breeders, farmers and small scale cattle husbandries as it can process 15 liters a day of animal manure and a huge amount of biogas can be produced along with liquid fertilizers to be used for agriculture purposes. HomeBioGas is the perfect choice for rooftop Barbeques and grilling parties. As the system needs to be kept outdoors, it works best in warmer climate i.e. 17-degrees or above. Its efficiency will be affected by lower temperatures. As a rule of thumb, the warmer is certainly better.

In order to take control and save the environment from further destruction, this amazingly innovative and sustainable HomeBioGas technology should be owned by every household. As this technology reduces per domestic kitchen waste to zero, every household should get it installed to ameliorate its own share of environment conservation. It should be made accessible to every household as it is an ideal technology to decrease carbon/methane emission, water & land pollution and fossil fuel consumption.

HomeBioGas is also supporting some international NGOs like Innovation Africa and Arava Institute for Environmental Studies (AIES) to ensure a safe and healthy environment for a brighter future for our generations to come. Projects run by Innovation Africa include Buvundya Orphanage Support Program in Uganda which provides boarding facilities and education to a total of 518 orphans. HomeBioGas system is facilitating orphanage's kitchen for a safer & healthier cooking environment free from firewood system and excessive smoke providing students with practical experience with innovative clean & green technology. This technology seems to provide students an opportunity to improve health standards by active agriculture farming and low firewood consumption.

Arava Institute for Environmental Studies (AIES)'s project "Middle East Biogas initiative" is based on promoting peace-building, social justice, and environmental leadership and research trends in the Middle East. HomeBioGas systems are being installed in Bedouin schools to ensure healthy cooking environments, less water pollution and an inspirational clean technology innovation for the community.

Similarly, a Non-Profit Organization "The Peres Center for Peace" is working with different communities and welfare societies to introduce renewable energy sources to underprivileged Palestinian communities.

SWOT ANALYSIS

Strengths	Weaknesses
Creating a • Economical • Portable • Comfortable • Practical • Easy to manage • Understanding public requirement • Solution to gas and electricity crisis • Compact Solution, with the learnt skills and thorough research.	Lack of knowledge about the practical use of biogas and accessibility of experts in guiding about its fabrication and practical equipment. • Cultural differences • First time investment
Opportunities	**Threats**
• Clients from massive sphere can be catered • Growing market of organic and sustainable solutions	• Time constraints • Cheap knock offs • Inadequate resources and exploration on the system before prototyping

The outcome from the conducted SWOT analysis helped in highlighting the main constraints and prospects about the project frame work. The analysis also informs that with proper research and resources a niche for such solution can be created which will change the life and economy in Pakistan.

PEST ANALYSIS

	Fact	Opportunity	Threat
	Manufacturing Legalities As there are gas and electricity crisis exists widely in Pakistan. So the kitchen appliance must work on bio gas	Relation with other fields of manufacturing may provide better relations with them Decreasing the energy load	Political affiliations might Cause some issues
	Affordability Energy Assembled and manufactured locally	Affordability. The energy resources available in Pakistan, very few kitchen appliances industries exist; the appliance will boost their morale and increase their market.	An unstable economy can harm the demand Local available materials usage so that it will be affordable as well as it brings back the industrial power of Pakistan
	Acceptability	The current generation in Pakistan is open to experimentation and wants to keep up with the trends of the world.	In our culture, old norms are appreciated and people stick to them
	Innovation and invention	A new technology might ease production and make the product more affordable	Rapid technology might take away the lime light from this product

The result of the conducted PEST analysis helped in highlighting the main constraints and prospects about the project frame work. The analysis also informs the similar domains as that of SWOT. With proper research and resources a niche for such solution can be created which will change the life and economy in Pakistan.

User Personas

A young student in her 20s.

From Islamabad
A bold introvert
Looks to escape rigid gender role stereotyping
Lives in a hostel in G11
Imaginative
Cooks her own food

Saira has a bunch of friends in her close circle and she loves to cook and eat and is planning to open her own cafe soon after her graduation.

An entreprenuer in his 30s.

Recently moved to Lahore
Keeps himself prepared
Decisive and balanced
Zoom lens equipped
Keeps a realistic and practical approach
Loves cooking

Ali is a focused individual who is looking for new ideas to bring reform around himself and his society. In between he needs food which he mostly prepares himself or his friends do when they spend time together at his apartment.

An engineer in his 50s.

From KPK
Very calculative
Keeps lifelong connections
Its all about his work
Very persuasive

Habib owns an office in bara kahu and he is working at a company called BETA Pak which deals with the sustainable energy solutions.

A House wife in his 40s.

Spends time doing house chores
Loves cooking for her family
Hosts parties at her place
Enjoys steaming cup of tea
emotionally vulnerable
Have a busy home routine

Farida lives in Rawal pindi in a joint family system. She spends her time mostly doing her house chores.

Interviews

Two main interviews with the stake holders were conducted for a better insight about the problems and usage of the proposed problem and its solution.

Interview: 1

House 37, street 45,
Gulshaneabad adiala road, Rwp

Stakeholder: Mrs Rubina
House wife
Age: 50

8:30 am

The kitchen is bustling with activity as she scurries from one corner to the other, hurriedly preparing breakfast— the older children have already been fed, dressed and shipped off to school and now it is their father's turn. Asking the maid to supervise the stove for a bit, she rushes up to tend to guests. Unfortunately, their arrival coincides with the absence of gas load shedding, halting all the chores in the middle due to the off timings of the sui gas, hence creating a chaos. After a while, when she gets free, she was requested for the interview for the research project.

Assalam o Allikum

Walikum Assalam

How are you?

I am good, just busy in daily house chores.

How does it feel whenever there is load shedding?

I am among those people who cursed the officials of sui gas whenever the gas goes out. Initially, I used to use the gas cylinders for quite some time with heavy heart, but now it's also getting expensive and dangerous, so we have stopped buying that. It's quite a hassle going every other day to get it, and having kids around the house, it's not even secure.

How much of your and the family routine gets disturbed due to the load shedding?

My family members gets really annoyed after a tiring day at school and offices when sometimes the food is not ready on time, it has been affecting my daily life quite badly, now as its winters so the condition of it is getting worse. But they do understand that I am not responsible for it.

Does the power just abruptly cut out, or does it 'brown out' slowly? And when it returns, same question, all at once - or slowly?

It goes abruptly and then comes back just as abruptly for me

Are you used to the idea now, of 'gas' being something which sometimes, simply isn't there for use? Has it changed your view?

No, it still infuriates me, trying to make plans to work around it so we can maintain a semblance of civilization.

Interview: 2

Flat No-2, Abbasi Plaza,

Bhara Bridge, Main Muree Road,

Bara Kahu Islamabad.

Stakeholder: Mr. Habib

BETA PAK PVT Ltd

Age: 55

Assalam o Allikum

Walikum Assalam

How are you?

I am good.

I am going to ask you a few questions about my thesis project. I hope you have read the details I emailed you earlier.

Yes sure, I have.

So what can you tell me about biogas how can it help me in this project?

There's a unique and added feature of biogas which in itself, in my opinion, is even more valuable than the biogas itself. I'm talking about the organic manure; it's even more useful than the biogas. Since we are running short on gas, this is primarily why we specifically emphasize on the gas. So you should certainly mention the importance of the organic manure and each of its constituents.

So the organic manure that is an outcome of the entire process of biogas, is at least 1.5 to 2 times more practical and useful as compared to the common animal dung used as compost. Furthermore, the animal dung takes at least half a year to one complete year at most to be converted into compost, after which it can be used as a fertilizer. The organic manure as a product of the aforementioned process, however, is not only manufactured efficiently but is readily usable as fertilizer as well. So for instance, in the agricultural industry, where tube wells are being operated with the use of biogas, the organic manure is automatically confected in the water and the mixture is then provided to the fields.

Moving on to what else it has to offer. When animal dung is used as compost and is applied in the fields as a fertilizer, there is an associated downside of unnecessary growth of weeds. However, the organic manure from the biogas process has a retention time of 40 days in which it is processed that serves the purpose of attenuating the seeds of weeds.

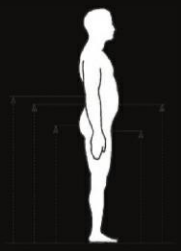
Therefore, when applied in the fields, the enhanced growth is only experienced in the defined plants with an absolute lack of weed growth.

What's more is that the processed compost of the biogas process acts as a natural repellant for the flies and mosquitos and no amount of pungent smell is a feature of the processed compost either. It can also act as a power source. On a smaller scale in the household, while it does also have a sufficient capacity to power a farm house as well. An added benefit is that the production of biogas is not limited to the availability of animal dung. It can utilize the kitchen leftovers, sewage, poultry waste, or the everyday waste of a household as the input material. In other words, all types of organic wastes can be used for the production of biogas.

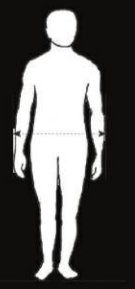
Ergonomic Study

BIOGAS STOVE ERGONOMICS

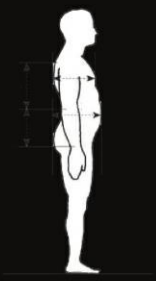
With the changing nature of today's kitchen work,
this stove incorporates
ergonomics for an effective experience.



UPPER POSITION LENGTH	MALE	1110
	FEMALE	930
	COMBINED	1074
UPPER POSITION HEIGHT	MALE	1701
	FEMALE	1655
	COMBINED	1692



MID POSITION LENGTH	MALE	1316
	FEMALE	1282
	COMBINED	1146
MID POSITION HEIGHT	MALE	1207
	FEMALE	1141
	COMBINED	1193
LOWER POSITION LENGTH	MALE	1110
	FEMALE	966
	COMBINED	1106
LOWER POSITION HEIGHT	MALE	1110
	FEMALE	966
	COMBINED	1106
SIDEWAYS STEP LENGTH	MALE	671
	FEMALE	545
	COMBINED	647



NORMAL STANDING	MALE	1645
	FEMALE	1506
	COMBINED	1607
VERTICAL UPWARD ARM REACH FROM FLOOR	MALE	2101
	FEMALE	1914
	COMBINED	2050
MAXIMUM VERTICAL ARM REACH, BODY RAISED ON TOE	MALE	2188
	FEMALE	2013
	COMBINED	2145
VERTICAL UPWARD ARM REACH FROM FLOOR	MALE	2101
	FEMALE	1914
	COMBINED	2050

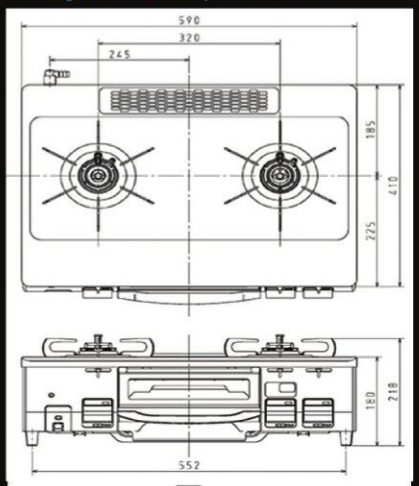
HAND GRIP LENGTH	MALE	95
	FEMALE	64
	COMBINED	95

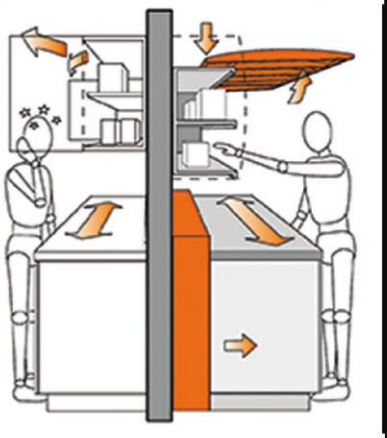
HAND GRIP BREADTH	MALE	130
	FEMALE	104
	COMBINED	130
HAND GRIP BREADTH WITH THUMB	MALE	117
	FEMALE	100
	COMBINED	117

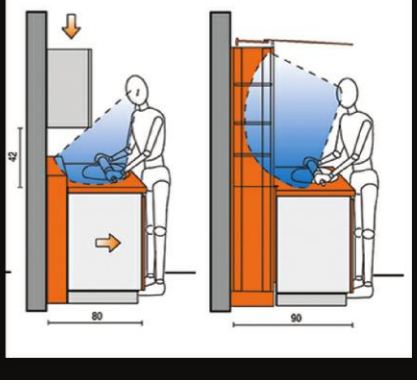
HAND GRIP BREADTH WITHOUT THUMB AT METACARPEL	MALE	100
	FEMALE	92
	COMBINED	100
FINGER TIP DEPTH	MALE	18
	FEMALE	15
	COMBINED	18

*dimensions in mm

For most cooks the optimum height is between 37 and 39 inches.
Cooking surfaces are usually set at about 36".







CHAPTER 5

Sustainability

The materials required for the project are somewhat easily available since that is the primary focus of my project, to make a biogas plant with the utilization of the local resources in order to keep it cost effective and efficient for the target market. However, for better negotiations and price comparisons, I decided to visit quite a few markets before purchasing the entire list of materials.

Owing to its small size, collecting the material required to make a biogas stove was somewhat convenient and I realized that I won't need a highly dedicated space for the purpose of implementing my experiment at a small level. It was, however, vital for me to familiarize myself with the accentuated safety precautions that I was required to take through the implementation of the process. Since methane is the major constituent of the biogas, it is understandable that it is highly explosive and hence, can turn out to be very dangerous. But getting rid of electrical items or flames during the experiment was not the only precaution that I had to take since there are various elements in biogas which are known to suffocate an individual in an event of inhaling over an extended period of time.

Materials chosen:

- Stainless steel
- High-density polyethylene (HDPE)

High-density polyethylene (HDPE)

HDPE is a plastic polymer that distinguishes itself with flexible properties making it far more useful and suitable for a remarkable range of applications. HDPE, as suggest by the name, offers a specific density that is higher than the standard plastic but the difference is generally considered to be marginal. What distinguishes HDPE from the rest of the forms of plastic is the complete absence of branching that makes it lighter but without having to make a compromise in terms of its tensile strength. HDPE is a linear polymer since it is closely packed without structural branching. Specific catalysts are actively used for the purpose of controlling or even causing a reduction in branching. A wide range of beneficial properties associated with HDPE make it a commendable option for multiple different products. It offers a specific gravity of 0.95 and its density is relatively higher as compared to the competitive polymers. It offers resistance against impact and is significantly harder in nature that makes it suitable to be subject to extreme temperature such as 120^{o}C without being damaged in any way.

The properties of this chosen material are as under:

- Offers super strength while being lightweight. A common milk jug that is made up of HDPE and weighs not more than a couple of ounces only is capable of holding at least a gallon of milk. This is exactly why the fuel and gas storage tanks are being made up of HDPE since reduced weight plays its role in improved efficiency and easy portability.
- Offers a unique feature of impact resistance. A toy truck that is dropped down the stairs will bounce back to avoid any kind of a damage. So in case of moving the storage tank made of HDPE any accident caused will have minimum damage.
- Offers resistance against weather and is long lasting. A product made of HDPE is more than sufficient for generations within the family.
- Offers resistance against insects, mold, rotting, and mildew.

- Offers a convenience of molding it into literally any shape possible, promoting the benefits of malleability of the plastic.

Since the companies and the communities are in pursuit of sustainability, the utilization of HDPE as an alternative to metals has been on a rise. Hence the biogas storage tank is being made from it as HDPE enables a reduction in the amount of material that will be utilized for the purpose of manufacturing. Thanks to its improved strength and reduced weight, HDPE casts a significantly lesser effect on the environment. For instance, it has been reported in a recent study that among the six different types of materials used for packaging, plastic is the one that delivers maximum amount of food with minimum amount of waste, utilization of energy, or a potential for global warming.

The recycle programs for plastics started back in the 1990s and via collective efforts, HDPE has enabled avoidance of landfills quite conveniently. HDPE even in the recycled form is just as versatile and useful as the virgin counterpart. It can conveniently be used in a range of similar applications as already mentioned above.

HDPE as a Sustainable Material:

Once the product has completed its life cycle, to begin with, the plastic is thoroughly sorted as well as cleaned in order to make sure that no amount of unwanted debris remains. Next, homogenization of the plastic occurs in order to ensure the HDPE is the only form that is being processed since the rest of the plastic polymers are known to cause damage to the recycled end-product.

Once produced, HDPE is melted down and shredded further in order to refine the quality. Once cooled, the pellets of HDPE are then useful in the manufacturing industry. The utilization of a baler can offer benefits to the recycling plants as

well. This is what helps in compressing the post-consumer waste leading to a reduction in the expenditure of energy for the purpose of transport.

- Since it is 100% recyclable, it is more convenient to be used over and again.
- The recycled HDPE materials can easily be placed back in the supply chain.
- HDPE is remarkably lightweight as compared to the alternatives.
- It is highly adaptable.
- It is the only form of plastic that offers packaging with an integrated handle as well as the pouring aperture that offers a better grip.
- It is highly innovative since it offers the blow molding equipment that aims at hitting the new milestones and push the boundaries a little.

STAINLESS STEEL

Stainless steel was first introduced in the year 1915. Ever since its launch, it has been utilized in a wide range of projects and industries owing to its corrosion and mechanical properties. Now since importance is being given to the utilization of sustainable materials, the remarkable environmental properties of stainless steel are also getting the recognition. Stainless steel is more than capable of meeting the lifetime requirements of pretty much any project. Combine it with the end of life recapture rate which can only be defined as astonishing and 100% recyclability; it is a commendable choice to say the least therefore in making of the biogas generating tank. It is also among the very few options of materials which offer the luxury of being cost-effective as well as being a green solution.

Stainless steel doesn’t degrade at all upon recyclable. The recycling process is quite similar to the one used for the production of its virgin form. A few of the raw materials included in stainless steel are iron, chromium, nickel,

molybdenum etc. all of which are pretty much in demand. Such factors play their role in making it a cost-effective option with high recapture rates.

The amazing recapture rates or its recyclability is not all that stainless steel has to offer in the realm of sustainability. If the corrosion conditions are considered thoroughly, a suitable or more compatible form of stainless steel can then be used in industry leading to a prolonged life time. The best part about stainless steel is that it doesn't lose its appearance or functionality over a period of time. Hence when the organic waste is being put inside in over the time, it won't corrode and will be quite suitable for the production of gas.

In addition, the appropriate stainless steel for a domestic project can lead to less lifetime maintenance and inspection costs, along with less production downtime costs. These properties allow stainless steel to be used in all types of application:

- In corrosive environments
- When strength is important.
- For appearance sake

1. PEOPLE

The material either in terms of its usage or in the process of production is not harmful for the mankind as far as health and safety is concerned. A sustainable material must not be harmful for the people who are working to produce it. It should also not be harmful to the people who are likely to be handling it or otherwise dispose or recycle it. Thanks to the added chromium, stainless steel offers a layer of protection by itself. Since it prevents corrosion, such a layer is known to improve the life of stainless steel. What needs to be ensured is that the stainless steel of correct grade is being used that is suitable for the individual requirements of the applications; it will remain to be harmless for the mankind

and inert in nature. This is what has made stainless steel a priority material in the food processing applications.

2. PLANET

The emission footprints in terms of the water, carbon, and air must be minimized. High levels of recyclability and reuse must be offered by the material. Owing to its longer life and low maintenance cost, it is destined to cast a minimal impact on the planet. It is highly convenient to use the stainless steel and recycle it for the purpose of producing more of stainless steel. The process can be carried out with no limitations. As per an estimate, it has been reported that at the end of stainless steel's life, at least 80% of it is recycled. Owing to the high intrinsic value of stainless steel, its collection and the process of recycling it is not usually associated with an economic incentive.

3. PROFIT

Long term sustainability, excellent reliability, growth, quality and value for the customers, and a supply chain that can be relied upon is what should be the features of an industry that makes use of a sustainable material.

Choosing stainless steel offers the benefits of being cost-effective, better life, and improved or convenient recycling once the life is over. This is what makes it a commendable choice in the context of economy not only for consumer durables but also in capital goods applications. As compared to the metals, the mechanical properties of stainless steel are also relatively better. Since it offers resistance against corrosion and fire, it is suitable for transportation purposes, public projects such as the subways and railways as well as for building bridges and tunnels. Such properties and the mechanical features make it a more cost effective and safer option for the consumer. It is also a commendable option for design or architectural projects since the appearance of stainless steel is quite aesthetic to say the least. Considering the reusability, recyclability, low maintenance, long life, emission associated with the process of production,

product safety, etc. the utilization of this material is still minimal as compared to any of the other alternatives. A precise yet detailed analysis on the sustainability feature that stainless steel has to offer makes it a reasonable choice to say the least. This is perhaps why the increment in the environmental or economic concern in the governments as well as the society is causing an increase in the utilization of stainless steel in various different projects.

It is interesting to note that as society and governments are becoming more conscious of environmental and economic factors, the growth in the terms of sustainability by the usage of such product will be wildfire in upcoming times. The usage of such sustainable product highlight a growing amount of awareness in regards to how to make responsible decisions when it comes to material selection and waste management. Ideally, the material industry, together with the green industry, will continue to educate designers, architects and consumers on the benefits of such materials, so as to ensure that this trend continues.

SUSTAINABLE DESIGN PARAMETERS

The entire life of this bio gas stove can be described as one set of activities and processes, while every one of them consumes a certain amount of resources and energy, goes through series of transformations and triggers emissions of various kinds.

To help to map out the actual life cycle of this biogas stove, these processes are divided into the following phases:

- Pre-production
- Production
- Distribution
- Use
- Disposal

The said solution hence keeping in mind the above processes is designed in such a way that it fits the parameters for the sustainable design, hence making it:

- Low cost solution
- Locally usage of material
- Portable
- Compact
- Sustainable

The Three P's of Sustainability

The concept of Triple Bottom accentuates the importance of social (people), economic (profit) and ecological (people) elements and states that an unequally distribution, compromise, or else exploitation of such factors is to be addressed in order to accomplish the goal of sustainability especially in this product. Alternatively, it is imperative for a product pursuit to emphasize on satisfying all three of these bottom lines or end values.

The concept of triple bottom was extensively utilized in designing the aforementioned product with a specific aim on protection of the:

1. **People:** None of the included groups are to be exploited in any way that inflicts harm or leads to unequal burden. Each individual is to be treated with fairness.
2. **Planet:** It is to be ensured that the major natural resources of the Earth including plants, wildlife, or otherwise the ecology of the planet are not being placed under unnecessary stress.
3. **Profit:** Lastly, it is being ensured that the pursuit of the above mentioned values does not hinder the economic or fiscal success of the product in any way.

The Three E's of Sustainability

Economy, Ecology, and the Equity are three of the prominent E's of Sustainability. The aforementioned approach is different from the traditional notion regarding sustainability since it creates a link between all of the three E's rather than focusing primarily on the concept of ecology and environmentalism only.

Attaining ecological sustainability without implementing the concept of equity is next to impossible. Similarly, the economic sustainability is also largely dependent on sound ecology. As a matter of fact, the origin of both the words (Ecology, Economy) is quite identical. "Oikos" as well as "Ecos" is a Greek work that means "Household". The basic concept being the sharing of a common household that goes by the name of the Earth.

The primary aim of sustainability is to address poverty and inequality. While on one hand, it's concerned with the preservation of the forests, on the other hand, it does also focus on the preservation of the communities which rely upon the forests. Addressing and eliminating discrimination is an imperative goal for sustainability. It aims at killing the corporate personhood. It focuses the resources on preventing the drastic climate change without necessarily having to exploit the impoverished or deprived mankind. It means real food or clean energy with but not at the expense of hurting the equity. It means empowering students and getting the younger generation out to cast their votes and be the protectors of justice not only within the campus but also far and beyond.

As Martin Luther King once said,

"Injustice anywhere is a threat to justice everywhere. We are caught in an inescapable network of mutuality, tied in a single garment of destiny."

Hence taking into account of the aforementioned values and principles, the biogas stove being designed is a cost effective solution which will cater to the domestic problem of people belonging to any class.

3E Framework

Ecological

This kitchen appliance is entirely free of producing any form of harmful radiations which are commonly associated with other appliances such as microwave ovens. Also with the utilization of the waste being produced in the kitchen, the costumers will be able to deem the organic waste useful by consuming it as an energy resource instead of just dumping and increasing landfill it will thereby, cause a remarkable reduction in the resources going to waste.

Due to the lack of complex mechanics, it would be far more convenient and user-friendly for the consumers to operate.

Economic

Owing to the gas shortage in Pakistan that is no longer confined to a particular geographical location, it is imperative that the kitchen appliance uses a self-producing energy system.

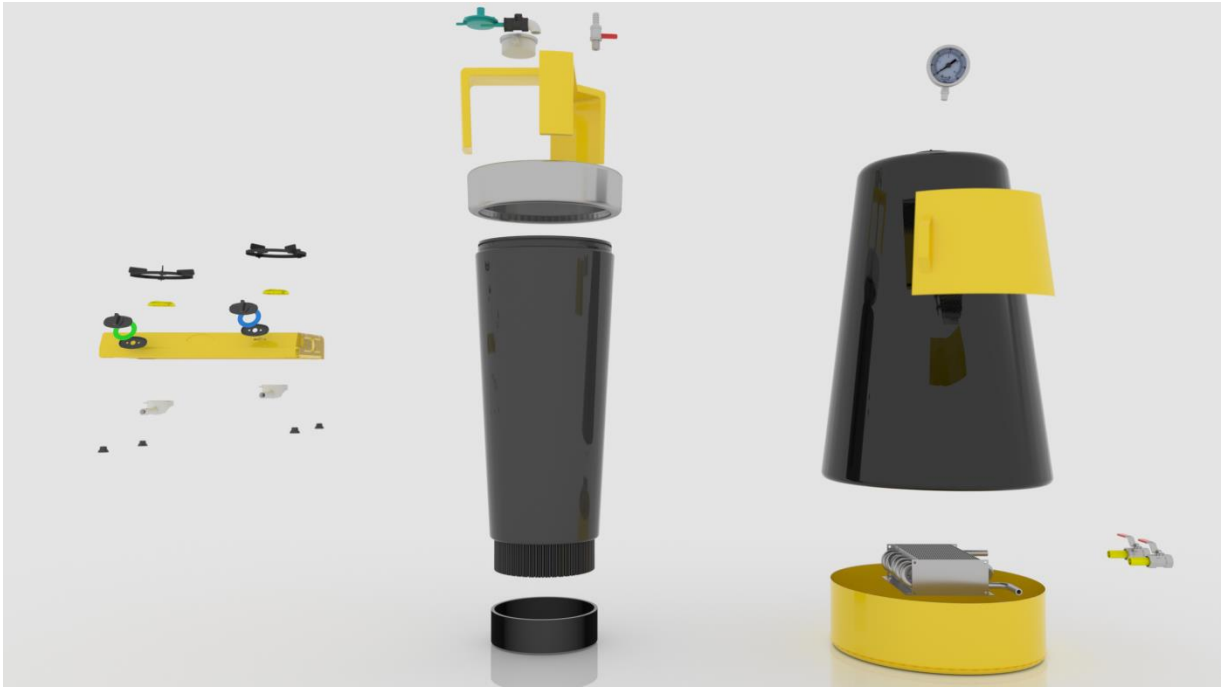
Incorporation of temperature, auto-control technology will introduce a user-friendly yet highly useful control panel in the unit.

Existence of kitchen appliance industries in Pakistan is next to nothing. Implementation of the product is likely to cause a boost in terms of the morale to improve the market demand. The assembly as well as manufacturing will be carried out locally with the utilization of the materials which are locally available. This is what will play its role in reviving the power of the Pakistani industries while being more cost-effective for the end user in the meantime.

Equity

No amount of encouraging the consumer to make use of the organic produce can offer the same results as the hands on experience where a user gets to watch the production of a resource all by himself. This social activity further strengthens the concept that the product is 100% organic in nature. Furthermore, it offers a learning experience for the user to not consider anything pure or organic in nature and also it will eliminate the frustration which one faces by daily load shedding.

Design for Disassembly



Sustainability Timeline

CHAPTER 6

Design Criteria

The following aspects will be addressed in the design criteria.

- Sustainable
- Compact
- Accessible
- Affordable
- Aesthetics
- Efficiency
- Easy maintenance

CHAPTER 7

Design and Fabrication

Components:

- Digester tank
- Inlet for feeding the kitchen waste
- Outlet for the digested slurry
- Gas collection and storage system
- Heat regulator
- Safety shutoff valve
- Moveable access hatch
- Chute
- Shredder
- Radiator
- Pressure regulator
- Pressure gauge
- Tubeless tire
- Gas valves
- Gas nozzle
- Stove

Processes:

1. Sheet cutting
2. Sheet bending
3. Welding
4. Leakage testing
5. Boring
6. Paint

Machines:

1. Cutting press
2. Bending press
3. Electric welding plant

TECHNOLOGY

LPG cooking burners (two burners) are usually modified to make it compatible with the biogas in atmospheric form. These burners consist primarily of four parts namely a nozzle, air regulator, injector and a head. The head is like that of LPG burners, however, it differs greatly in terms of the gadgets. Five trials were performed in order to get an insight about the performance of the burner specifically in terms of its color, the pressure, and the length of the produced flame. A blue colored flame was produced by the modified LPG burner in three layers. The lack of flu gas ensured minimization of environment hazards and promoted fire health.

The flame of combustion in atmospheric form is compost of three layers, Bunsen added, its most interval layer is inner flame. It is formed by combustion after Biogas mixed with primary air, and a cone in shape and blue in color. Outer flame is outside inner flame. It is formed by unbury Biogas from inner flame area which is differing and mixing with the surrounding air. It is purplish blue, and its tip is a bit round in shape. The outer flame is surrounded by an invisible high temperature film. The highest point of flame temperature is at the place which is outside, but was the tip of inner flame. (The Biogas Technology in China. December 05, 1989).

FORMING TECHNOLOGIES

Blow Molding is a manufacturing process by which hollow parts are formed. In general, there are three main types:

- Extrusion blow molding (EBM)
- Injection blow molding (IBM)
- Injection stretch blow molding (ISBM)

Cost:

- Moderate tooling costs
- Low unit costs

Quality:

- High quality: uniform thin walled parts
- High Quality surface finish i.e. gloss,
- Texture or matt

Compatible Materials:

- Thermoplastics

Deep Drawing is a metal forming process that forces a sheet metal blank into a closely matched die to produce very deep parts.

Cost:

- High to very high tooling costs
- Moderate unit costs

Quality:

- Good surface finish

Compatible Materials:

•Steel
•Zinc
•Copper
•Aluminum alloys

CNC Machining is a manufacturing process in which CAD data can be transferred directly onto the piece. It is carried out on a milling machine, lather and the result is rapid.

Cost:

•Low tooling costs
•Low unit costs

Quality:

•High quality finish that can be improved with grinding, sanding and polishing.

Compatible Materials:

•Plastic
•Metal
•Composites
•Ceramic etc.

Electrical Discharge Machining (EDM) uses high voltage sparks which erode the surface of the work piece or cut a profile by vaporizing the material, making it extremely precise. Used in conjunction with CNC machining and ideal for tool making of injection molding.

Cost:

•Low tooling costs
•Moderate to high unit costs

Quality:

•Very high control of surface finish and texture

Compatible Materials:

•Stainless steel

•Aluminum

•Titanium

•Brass

•Copper

Die Cutting is also referred as blanking, is a stamping process in which shapes are cut from sheet material using steel knives mounted on wooden tools. It is a rapid process utilized for mass producing.

Cost:

•Low tooling costs

•Low unit costs

Quality:

•High quality edge finish

Compatible Materials:

•Plastics

•Steel

•Fiber glass

•Other thin metals

Friction Welding is used for permanent joints in metals. There are 4 main techniques:

•Rotary Friction Welding

•Linear Friction Welding

•Orbital Friction Welding
•Friction Stir Welding

Cost:
•Low to moderate unit costs

Quality:
•High strength joint

Compatible Materials:
•Most ferrous and nonferrous materials including
•Low carbon steel
•Stainless steel
•Aluminum Alloys etc.

FINISHING TECHNOLOGY

Anodizing refers to a group of processes that are used to treat the surface of metals. It builds up a naturally occurring oxide layer on the metal. The film is hard, protective and self-healing.

Cost:
•Tooling is not necessary
•Low unit costs, but increases with film thickness

Quality:
•High quality, light weight and very hard

Compatible Materials:
•Aluminum
•Magnesium
•Titanium

Future Technology Paving the Way:

The availability of a uniquely design combustion system that is likely to capacitate switching between biogas, natural gas, and even propane and that too in real-time is destined to make the proposed solution more convenient and acceptable to the target market, specifically the one that is under the curse of gas load shedding. With the utilization of low-swirl burner that is highly fuel efficient and an inbuilt fuel sensor technology, such a combustion system will make it more viable for the small-scale biogas solution to be used by a layman in everyday life.

Owing to the fact that a major hurdle in implementing a biogas solution in the kitchen is an inconsistent supply of biogas, such a hybrid technology addresses the concern and paves the way for commercial availability of biogas solutions. With an inbuilt sensor, the combustion system automatically switches to propane or natural gas, depending on what is available, as soon as the biogas supply starts to dwindle. Since none of the components are to be shut down and the switching is completely automatic, the hybrid technology opens new horizons of solutions for the potential consumers who are taking a serious hit in the name of gas load shedding.

CHAPTER 8

Conclusion

In summary, being a reliable source of energy, biogas-based solutions are remarkably cost efficient in it since it makes use of the daily organic waste of the household including the kitchen leftovers etc. Furthermore, since the waste material is being recycled to produce energy, it further saves the cost of waste removal in order to prevent its negative impact on the environment and human life. The project after this research phase informs further understanding of the mechanism and the control of bio gas. This can be conducted in alliance with the minds from the environmental and chemical engineering domain.

The research conducted until now sheds light on data gathered, the user habits and the technological advancements in this field around the world. With the implementation of the learned skills to articulate the identified problem, an affordable and sustainable solution which understands the target user will be developed to form an expression for the respective design problem.

The effective execution of this biogas digester for production of biogas by decomposing kitchen waste offers a relevant resource development solution and a rigid waste management system. Its low cost and its independent working conditions under suitable considered parameters prove that it is economic. It has suddenly experienced a significant positive vibe in the recent go and is a strong contender in becoming the next renewable energy source. This plant is more employable in urban region as more amount of organic waste is generated in urban region due to larger population. Whereas it is worth mentioning that it can also influence rural regions as this regions are deceived from sufficient fuel supply. In the long run it could reduce the consumption of LPG and thus curb dependence on imported fossil fuel. For this graduation project, the built system costed around Rs. 30,000 which can be further reduced once mass produced.

By using kitchen waste as a source of biogas, there will also be a reduction in the volume of household garbage and reduction in the dependence on imported

fossil fuel like LPG. Also with the utilization of slurry for gardening it can be easily managed and used in kitchen gardening.

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