Eco Friendly Fuel Methane Its Production, Separation, Storage And Data Acquisition System.

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Abstract **- The enormous consumption of petroleum has increased the depletion rate of petroleum from the earth's crust. The combustion of these fossil fuels release carbon-dioxide along with other harmful gases. This has increased global warming to much extent. To solve this problem we need to make use of Eco-friendly fuels. Also there is Rapid increase in generation of waste, which has resulted in increase in pollution rate of environment. There are many people working on reusing of the waste but the amount of waste generated is so high that it has become difficult to collect waste, store it, separate it, recycle it and reuse it. So we decided to make such a system that will generate Eco-friendly fuel and also can be installed in every residential area or to be more précised in every building not only this but a system that can be installed in each and every house which would solve the problem of waste management and we will get an pollution free environment to live in. For making this system small so that it can be easily installed anywhere we have taken help of electronics and controlled all procedure with electronic circuits.**

Keyword – Bio-waste, Crusher, Digester, Biogas, Methane, Gas sensor, Compressor, Blades, Cow dung, sludge.

I. INTRODUCTION

Waste is such a parameter of day today life which cannot be neglected neither can be eliminated from environment, so we have found a solution to collect it in a disciplinary manner and then recycle it and reuse it for other chores of work.

The problem that we are facing is the collection of waste and its separation. People just dump the waste from their houses, general stores, etc in environment without thinking on future consequences. Not only this but people also burn the non degradable waste like plastic which results in air pollution, they even dump wastes in water making it polluted.

So we decided to make such a system that can be installed anywhere and can be used by anyone easily. In our system we are going to use only bio degradable waste.

Methane is the chief constituent of natural gas. It is a colourless and odourless gas. Methane is simplest alkane with the chemical formula CH_4. Methane is called as an attractive fuel as it is available in abundance. However, methane is a gas at normal conditions, it is difficult to store and transport it. Methane is often transported as refrigerated liquid.

Methane is also a potent greenhouse gas. The boiling point of methane is -161^0 C at a pressure of one atmosphere. It is lighter than air and it is lightly soluble in water.

In general methane is very stable; however the mixtures of methane and air are explosive. Combustion of methane produces less carbon-dioxide when compared with other fuels. Also methane produces more heat than other fuels when compared with the same quantity.

Why methane?

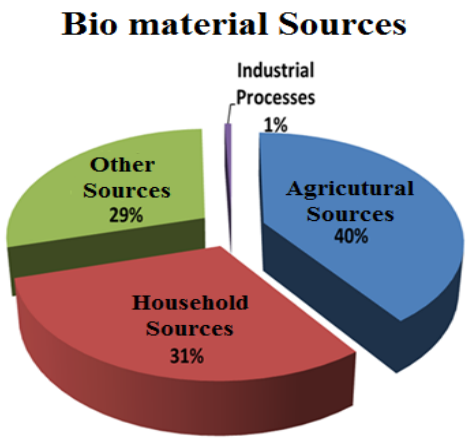
India is called land of villages and the main occupation here is farming. More than 50% population leaves in villages and almost in every house their lives cattle. Thus production of methane in India is not a big deal. Not only from cattle's but methane can be easily produced from many other sources. For production of methane the main ingredient required is biomaterials and this can be easily obtain from not only from residential areas but from industries too.

Some sources of Bio materials are:-

1. Cattle dung.
2. Bio-waste from agriculture.
3. Bio-waste from residential areas.
4. Bio-waste from industries.
5. Leftover food products from Hotels, Restaurants, Parties, etc

And the list is never ending.

The above scenario can be easily understood by graph given below.



Converting Waste-to-Energy are hot topics throughout the global landscape. The conversion process consists of a number of physical and complex chemical steps which serves a much needed civic function that at the end of the day produces potentially carbon-neutral energy.

We made use of use of all available resources as per mentioned list and made this project a success.

Composition of Biogas:-

The biogas contains different types of components in different amounts depending upon the source of waste material used. The following table shows us the percentage of each component in different types of sources used.

RAW BIOGAS	VOLUME IN %		
	HOUSEHOLD	AGRICULTURE	AVERAGE
CH4	55-65	60-75	60-75
CO2	25-35	23-31	24-33
H2O	0-1	0-1	0-1
O2	0-0.5	0-1	0-0.75
N2	0-7	0-1	0-5
H2S	0-1.5	0-2	0-1.5
OTHER	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE

Table no 1. Composition of Biogas

II. OPERATION AND WORKING

Methane, the chief component of natural gas, is produce in nature by bacterial decay of bio-wastes in the absence of oxygen. This process is called anaerobic digestion. The condition necessary for anaerobic digestion process include temperature e, pressure, type of biomass used, mixing ratios, amount of moisture added, acidity, stirring, etc. The by-product of this process is mineral rich fertilizer. After achieving all this parameters we mix this all in a container mainly made of concrete and keep this mixture into it till we get methane and use it as per our needs. This is how methane is produce using natural process. But being an electronics engineer aim of our project is to produce it by creating an electronic environment and setup its working model in every house (mainly in metropolitan cities as here land available for natural production manner is negligible), industries, etc and try to minimize consumes of petroleum products such as Petrol, Diesel, gasoline, etc.

III. LITERATURE SURVEY.

- Methane as a fuel is already been used in the form of CNG, and this what have made us to think out of the box.
- We want methane use to be boosted but there are many problems been faced currently.

Example:

1. **Production:** The plants need to be setup in or near the coastal regions as CNG is obtained from oceans and seas.
2. **Refination:** The obtained fuel from earth crust is not pure and also it has other fuels mixed with it, and thus for Refination huge plants are needed to be setup.
3. **Storage:** Once the fuel has been refined it needs to be stored, so large storage tanks/containers are required.
4. **Transportation:** As these plants are located mainly in coastal areas, transportation of fuel to other parts of the country is carried out using huge tankers may be via road or via rail.

From the examples mentioned above its crystal clear that the in order to use methane as fuel the cost of its production till transportation is very high and thus the fuel costs are also very high.

- Taking into account the importance of methane and the cost of its production till transportation we got an idea that why we cannot built a plant which will produce methane that to in each and every residential areas and overcome the above problems and make methane available to every individual at much cheaper rate.
- There are many methane generating plants and our project is relevant to them.
- But the plants that are present are very huge and situated in a very large area.
- Thus there is wastage of land and money and also the time and raw materials required in setting such a huge plant.
- The basic idea of our project is to build a miniature module of this plant that can be easily installed in urban areas.
- And to make this project possible in electromechanical platform.

IV. BLOCK DIAGRAM.

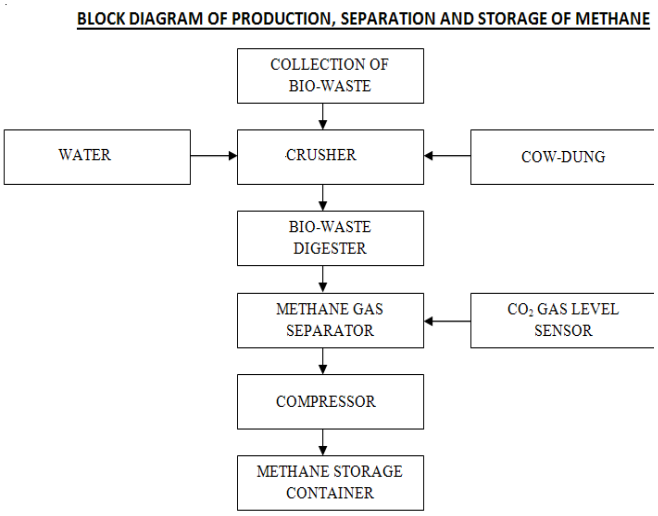


Fig 2. Block diagram of production, separation and storage of methane.

A. Cow Dung:

This is the most important element in Bio-waste. Cow Dung contains anaerobic microorganism that are essential for production on high quality manure. It acts as a catalyst in the reaction. It takes long time for the decomposition on other Bio-wastes thus Cow Dung is used.

It also plays an important role in maintaining pH level of the reaction. For production of manure the acidity of the reaction is one of the most important parameters. There is decrease in acidity of the mixture in accordance with time. So using mixture of Cow Dung and water we are going to maintain acidity of the reaction.

B. Water:

For production of manure we are using different types of Bio materials such as Cow Dung, Dead/Dry leaves, Bio-waste from agriculture, Bio-waste from residential areas, Bio-waste from industries, Leftover food products from Hotels, Restaurants, Parties, etc. Viewing the above list it is very clear that they all are in different states, i.e.: Solid, Liquid, Semi Solid, etc. So in order to bring them all in same in same state that is a Semi Solid state but with high amount of water content we use water.

And also water plays its role in maintaining pH level of the reaction. It acts as a neutralising agent.

C. Other Bio-waste:

The Biological wastes from agriculture, residents, restaurants and hotels, industries, etc., are the few examples of bio-waste that are to be used in production of manure. The care should be taken that only Bio degradable waste is used and not any other waste which are not degradable such as plastic.

D. Crusher:

The size of different waste materials differs from each other, which may lead into slowing down of reaction. It is very important to maintain unit size of it. So by using crusher, the waste materials will be grinded to a unit size and it will be supplied to the digester along with water. The grinded waste material along with water is now in semi-liquid form. This semi-liquid form of waste is called as sludge.

E. Bio-waste digester:

The sludge is then passed into the bio-waste digester. Here the actual fermentation process takes place. To fasten the process we need to add cow dung in appropriate amount. As the fermentation process takes place, biogas is generated. The by-product of this process is mineral rich fertilizer. This fertilizer can be used in farms for the enrichment of soil in farms. Thus the fermentation process does not create any waste material further. Thus we are making proper use of bio-waste material for the generation of eco-friendly fuel-Methane.

F. Methane separator:

Main target is to separate methane from generated biogas and this process will take place here. The biogas contains 65% of methane and 30% of carbon dioxide on an average. To use this methane as fuel we need to substitute this percentage of carbon dioxide by oxygen. The oxygen helps methane to combust properly. We can neglect the rest 5% of other gases as this amount is negligible when compared with the content of methane gas in biogas.

The scientific methods used in laboratory for the separation methane from gas are listed below:

1. The biogas is passed through NaOH bath.
2. Separation using water scrubber method.

The methods mentioned above are time consuming methods. And also these methods are not suitable for the miniature model which is to be setup in residential area.

We only need to eliminate the content of carbon dioxide from the biogas. For this the best solution is to pass the gas from a closed container containing **Tulsi (Ocimum tenuiflorum) Plants**. The gas is allowed to be in this container for duration of approximately 20-30 minutes. During this period the Tulsi plant absorbs the carbon dioxide and gives equivalent amount of oxygen. This setup is small and less time consuming method when compared with the above two methods mentioned. Hence this method is preferred.

The mixture of methane and oxygen is now explosive and it is ready to be used as a fuel.

G. Compressor:

The separated methane gas is then given to compressor, where it compressed at a very high pressure but mainly below 4atm pressure.

H. Methane gas storage container:

The methane gas is now stored in the methane gas storage container. The gas is now ready to be used from the cylinder just like we use an LPG gas cylinder.

I. Gas sensor:

We use a carbon dioxide sensor in the methane separator to know the relative level of carbon dioxide in the separator. Depending on the value of gas sensor we can extend the duration for separation.

V. SCHEMATIC DIAGRAM.

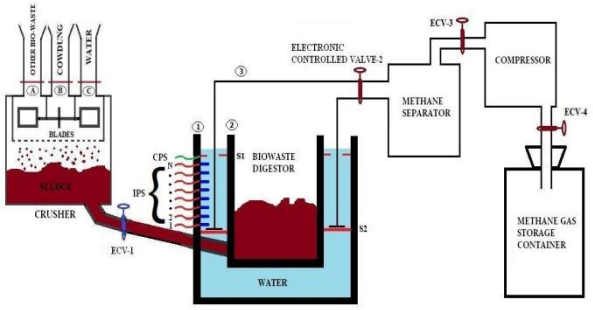


Fig no 3. Schematic diagram of whole system

Fig no 3. Depicts schematic diagram of the whole system. Here we have three inlets. We collect the bio-waste material through Inlet A. Inlet B and C is for cow dung and water respectively. With the help of blades, the crusher grinds the bio-waste along with water and cow dung to make it in uniform size known as sludge. The sludge is passed on to the bio-waste digester with the help of electronic controlled valve ECV-1.

The bio-waste digester consist of 3 containers, 1st is outer container, 2nd is inner container and 3rd is inverted container. The sludge is then allowed to get fermented in this bio-waste digester i.e. in 2nd container. The gas generated after the fermentation is the biogas. Biogas is low density gas and rise above, which is against the force of gravity, thus when amount of biogas in a digester increases, the 3rd container lifts up. Here we use IPS sensor to detect the relative position of the 3rd container. Initially all the IPS sensors are on. As the 3rd container lifts up to the maximum level one by one IPS sensors gets off. When all the IPS sensors are off, then ECV2 is opened and gas is passed to methane gas separator. As soon as the gas is passed to the separator all the IPS sensors are on again and then the ECV-2 is closed.

Water acts as anti-catalyst so it is filled between 1st and 2nd container. There by restricting methane gas to escape. Here we use CPS sensor to detect the water level within the two containers.

After the separation of methane from other gases mainly the carbon dioxide in the separator, the gas is given to the compressor through ECV-3. The methane gas is then compressed and stored in the storage gas container.

Reactions of methane with other gases in bio-waste digester:

$$CH_4 + O_2 \rightarrow CH_3 + HO_2$$
$$CH_4 + OH \rightarrow CH_3 + H_2O$$
$$CH_4 + O \rightarrow CH_3 + OH$$

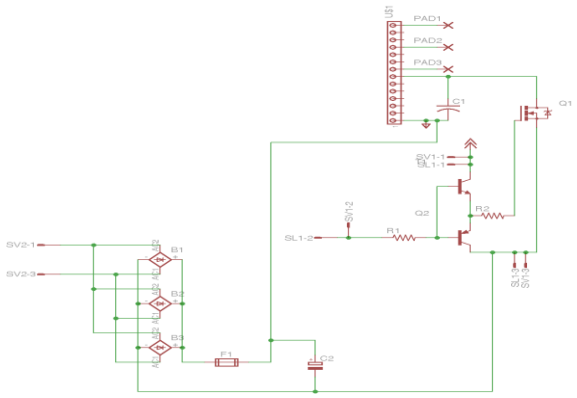
Methane reacts with halogens given appropriate conditions as follows:

$$X_2 + UV \rightarrow 2\ X\bullet$$
$$X\bullet + CH_4 \rightarrow HX + CH_3\bullet$$
$$CH_3\bullet + X_2 \rightarrow CH_3X + X\bullet$$

Where X is a halogen: fluorine (F), chlorine (Cl), bromine (Br),iodine (I). This mechanism for this process is called free radical halogenations. It is initiated with UV light or some other radical initiator

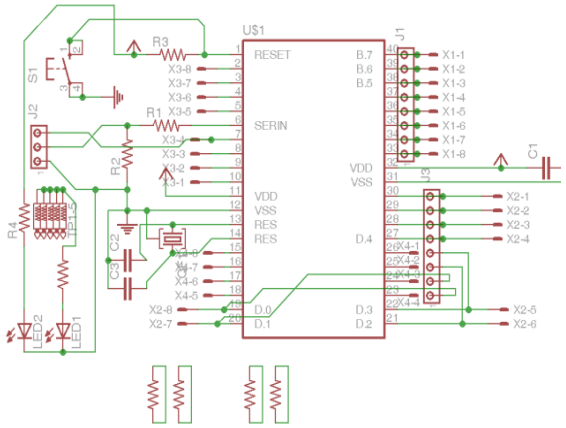
VI. CIRCUIT DIAGRAM

A. MOTOR DRIVING CIRCUIT.



The above circuit is used for controlling RPM of the motor used for driving blades of crusher. This circuit can be used for controlling all types of motors that are available in market. Here power MOSFET (IRFP460) is used to control the motor. Switching of MOSFET is controlled by using simple configuration of class B complementary push-pull amplifier (You can also use class AB). Input to both the BJT is a square wave. Square wave can be generated either by using op-amp or using micro-controller. Supply to motor is 230Vdc given via fuse, in order to avoid excess current to motor. Capacitor C2 is filter capacitor and capacitor C1 is used as a protection to the circuit from the back emf of the motor.

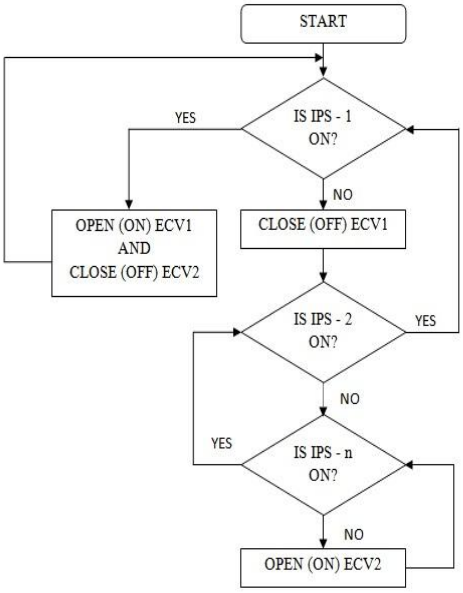
B. DATA ACQUISITION SYSTEM.



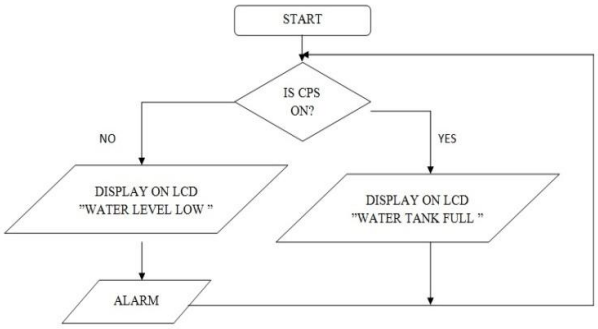
For making system automated we are using PICAXE-40X2 (micro-controller). PICAXE-40X2 has 4 ports that are A, B, C, and D. You can use any port as input and any port as output. The output from the sensors is given to any of the above port (let us consider Port A as input port). As per the below flow chart the controller will take action and control the output (Input to ECV, LCD, etc) and whole system will be controlled.

VII. FLOW CHART.

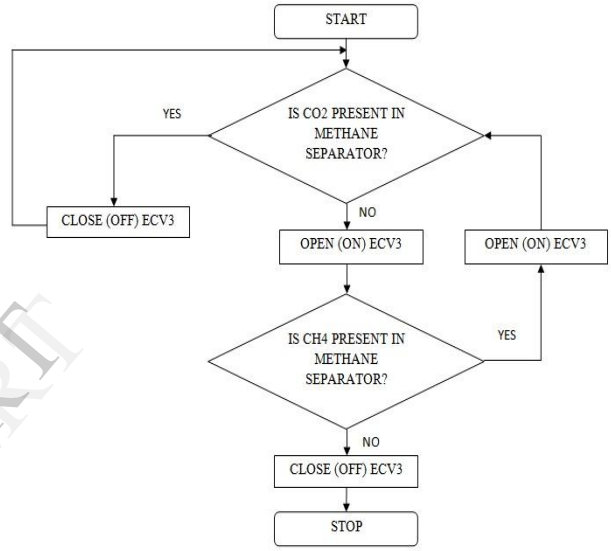
FLOW CHART FOR CONTROL OF DIGESTOR.



FLOW CHART FOR CONTROLING WATER LEVEL.



FLOW CHART FOR CONTROL OF METHANE SEPARATOR.



VIII. SENSOR DECLARATION.

A. **IPS** – Inductive Proximity Switch. This sensor is used for controlling/monitoring height of the 3rd container.
B. **CPS** – Capacitive Proximity Switch. This is used for monitoring water level in the 1st container.
C. **MQ-4** – Methane gas sensor.
D. **PT100** – Temperature sensor.
E. **MG811** – CO2 gas sensor.

IX. ADVANTAGES.

1. Portable system.
2. Cheaper module from installation point of view in urban areas.
3. Miniature module.
4. Easy to install.
5. User friendly.
6. Readily available.
7. Proper waste management.
8. Pollution free environment.
9. Cheaper than any other fuel.

X. RESULTS.

1. **Universal Bio Mass Crusher:** Any type of Bio Mass can be converted into sludge.
2. Small module of sludge production.
3. Small module of methane production.
4. Effective utilization of waste materials.
5. Lesser consumption of petroleum.
6. Pollution free environment.

XI. FUTURE SCOPE.

1. Revolution in automobile industry.
2. Lesser dependency on foreign countries for petroleum.
3. Inclusion of Data Acquisition System.
4. Whole system monitoring using SCADA.
5. Maximum utilization of non-conventional resources.

XII. REFERRENCES.

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5. Organic chemistry, By Prof. Arihant.