BIOGAS FROM KITCHEN WASTE

The methanogens (methane producing micro-organisms) belong to a group of bacteria called Archebacteria. They evolved when the earth's atmosphere did not have any oxygen. After the evolution of green plants, the oxygen content of the atmosphere started to rise. Being unable to survive in an oxygen rich atmosphere, the methanogens retreated to places that were devoid of oxygen. Today they are found in marshes, rice paddies, at the bottom of water bodies and in the intestines of animals. They survive in the intestines of animals by eating what the animals eat. The methanogens can easily digest sugar, starch, fats and proteins. They can also digest cellulose, albeit rather slowly, but they cannot digest lignin at all. Their digestive mechanism is similar to that of many other organisms, up to the point of converting the food into acetic acid. In the case of organisms breathing oxygen, the acetic acid gets converted into carbon dioxide and water ($CH_3COOH+2O_2 = 2CO_2+2H_2O$), whereas the methanogens convert it into methane and carbon dioxide ($CH_3COOH = CH_4+CO_{2)}$. The methanogens, are universally present in the faeces of all animals, because they are thrown out of the body along with the faeces. Faecal matter is not their food.

Because the methanogens can digest all forms of human food and also cellulosic biomass, they are ideal for producing methane from kitchen waste. Because the metanogens reside in the intestines of animals, they work optimally at temperatures equal to the body temperature of animals, which is about 38C. They also need a medium having pH value of around 7. At this temperature and pH, they can convert human food into biogas within a period of about 24 hours. 1 kg (dry weight) of human food yields about 1 kg (about 800 litres) biogas. To get the same quantity of biogas from dung, one needs about 40 kg dung, and a fermentation period of about 40 days. Because of the lower quantity of feedstock and lesser fermentation time, the size of the kitchen waste biogas plant is much smaller than that utilising dung. According to theoretical calculations, biogas should normally contain volumetrically about equal amounts of methane and carbon dioxide, but actually the methane content is generally around 60%. Pure methane has the same calorific value as LPG (about 11,000 kCal per kg), but because of the presence of carbon dioxide, the calorific value of biogas is only about 4000 kCal per kg. Therefore, to get the same heat as from an LPG burner, a biogas stove is designed to deliver volumetrically about 3 times as much gas per unit time as LPG.

The waste material to be fed into a biogas plant should contain only digestible organic material. Other organic products like plastic, rubber, petroleum, bones, hair, horns, hooves or wood (i.e. lignin), cannot be digested by the methanogens. If highly lignified material like agricultural waste is to be converted into methane, one has to use a biphasic digester. In this system, the waste is first subjected to aerobic decomposition, after which it is leached out with water and the leachate is fed into the anaerobic digester. The aerobic organisms in the leachate die due to lack of oxygen in the anaerobic digester and their cells serve the methanogens as food.

Operators of a biogas plant must keep in mind that this is a living system. Introduction of any toxic or bactericidal material into the biogas plant would kill the methanogens and the system would stop producing methane. Overfeeding should also be avoided. A biogas plant harbours several other micro-organisms besides the methanogens. If the biogas plant receives more feed than the digestive capacity of the methanogens, the undigested food serves the non-methanogenic organisms as nutrition, causing the latter to increase their numbers. Increase in the population density of non-methanogenic organisms causes reduction in that of the methanogens, inhibiting the formation of methane.

ARTI Biogas:

Appropriate Rural Technology Institute (ARTI) has developed a biogas system for using food waste as feedstock. The biogas systems are supplied by Samuchit Enviro Tech Pvt Ltd (SET).

The particulars of the standard modules offered are as follows.

Description	**0.5 m^3 digester**	**1 m^3 digester**	**2 m^3 digester**
Maximum food waste that can be accommodated:	1-2 kg	4-5 kg	10-12 kg
Gas production capacity:	~ 100 gm LPG equivalent per day	250-300 gm LPG equivalent per day	750 gm LPG equivalent per day
Space required:	1 m^2, open to sunlight throughout the day	2 m^2, open to sunlight throughout the day	4 m^2, open to sunlight throughout the day
Water required:	10-20 lit/day (if operated only on food waste)	20-30 lit/day (if operated only on food waste)	30-40 lit/day (if operated only on food waste)
Labour required:	30 min/day	30 min/day	1 hr/day
Approximate Cost (including installation, excluding transport)	Rs.15,000	Rs.25,000	Rs.40,000

Advantages:

- It generates a clean cooking fuel that can replace LPG.
- It also generates organic fertilizer in the form of spent slurry.
- It is easy to use and maintain because it is above ground.
- There is no smell, mosquitoes, dogs, vermin, flies, etc.
- All the organic waste is disposed off at source.
- Payback period is expected to be 4-5 years only, whereas the life of the biogas plant is 20 years.

Based on quantity of food waste as well as space available, customised solutions are also offered.

For more information:

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Please visit: www.samuchit.com, for free downloadable videos on ARTI biogas.

0.5 m^3 ARTI biogas plant

1 m^3 ARTI biogas plant

7 m^3 ARTI biogas plant – customized solution