BIO- GAS

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INTRODUCTION

• **Biogas**
  
  One excellent source of energy is Biogas. A fuel which is produced from the breakdown of organic matter. When bacteria decompose, *especially in the absence of oxygen*, i.e. *anaerobic digestion of organic material* like animal residues and domestic and farm wastes, abundantly available in the countryside. Biogas is a mixture of about 60 percent methane and 40 percent Carbon dioxide.

• **Methane** is the main component of natural gas. It is relatively clean burning, colourless, and odourless. This gas can be captured and burned for cooking and heating.

• **Bio gas generally comprise of 55-65% methane, 35-45% carbon dioxide, 0.5-1.0% hydrogen sulphide and traces of water vapour.**

• **Average calorific value of bio gas is 20MJ/m3 (4713kcal/m3).**
• Biogas Cannot be liquefied under normal temperature and pressure.
• Critical temperature required for liquefaction of methane is -82.10°C at 4.71 Mpa pressure, therefore use of biogas is limited near by the biogas plant.
• An estimate indicates that India has a potential of generating 6.38×1010 m3 of biogas from 980 million tones of cattle unproduced annually.
• The heat value of this gas amounts to 1.3×1012 MJ. In addition, 350 million tones of manure would also produce along with biogas.
THE QUANTITY, RATE AND COMPOSITION OF BIOGAS GENERATED DEPENDS ON

- Temperature (35-37°C, Mesophilic condition)
- C/N ratio (optimum between 25:1 to 30:1)
- pH (optimally pH between 6.8-7.2)
- Solid content (feed material should have approx. 10:1)
- Should not have toxic material/harmful material to bacteria in digester
- HRT (Hydraulic Retention Time – 30, 40, 55 days)
- Loading rate
SOURCES OF BIO-GAS

• Animal manure
The largest resources for biogas production are found in agriculture. Approx. **4-5% of the animal manure** produced is currently used for biogas production.

• Industrial waste
Existing biogas plants also take in considerable amounts of organic industrial waste from the **food industry** including slaughterhouse waste. In this case, the organic matter is used for energy production and the nutrients are recycled to agricultural land to replace commercial fertilizer. This resource also contributes significantly to making the biogas plants viable, partly because the waste often has a **high gas potential**.

• Sewage sludge
Much of the sewage sludge currently produced is already being digested at sewage treatment plants around the country. In certain instances, it may be possible to redirect the sludge to biogas plants and thus ensure a better digestion of the sludge and, not least, a recycling of the nutrients to farmland. In any future expansion of sewage treatment facilities, it is advisable to opt for the **anaerobic process that produces energy** rather than the aerobic process that uses energy.
• Household waste

Household waste can also be used in biogas production and has previously been used in several plants. In some plants this is still the case, but most have stopped the use, either due to problems with the sorting resulting in too many impurities (knives and forks, plastic bags etc.) that upset the digestion process, or due to problems with smell. This disposal route must, however, still be regarded as the most sustainable, due to the scope for energy extraction and recycling of nutrients.

• Energy crops

In recent years the use of energy crops has become increasingly interesting partly because of the limited supply of organic industrial waste. Virtually all arable crops can be used, as can crop residues such as turnip and potato tops. The only requirement is that the crop must be relatively easily digestible.
Biogas plant

Fixed-dome plant

1. Mixing tank with inlet pipe.
2. Digester.
3. Compensation and removal tank
4. Gasholder
5. Gaspipe
6. Entry hatch with gastight seal
7. Accumulation of thick sludge
8. Outlet pipe
**Digester**
The digesters of fixed-dome plants are usually masonry structures, structures of cement and ferro-cement exist. Main parameters for the choice of material are:
· Technical suitability (stability, gas- and liquid tightness);
· cost-effectiveness;
· availability in the region and transport cost

**Advantages:**
Low initial costs and long useful life-span; no moving or rusting parts involved; basic design is compact, saves space and is well insulated; construction creates local employment.

**Disadvantages:**
Masonry gas-holders require special sealants and high technical skills for *gas-tight construction*; gas leaks occur quite frequently; expensive in bedrock.
A floating-drum plant consists of a cylindrical or dome shaped digester and a moving, floating gas-holder, or drum. The gas-holder floats either directly in the fermenting slurry or in a separate water jacket. The drum in which the biogas collects has an internal and/or external guide frame that provides stability and keeps the drum upright. If biogas is produced, the drum moves up, if gas is consumed, the gasholder sinks back.
Advantages:

They provide gas at a constant pressure, and the stored gas-volume is immediately recognizable by the position of the drum. **Gas-tightness is no problem, provided the gasholder is de rusted and painted regularly.**

Disadvantages:

The steel drum is relatively expensive and maintenance-intensive. **Removing rust and painting** has to be carried out regularly. The life-time of the drum is short.
Biogas Plant

20 m³/day Capacity Biogas Plant installed at IIT Delhi
Biogas Plant Designs

Floating Drum

Fixed Dome
## ORGANIC WASTES & THEIR ESTIMATED AVAILABILITY IN INDIA

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Organic Wastes</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Municipal Solid waste</td>
<td>30 million tons/year</td>
</tr>
<tr>
<td>2.</td>
<td>Municipal liquid waste</td>
<td>12000 million litres/day</td>
</tr>
<tr>
<td>3.</td>
<td>Distillery (243 units)</td>
<td>8057 kilolitres/day</td>
</tr>
<tr>
<td>4.</td>
<td>Press mud</td>
<td>9 million tons/year</td>
</tr>
<tr>
<td>5.</td>
<td>Food &amp; fruit processing wastes</td>
<td>4.5 million tons/year</td>
</tr>
<tr>
<td>6.</td>
<td>Willow dust</td>
<td>30000 tons/year</td>
</tr>
<tr>
<td>7.</td>
<td>Dairy industry waste</td>
<td>50-60 million litres/day</td>
</tr>
<tr>
<td>8.</td>
<td>Paper &amp; pulp industry waste (300 mills)</td>
<td>1600 m$^3$/day</td>
</tr>
<tr>
<td>9.</td>
<td>Tannery (2000 units)</td>
<td>52500 m$^3$ waste water/day</td>
</tr>
</tbody>
</table>

Source: MNES Report, Renewable Energy in India and business opportunities, MNES. Govt. of India, New Delhi, 2001
# BioGas Production Potential from Different Wastes

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Raw Material</th>
<th>Biogas Production (Litres/kg)</th>
<th>Methane Content in Biogas (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cattle Dung</td>
<td>40</td>
<td>60.0</td>
</tr>
<tr>
<td>2.</td>
<td>Green leaves and twigs</td>
<td>100</td>
<td>65.0</td>
</tr>
<tr>
<td>3.</td>
<td>Food Waste</td>
<td>160</td>
<td>62.0</td>
</tr>
<tr>
<td>4.</td>
<td>Bamboo dust</td>
<td>53</td>
<td>71.5</td>
</tr>
<tr>
<td>5.</td>
<td>Fruit waste</td>
<td>91</td>
<td>49.2</td>
</tr>
<tr>
<td>6.</td>
<td>Bagasse</td>
<td>330</td>
<td>56.9</td>
</tr>
<tr>
<td>7.</td>
<td>Dry leaves</td>
<td>118</td>
<td>59.2</td>
</tr>
<tr>
<td>8.</td>
<td>Non-edible oil seed Cakes</td>
<td>242</td>
<td>67.5</td>
</tr>
</tbody>
</table>
APPLICATIONS OF BIOGAS

**Cooking**: Biogas can be used in a specially designed burner for cooking purpose. A biogas plant of 2 cubic metres capacity is sufficient for providing cooking fuel needs of a family of about five persons.

**Lighting**: Biogas is used in silk mantle lamps for lighting purpose. The requirement of gas for powering a 100 candle lamp (60 W) is 0.13 cubic metre per hour.

**Power Generation**: Biogas can be used to operate a dual fuel engine to replace up to 80 % of diesel-oil. Diesel engines have been modified to run 100 per cent on biogas. Petrol and CNG engines can also be modified easily to use biogas.

**Transport Fuel**: After removal of CO2, H2S and water vapor, biogas can be converted to natural gas quality for use in vehicles.
FIG: POSSIBLE APPLICATION OF BIOGAS

- 5 hp Engine for 1.5 Hrs.
- Cooking for 16 Person
- Mantle lamp (100 C.P.) 25-28 Hrs.

- 10 Cattle or 6 buffaloes or 8 bullocks
- 100 kg. Dung + water equal 4 cum gas/day
- 70-80 kg. wet Digested slurry Enriched manure
- Electricity (5 Unit)
BIOGAS BURNERS FOR COOKING
Biogas Lamp For Lighting

ON - OFF Gas Lock

Gas Regulator

Opening screw

Mantle

Venture Tube

Clay Nozzle

Glass Globe

INSIDE TYPE Lamp
Diesel / petrol saving (dual fuel mode) However, the power obtained is less as compared to liquid fuel alone, engine become hotter hence cooling has to be kept in good condition.
Table - Quantity of Diesel oil saved by running a 5 hp dual fuel engine on biogas.

<table>
<thead>
<tr>
<th>Size of biogas of dies (lit./day)</th>
<th>5 hp engine is run twice a day</th>
<th>Quantity Diesel oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4 hr</td>
<td>3.6</td>
</tr>
<tr>
<td>15</td>
<td>6.5 hr</td>
<td>5.8</td>
</tr>
<tr>
<td>25</td>
<td>12 hr</td>
<td>10.8</td>
</tr>
</tbody>
</table>
Possible Application of Biogas - Cooking. Lighting “Motive power Generation”

Table: Quantities of Biogas consumed for different applications.

<table>
<thead>
<tr>
<th>Use Biogas consumed (M)</th>
<th>Specification</th>
<th>Quantities of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking</td>
<td>2” Burner</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>4” Burner</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>6” Burner</td>
<td>0.62</td>
</tr>
<tr>
<td>Per person Per day for cooking</td>
<td>100 Candle Power</td>
<td>0.24 m³/day</td>
</tr>
<tr>
<td>Per person Per day for cooking</td>
<td>75-80% Replacement</td>
<td>0.13 cum/hr</td>
</tr>
<tr>
<td>Gas Lighting mantles lamp of</td>
<td>1kwh</td>
<td>0.75</td>
</tr>
<tr>
<td>Dual fuel Engine m³/bhp/hour.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MERITS

• Better and cheaper fuel for cooking, lighting and power generation.
  • Produces good quality enriched manure to improve soil fertility.
  • Effective and convenient way for sanitary disposal of human excreta, improving the hygienic conditions.
  • Generate social benefits - reducing burden on forest, reduction in drudgery of women and children.
  • As a smokeless domestic fuel it reduces the incidence of eye and lung diseases
DEMERTS

• Number and kind of animals to be served.
• Location of the system.
• Collection and transportation of inputs.
• Temperature maintenance.
• Handling of outputs.
• Distribution of benefits.
• Management and monitoring required.
INNOVATIVE USES FOR HEAT AND ELECTRICITY

• Jühnde is a small German village where all the energy to the village is supplied by the adjacent biogas plant. The plant supplies the electricity from the diesel engines operating on biogas running generators, and then excess heat from the engines is used to heat hot water which is supplied to the villagers for water and heating needs. In the winter when excess heat from the gensets is not enough to provide the homes with heat, extra boilers are fired with wood chips. Plants are currently under way to dry the wood chips with extra heat that is available in the warm summer months.
Another unique stop was to a “gas” station that offered its customers the option of filling up with biogas. The biogas supplied to the gas station was produced at a nearby plant similar to the others, but it had an extensive refining process to concentrate the gas to a level that could be used in natural gas powered vehicles.
CONCLUSIONS

- India has second largest biogas programme in the world at rural and as well as urban levels.
  - Many technologies/ models have been successfully developed in India for biogas programme.
  - There is need to develop a sustainable renewable energy programme on biogas for replacing petroleum products by utilization of biogas in the country.
  - This will helping green energy technology and reducing green house gas emissions.

- Biogas is a potential renewable energy source for rural India and other developing countries.

- Biog as generation and subsequent bottling will cater the energy needs of villages, supply enriched manure and maintain village sanitation.

- The bottling system will work as a decentralized source of power with uninterrupted supply using local resources, generate ample opportunities for employment and income of the rural people.