Dissertation Topic

Waste-to-Energy:
Optimum utilization of Commercial kitchen waste to generate energy

PRESENTED BY:
SONAL KOTKAR ; Sem IV
Globally 1/3 food produced is wasted annually.
- Single largest constituent of municipal solid waste stream.
- 3R of waste management hierarchy not applicable.
- Food waste contains high calorific value, moisture content & nutritive value to microbes which generates methane (CH4), which can be further converted into different forms of energy.
- It also contains a significant fraction of lingo-cellulosic material, so acidification of this material influences the biogas yield.
- Hence, food/kitchen waste holds the highest economic & environmental value.
BACKGROUND

LONAVALA-KHANDALA

- Lonavala- Khanadala is a twin hill station, located in Pune district of Maharashtra, India.
- **Total Area of town : 38.84 SqKm**
- **15 administrative Wards**
- **Population of 57,698** (Census 2011)
- It close proximity to Mumbai & Pune and unique location makes it a attractive tourist destination, hence it’s a hub of hospitality.

HOSPITALITY SECTOR : 112 Municipal registered commercialised kitchens in town.

MUNICIPAL SOLID WASTE STATUS :
- Current status (2014) : 17.35 TPD
- Projected status (2034) : 30.34 TPD
- Biodegradable waste is maximum (50%)
- **No provision for processing MSW !**
AIM & OBJECTIVES

AIM
To assess a system for optimum utilization of food/kitchen waste generated by commercialised kitchens under Lonavala-Khandala Municipal limits.

OBJECTIVES
1. To explore the quantity & quality of food /kitchen waste generated by all categories/grades of commercialised kitchens.
2. To study the current status and initiatives undertaken by the local Government towards disposal of organic waste.
3. Analysing & exploring technologies based on anaerobic digestion of food waste for generating energy.
4. To evaluate the economic-environmental potentials to implement energy recovery principles by utilizing food/kitchen waste generated by commercialise kitchens.
5. To recommend a viable & beneficial system for optimum utilization of food/kitchen waste generated by commercialised kitchens.
**HYPOTHESIS & DELIMITATION**

**HYPOTHESIS**
Biogas generated via food/kitchen waste can replace conventional fuel requirement of commercialised kitchen.

**DELIMITATION**
Food / Kitchen waste generated via commercialised kitchens registered under Lonavala Municipal council is being considered for research.
METHODOLOGY

STEP 1
• Overview of environmental problem associated with Food/Kitchen waste disposal.

STEP 2
• Understanding Solid waste management system and Hospitality sector in study area

STEP 3
• Stratified random sampling of Commercialised Kitchen in study area for data collection & analysis

STEP 4
• Understanding the processing system & technologies available for food waste disposal and selecting appropriate technology suitable to the context.

STEP 5
• Propose a system with a suitable technology for food waste disposal which is economically feasible and environmentally beneficial.
DATA COLLECTION & SAMPLING

HOSPITALITY SECTOR OF LONAVALA
- 112 Municipal authorised commercialised kitchens
- Divided in 5 category depending on facilities & capacity.

SAMPLING DETAILS
- Stratified Random Sampling method
- 30% sampling of each category
- Total 32 Samples considered for research
- Sampling of commercialised kitchen through questionnaire & observations.

Graph showing the distribution of samples across different categories.

- 5 star: 2, 1
- 3 star: 32, 9
- 2 star: 46, 13
- Restaurant: 24, 7
- Sanatorium: 8, 2
DATA CLASSIFICATION

TOTAL LPG CONSUMPTION

42 cylinders required by 32 kitchens (30%)
Hence, 141 cylinders for 112 kitchens (100%)

TOTAL FOOD WASTE GENERATED

1,180 kg/day generated by 32 kitchens (30%)
Hence 4,130 kg/day by 112 kitchens (100%)
## COMPARATIVE ANALYSIS OF ORGANIC WASTE TREATMENT TECHNOLOGY

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Composting</td>
<td>• No power</td>
<td>• Very slow process</td>
</tr>
<tr>
<td></td>
<td>• Production of high grade manure</td>
<td>• Huge land area required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Economic benefit low.</td>
</tr>
<tr>
<td>2. Anaerobic digestion/ Bio methanation</td>
<td>• Bio gas recovered can be used as renewable as energy.</td>
<td>• The capital cost for setting up of plant is comparatively higher.</td>
</tr>
<tr>
<td></td>
<td>• Digested residue can be used as organic manure.</td>
<td>• Properly segregated organic waste is required</td>
</tr>
<tr>
<td></td>
<td>• Suitable for waste with high moisture content.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Operational in rainy season.</td>
<td></td>
</tr>
<tr>
<td>3. Pyrolysis/ Gasification</td>
<td>• Production of fuel gas.</td>
<td>• Not suitable for the waste with excessive moisture.</td>
</tr>
<tr>
<td></td>
<td>• O&amp;M cost is less</td>
<td></td>
</tr>
<tr>
<td>4. Palletisation</td>
<td>• Pellets can be used as supplementary fuel</td>
<td>• Process is not operational in rainy season.</td>
</tr>
<tr>
<td></td>
<td>• High calorific value.</td>
<td>• Consumes more energy.</td>
</tr>
</tbody>
</table>
### COMPARATIVE ANALYSIS OF ANAEROBIC DIGESTION TECHNOLOGY

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>CONVENTIONAL</th>
<th>B.A.R.C TECHNOLOGY</th>
<th>Seri Gas TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of organic waste processed</td>
<td>Gobar</td>
<td>Food waste, dry leaves, green grass, animal remains, paper etc.</td>
<td>Food waste, non-consumable part of fruits, vegetables and other agricultural waste.</td>
</tr>
<tr>
<td>Handling of waste</td>
<td>Direct feed</td>
<td>Needs segregation`</td>
<td>Needs segregation</td>
</tr>
<tr>
<td>Type of bacteria</td>
<td>Methanogenic</td>
<td>Thermophilic and Methanogenic bacteria</td>
<td>16 different species of microbes which are cultured.</td>
</tr>
<tr>
<td>Processing time</td>
<td>30 days</td>
<td>10-12 days</td>
<td>7 days</td>
</tr>
<tr>
<td>Operation</td>
<td>Manual</td>
<td>Semi automated</td>
<td>Fully automated</td>
</tr>
</tbody>
</table>
## COMPARATIVE ANALYSIS OF ANAEROBIC DIGESTION TECHNOLOGY

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>UNITS</th>
<th>CONVENTIONAL</th>
<th>B.A.R.C TECHNOLOGY</th>
<th>SERI Gas TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Capacity</td>
<td>MTD</td>
<td>04</td>
<td>04</td>
<td>04</td>
</tr>
<tr>
<td>Water Requirement</td>
<td>M3/day</td>
<td>2.6</td>
<td>4.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Power consumption</td>
<td>KWh</td>
<td>0</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>Area required</td>
<td>Sq m</td>
<td>400</td>
<td>600</td>
<td>160</td>
</tr>
<tr>
<td>Purity of gas produced</td>
<td>Percentage</td>
<td>50 % methane</td>
<td>70 % methane</td>
<td>80% methane</td>
</tr>
<tr>
<td>Capital cost</td>
<td>Rupees</td>
<td>40 lakh</td>
<td>70 lakh</td>
<td>150 lakh</td>
</tr>
<tr>
<td>Gas generated</td>
<td>M3/day</td>
<td>280</td>
<td>400</td>
<td>450</td>
</tr>
</tbody>
</table>
**DATA ANALYSIS**

**COMPARATIVE ANALYSIS OF ANAEROBIC DIGESTION TECHNOLOGY**

<table>
<thead>
<tr>
<th>Water Requirement (M3/day)</th>
<th>Power requirement (kW)</th>
<th>Area required (Sq.mt)</th>
<th>Purity of gas produced (% Methane)</th>
<th>Capital cost (Rupees in Lakhs)</th>
<th>Gas generated (M3/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>B.A.R.C</td>
<td>S.E.R.I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>4.1</td>
<td>600</td>
<td>50 70 90</td>
<td>40 70 120</td>
<td>280 400 500</td>
</tr>
</tbody>
</table>

Rachana Sansad’s Institute of Environmental Architecture, Mumbai
FINDINGS DERIVED FROM SAMPLING

- LPG requirement is 2687 kg/day
- Food waste generated is 4130 kg/day
- 90% owners are interested for utilizing Bio energy
- 65% commercialised kitchens practise segregation of food waste.
- Hence, it is an ideal concept to utilize food/ kitchen waste for generating biogas.

FINDINGS DERIVED FROM COMPARATIVE ANALYSIS

- Anaerobic digestion process of converting biomass into gaseous fuel is superior and sustainable process
- Nisargruna BARC technology gives best output in terms of time required, gas generated & cost invested. can be further purified and compressed in cylinders which
- It can partially substituting LPG requirement of commercialised kitchens.
Proposed project will be based on anaerobic digestion/ Biomethanation process by considering Nisargruna BARC technology.

- Net Biogas Gas produced: 340 m³ (which can replace 11% of LPG requirement)
- Manure Generated: 400 kg / day
- Thus total revenue from proposed system is Rs.62, 47,500/ year
- Pay back period 1.5 to 2 years
CONCLUSION

Proposed project can replace 11% LPG requirement of commercialised kitchens. Hence Anaerobic digestion process it is considered to be the most superior and sustainable process for converting Kitchen/Food waste into energy.

- **Economic Benefits**
  1. Saving on commercial LPG gas: Rs. 56,87,500/year. + Revenue from organic manure: Rs. 5,60,000 / year = Total revenue from proposed system is Rs. 62,47,500/year (INR)

- **Environmental benefits**
  1. Reduces methane emissions by entrapping and using it as fuel.
  2. Reduce the risks of pathogens and pollution risks in soils, groundwater, and surface water.

- **Social benefits**
  1. Employment and income for local people
  2. infrastructure in regional areas
  3. Improvement in the sanitation and hygiene
RECOMMENDATIONS

Towns below 1,00,000 populations which generates less than 30 TPD waste and have 45 to 65% of biodegradable fraction of MSW, a combination of bio-methanation & composting is considered the most suitable technological option for management of MSW.

Biodegradable Waste is difficult to handle, hence it is recommended to be segregated at source of generation.

Separate collection and transportation of commercialised kitchen wastes shall be ensured by the municipal authorities.

Biogas generation and further compressing it for decentralised cooking requirement of commercialised kitchens is the most recommended option for optimum utilization of Kitchen/ Food Waste.

For optimum utilization of Food / Kitchen waste generated from Commercial kitchen, centralized processing facility is always recommended.
Leftovers get new life.