EVALUATION OF THE ENVIRONMENTAL IMPACTS
OF THERMOCOL USING LIFE CYCLE
ASSESSMENT: A STUDY IN INDIA

by
Assistant professor
Dr. P. Sridhar
NIT Warangal
Contents

- Introduction
- Current Status
- Methodology adopted
- Results and Discussion
- Conclusion
Introduction

Solid waste

Source based classification
- Residential
- Commercial
- Institutional
- Municipal
- Industrial
- Agricultural

Type based classification
- Garbage
- Ashes and residues
- Combustible and non-combustible wastes
- Bulky wastes
- Biodegradable and Non-Biodegradable wastes
Plastic waste generated in India

<table>
<thead>
<tr>
<th>Year</th>
<th>Million tons per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012.00</td>
<td>0.21</td>
</tr>
<tr>
<td>2013.00</td>
<td>1.51</td>
</tr>
<tr>
<td>2014.00</td>
<td>1.83</td>
</tr>
<tr>
<td>2017.00</td>
<td>9.13</td>
</tr>
<tr>
<td>2018.00</td>
<td>10.63</td>
</tr>
</tbody>
</table>
• Thermocol is a high volume low density material which consists of 98% air.

• Expanded polystyrene (Thermocol) is also a type of plastic, made from monomer styrene can be solid or foamed which is clear, hard and rather a brittle packing material.

• The high density (16-640 kg/m³) and tensile strength (46-60 MPa).
### Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock absorption</td>
<td>35.8%</td>
</tr>
<tr>
<td>Thermal absorption</td>
<td>15.9%</td>
</tr>
<tr>
<td>Low weight</td>
<td>13.5%</td>
</tr>
<tr>
<td>Retention of vitamin C</td>
<td>11.5%</td>
</tr>
<tr>
<td>Resistance to humidity</td>
<td>11.1%</td>
</tr>
<tr>
<td>Compressive resistance</td>
<td>7.3%</td>
</tr>
<tr>
<td>Chemical resistance</td>
<td>3.6%</td>
</tr>
<tr>
<td>Hygienic in nature</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

### Applications of Thermocol

- Packaging: 35.8%
- Construction: 15.9%
- Textiles: 13.5%
- Consumer: 11.5%
- Transportation: 11.1%
- Industrial: 7.3%
- Others: 3.6%
- Electrical: 1.2%
Import Data of Polystyrene Beads

- China (92.77%)
- Korea (2.57%)
- Vietnam (1.64%)
- Italy (1.25%)
- Belgium (0.602%)
- Spain (0.87%)
- Denmark (0.21%)
- United Arab Emirates (0.05%)
Current Status Of Expanded Polystyrene (Disposal) in India

• **Landfill:**

  EPS being non-biodegradable and resistant to degradation, they continue to remain intact in the soil, without undergoing decomposition for a long amount time.

• **Burning:**

  EPS is also commonly burnt, since it is a petroleum product it naturally has a high energy content and combusts easily. But improper uncontrolled burning of EPS causes release of compounds like benzenes and Carbon monoxide which have high air pollution index.

• **Thrown in sewers and drains:**

  EPS is also often thrown into the open drains from where it travels, gets collected and ends up chocking the whole drain system resulting in flood. This is a serious problem and civic authorities have just come to
This advantageous material also has several negative effects when disposed in an unscientific manner.
Methodology adopted

**LIFE CYCLE ANALYSIS (LCA)**

1. LCA generally gives a complete picture of a product’s life cycle.

2. As the raw material extraction and polystyrene bead production for this product is not from India a *gate to gate life cycle assessment* study is done.

3. The life cycle assessment tool SimaPro helped in determining the various emissions and the problems it could cause through the production.

4. The principles and methodology have chosen according to ISO 14040:2006 and ISO 14044:2006.
Goal of LCA:

1. The objective of this LCA is to assess the environmental impacts of these production processes that are affecting India.

2. The goal of this analysis is to help the product development process to reduce the environmental impacts and a gate-to-gate variant is chosen for the life cycle assessment of the product.

Scope of LCA:

Functional unit and system boundaries:

3. The functional unit of this study is 1 kg of Thermocol Production.

4. The system consists of input material flows (energy, polystyrene beads, expanding agent) and the output material flows like (Thermocol, emissions to air).
Methodology adopted (contd.)

System

Boundary
• **Inventory Data:**

The data for the assessment is collected completely from the literature review.

<table>
<thead>
<tr>
<th>s.no</th>
<th>Name</th>
<th>Quantity per kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pentane</td>
<td>0.08 kg</td>
</tr>
<tr>
<td>2</td>
<td>Steam</td>
<td>48800 kj</td>
</tr>
<tr>
<td>3</td>
<td>Electricity</td>
<td>90 Mj</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTPUT</strong></td>
</tr>
<tr>
<td>1 Thermocol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EMISSIONS TO AIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Carbon dioxide</td>
</tr>
<tr>
<td>2 Methane</td>
</tr>
<tr>
<td>3 Nitrous oxides</td>
</tr>
<tr>
<td>4 Sulphur oxides</td>
</tr>
<tr>
<td>5 Carbon monoxide</td>
</tr>
</tbody>
</table>

**ASSUMPTIONS:**

- Transportation of beads is neglected.
- The use phase is not considered.
- Uncertainty analysis is not considered.
**IMPACT ASSESSMENT:**

The assessment method chosen in SimaPro is Impact 2002+ world 2000 for getting the results of:

1. Characterization
2. Damage assessment
3. Normalization

- The interpretation is not done due to the lack of company specified data but these assessed results shows the impacts caused due to Thermocol production.
- The results are used to develop the production process and substitution of the alternate raw materials.
- The article currently did not focused on the alternatives but focused on the easy collection and compaction technique followed in India.
- The damage assessment results given the overall damage caused by production process but the normalization results is restricted to particular locality (India).
Results and Discussions

Life Cycle Assessment Results:

1. **Characterisation:**

Analyzing 1 kg 'Thermocol';

Method: IMPACT 2002+ V2.15 / IMPACT 2002+ / Characterization / Excluding long-term emissions

- Electricity, medium voltage {IN-Western grid} | electricity voltage transformation from high to medium voltage | APOS, S
- Heat, from steam, in chemical industry {RoW} | market for heat, from steam, in chemical industry | APOS, S
- Perfluoropentane {GLO} | production | APOS, S
- Thermocol
Results and Discussions

2. **Damage assessment:**

![Diagram showing damage assessment percentages across different categories: Human health, Ecosystem quality, Climate change, Resources. The diagram illustrates the impact of different processes such as electricity, heat, and chemicals on these categories.]

- **Electricity, medium voltage (IN-Western grid)**: Electricity voltage transformation from high to medium voltage. APOS, S
- **Heat, from steam, in chemical industry (RoW)**: Market for heat, from steam, in chemical industry. APOS, S
- **Perfluoropentane (GLO)**: Production. APOS, S
- **Thermocol**

Analyzing 1 kg 'Thermocol'; Method: IMPACT 2002+ V2.15 / IMPACT 2002+ / Damage assessment / Excluding long-term emissions
Results and Discussions

3. Normalization:

![Bar chart showing normalized values for human health, ecosystem quality, climate change, and resources.]

- **Human health**: The highest bar, indicating a high impact on human health.
- **Ecosystem quality**: The lowest bar, indicating a low impact on ecosystem quality.
- **Climate change**: A moderate impact on climate change.
- **Resources**: A moderate impact on resources.

Legend:
- Electric, medium voltage {IN-Western grid} | electricity voltage transformation from high to medium voltage | APOS, S
- Heat, from steam, in chemical industry {Row} | market for heat, from steam, in chemical industry | APOS, S
- Perfluoropentane {GLO} | production | APOS, S
- Thermocol
The impact assessment of Thermocol at present time may look like is needed because of its high usage.

This method will help in developing environmentally benign production process effectively culminates to reduce the impacts and makes the product more sustainable.
References


2. CPCB. (2012). Implementation status of plastic waste (waste management and handling) amendment rules. CPCB.

3. EMISSIONS FROM WASTE INCENERATION. (n.d.).


THANK YOU AND QUESTIONS