Co-processing of Waste – Indian Scenario

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HW Generation in India

About 7.66 million tonnes per annum (MTA) HW is generated from about 40,722 industries of which

Landfillable - 3.39 MTA
Recyclable - 3.61 MTA
Incinerable - 0.65 MTA
Hazardous Waste Disposal Methods

Conventional
- Dedicated Hazardous Waste Incinerator
- Secured Land fill

Alternative
- Co-processing of compatible HW in Cement Kiln
**Present Scenario of Hazardous Waste Management in India**

**Major Hazardous Waste Generating States**: Gujarat, Maharashtra, A.P., Chhattisgarh, Rajasthan, West Bengal, and Tamil Nadu (Contribute about 83% of total waste)

**Number of Common Secured Landfills**: 29 (Approx. Capacity 34 MT) in 16 States

**Number of Common Incinerators**: 14 (Cap. ≈ 0.2 MTPA, Capacity Deficit ≈ 0.45 MTA) in 7 States
Why Cement Kiln for Co-Processing?

- High temperatures (1400 °C) and residence time of 4 – 5 seconds in an oxygen-rich atmosphere ensure the destruction of organic compounds.

- Any acid gases formed during combustion are neutralized by the alkaline raw material and are incorporated into the cement clinker.

- Interaction of the flue gases and the raw material present in the kiln ensures that the non-combustible part of the residue is held back in the process and is incorporated into the clinker in a practically irreversible manner.

- No waste is generated that requires subsequent processing.
### Types of co-processing

<table>
<thead>
<tr>
<th>Waste</th>
<th>Substitution</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Energy content (carbon, hydrogen) | Energy recovery | substitution of fossil energy | solvents  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | used tires  
| Energy content (carbon, hydrogen) | Energy recovery | substitution of fossil energy | waste oils  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | used paints  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | industrial sludge  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | molding sand  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | blast furnace slag  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | fly ash and bottom ash  
| Material content (CaO, Fe₂O₃, Al₂O₃ etc.) | Material recycling | substitution of raw material | by product gypsum  |
Co-processing as an alternate will -

• Avoid land disposal or incineration of wastes
• Avoid future liability for wastes and associated problems
• Avoid investment on developing TSDF
• Gain Environmentally responsible image
• Be seen as a good steward of resources

and also yield benefits
Benefits of Co-processing

- Reduction in Green House gases emission & related benefit of carbon trading
- Conversion of waste into energy / as a raw mix component
- Reduced burden on TSDF
- Conservation of fossil fuel & raw material resources
- Immobilization of toxic and heavy material
- Reduction in energy / cement production costs
Comparative GHG Emission from Conventional and Alternate mode of waste disposal

Waste incineration & cement manufacturing

Waste as fuel in cement manufacturing

GHG

Waste Incinerator + Cement plant

GHG

Fossil Fuels

Waste Fossil Fuels

GHG

Cement plant

Resources

Emissions

Waste Fossil Fuels

Cement plant

Waste
# Achievement in Substitution of Thermal Energy by AFR in Cement Industry in selected countries

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Location</th>
<th>Percentage of thermal energy substituted by AFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>France</td>
<td>32%</td>
</tr>
<tr>
<td>2.</td>
<td>Germany</td>
<td>35%</td>
</tr>
<tr>
<td>3.</td>
<td>Norway</td>
<td>45%</td>
</tr>
<tr>
<td>4.</td>
<td>Switzerland</td>
<td>47%</td>
</tr>
<tr>
<td>5.</td>
<td>USA</td>
<td>25%</td>
</tr>
</tbody>
</table>

Source: CEMBUREAU, SINTEF
Initiatives of CPCB

• Introduced concept of Co-Processing of wastes in Indian Cement Industries in the year 2005

• Developed Guidelines including monitoring protocol for Co-Processing of Wastes as an Energy Resource or as a raw material substitution in Cement Industries

• Under Rule 11 of Hazardous wastes (M,H & TM) Rules, 2008 Central pollution Control Board has been empowered to grant approval for utilization of hazardous wastes as a supplementary resource or for energy recovery, or after processing and obtaining such approval before hand is mandatory
• Granted approval for trial runs of various category of wastes in cement industries

• Granted approval for about 30 Cement Plants for Co-processing

• Initiated a project for assessing the feasibility of co-processing of different category of wastes in Indian Cement, Thermal Power & Iron & Steel industries under financial assistance from MoEF

• Bilateral Programme on Co-Processing of Wastes with SINTEF, Government of Norway was initiated to give International Exposure to the officials of CPCB, SPCBs & MoEF besides creating awareness in Indian Cement, Thermal Power & Iron & Steel industries
Waste Management Hierarchy

1. Avoidance
2. Minimization
3. Recovery of Material (Recycle & Reuse)
4. Co-processing
5. Incineration
6. Chemical - Physical PreTreatment
7. Landfilling
8. Uncontrolled burning

Energetic and material use of waste
Elimination of waste

Desirability
Accept / Refuse Flowchart for a Cement Plant Operator

- GCV* of total waste > 2500 Kcal/Kg and raw materials ** = 0%
  - Yes → accept (Energy Recovery)
  - No →
    - Ash > 50% and raw material in ash > 80%
      - Yes → accept (Material Recovery)
      - No →
        - Raw Material ** > 0% and CGV * of the rest > 2500 Kcal/Kg
          - Yes → accept (Energy & Material Recovery)
          - No →
            - Resolution of local waste management problem?
              - Yes → accept (Waste disposal/Waste destruction)
              - No → Refuse

GCV* gross calorific value
Raw material ** CaO, SiO₂, Al₂O₃, Fe₂O₃, SO₃
Probable Feeding points for AFR

• Main burner at the rotary kiln outlet end.
• Rotary kiln inlet end.
• Pre-calciner.
• Along with the traditional raw material.
Procedure to get permission for co-processing under Rule 11 of the Hazardous Waste (Management, Handling & Transboundary) Rules, 2008

• Application to be submitted to SPCB with copy endorsed to CPCB in the prescribed format.
• SPCB has been authorized to grant the permission for trial run
• Applicant shall inform to CPCB and SPCB about the trial run 15 days in advance.
• The trial run report shall be submitted to CPCB through SPCB.
• CPCB shall review the report and process the Application of co-processing.
Protocol for trial run

- 5 days comprehensive study
- Emission monitoring
- Ambient Air Quality Monitoring
- Characterization of hazardous waste
- Chemical Analysis of conventional fuel
- Clinker Analysis
- Raw Material Analysis
- Physical tests of cement
Emission Guidelines

• Particulate matter: As per consent order issued by concerned SPCB.

• For CO, TOC, NOx, HCl, SO2, HF, Total dioxins and furans, Cd+Tl+ their compounds, Hg and its Compounds, Sb+ AS+ Pb+Co+Cr+Cu+Mn+Ni+V+their compounds:

Emission values during co-processing should not exceed the base line emissions i.e. during pre-co-processing levels
## Year wise Quantity of waste co-processed in cement kiln in India

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Year</th>
<th>Approx. quantity of Hazardous Waste Co-processed (Tons)</th>
<th>Approx. Quantity of Non-Hazardous waste co-processed (Tons)</th>
<th>Approx. total quantity of waste co-processed (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2008-09</td>
<td>12,036</td>
<td>5,57,264</td>
<td>5,69,300</td>
</tr>
<tr>
<td>2</td>
<td>2009-10</td>
<td>24,692</td>
<td>9,04,185</td>
<td>9,28,878</td>
</tr>
<tr>
<td>3</td>
<td>2010-11</td>
<td>45,995</td>
<td>18,50,018</td>
<td>18,96,013</td>
</tr>
<tr>
<td>4</td>
<td>2011-12</td>
<td>73,037</td>
<td>1,83,947</td>
<td>2,56,984</td>
</tr>
<tr>
<td>5</td>
<td>2012-13</td>
<td>40,020</td>
<td>2,33,434</td>
<td>2,73,454</td>
</tr>
</tbody>
</table>
## Vital Statistics of Gujarat indicating Co-processing of HW

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Name of Waste</th>
<th>Raw Material (MT)</th>
<th>Fuel (MT)</th>
<th>Total (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hazardous</td>
<td>Non-hazardous</td>
<td>Hazardous</td>
</tr>
<tr>
<td>1</td>
<td>Plastic Waste</td>
<td></td>
<td>97045.09</td>
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<tr>
<td>2</td>
<td>Spent carbon</td>
<td></td>
<td>4416.06</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>White Coal</td>
<td></td>
<td>929.00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Organic Sludge(Solid)</td>
<td></td>
<td>1036.44</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Distillary Residue(Liquid)</td>
<td></td>
<td>51.00</td>
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<tr>
<td>6</td>
<td>TDI Tar</td>
<td></td>
<td>2216.37</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Mixed Waste Liquid</td>
<td></td>
<td>17542.73</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Resin Waste</td>
<td></td>
<td>83.00</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Process Residue Pharma ind</td>
<td></td>
<td>192.00</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Agro Chemical</td>
<td></td>
<td>630.36</td>
<td></td>
</tr>
<tr>
<td>Sr. No</td>
<td>Name of Waste</td>
<td>Raw Material (MT)</td>
<td>Fuel (MT)</td>
<td>Total (MT)</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
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<td>------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hazardous</td>
<td>Non-hazardous</td>
<td>Hazardous</td>
</tr>
<tr>
<td>11</td>
<td>Pharma Waste</td>
<td></td>
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<tr>
<td>12</td>
<td>Waste Oil</td>
<td></td>
<td></td>
<td>902.43</td>
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<tr>
<td>13</td>
<td>Tyre Chips</td>
<td></td>
<td></td>
<td>10367.87</td>
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<tr>
<td>14</td>
<td>Agri Waste</td>
<td></td>
<td></td>
<td>17086.38</td>
</tr>
<tr>
<td>15</td>
<td>Expired off spec drugs</td>
<td></td>
<td></td>
<td>36.00</td>
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<tr>
<td>16</td>
<td>Embroidery Waste</td>
<td></td>
<td></td>
<td>156.00</td>
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<tr>
<td>17</td>
<td>Solid Waste</td>
<td></td>
<td></td>
<td>8649.78</td>
</tr>
<tr>
<td>18</td>
<td>Rub Waste</td>
<td></td>
<td></td>
<td>4975.49</td>
</tr>
<tr>
<td>19</td>
<td>Wooden Dust</td>
<td></td>
<td></td>
<td>2163.03</td>
</tr>
<tr>
<td>20</td>
<td>Sugarcane E Bagas</td>
<td></td>
<td></td>
<td>1982.00</td>
</tr>
<tr>
<td>Sr. No</td>
<td>Name of Waste</td>
<td>Raw Material (MT)</td>
<td>Fuel (MT)</td>
<td>Total (MT)</td>
</tr>
<tr>
<td>--------</td>
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<td>------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hazardous</td>
<td>Non-hazardous</td>
<td>Hazardous</td>
</tr>
<tr>
<td>21</td>
<td>Glycerin Foot</td>
<td></td>
<td></td>
<td>237.72</td>
</tr>
<tr>
<td>22</td>
<td>RDF</td>
<td></td>
<td></td>
<td>4015.43</td>
</tr>
<tr>
<td>23</td>
<td>Wooden Chips</td>
<td></td>
<td></td>
<td>13399.34</td>
</tr>
<tr>
<td>24</td>
<td>Pet coke</td>
<td></td>
<td></td>
<td>268569.96</td>
</tr>
<tr>
<td>25</td>
<td>Chemical Gypsum</td>
<td>251504.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Iron Sludge</td>
<td>114107.06</td>
<td></td>
<td>114107.06</td>
</tr>
<tr>
<td>27</td>
<td>Copper Slag</td>
<td>130760.00</td>
<td></td>
<td>130760.00</td>
</tr>
<tr>
<td>28</td>
<td>Phospho Gypsum</td>
<td>28912.57</td>
<td></td>
<td>28912.57</td>
</tr>
<tr>
<td>29</td>
<td>Fly Ash</td>
<td>1115890.50</td>
<td></td>
<td>1115890.50</td>
</tr>
<tr>
<td>30</td>
<td>Mould Gypsum</td>
<td>33590.02</td>
<td></td>
<td>33590.02</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>365611.466</strong></td>
<td><strong>1309153.09</strong></td>
<td><strong>137604.99</strong></td>
</tr>
</tbody>
</table>

Raw Material: Haz+Non-Haz = 16,74,765 MT
Fuel: Haz+Non-Haz = MT 4,61,249 MT
Few wastes for which trial run conducted

- Toluence Dilsocyanate Tar (M/s Narmada Chematur Petrochemicals Ltd., Bharuch) - 7635 Kcal/kg
- Paint Sludge - 6755 Kcal/kg
- Plastic waste – 8200 Kcal/kg
- Solid Waste Mix (GEPIL, Surat) – 4174 Kcal/kg
- Liquid Waste Mix (GEPIL, Surat) – 3863 Kcal/kg
- Liquid Organic Solvent - 9098 Kcal/kg
- Lead Zinc Slag
- ETP sludge (textile industry)
Alternate Fuel Feeding System ... An Overview

...Way forward to use wastes
# Details of various trial runs for co-processing of wastes in Thermal Power Plants

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Waste Co-processed</th>
<th>Name of the Cement Plant</th>
<th>Period of Trial Run</th>
<th>% Utilization</th>
<th>Energy Utilization (Kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ETP Sludge</td>
<td>CPP of Raymond Ind. Ltd. MP</td>
<td>2009</td>
<td>1.0</td>
<td>(2718 Kcal/kg)</td>
</tr>
<tr>
<td>2</td>
<td>Spent Pot Lining</td>
<td>Hindalco, Renukoot, UP &amp; Hirakud, Odisha</td>
<td>2009/2010</td>
<td>1.0 &amp; 0.5</td>
<td>(4890 Kcal/kg)</td>
</tr>
<tr>
<td>3</td>
<td>Resins</td>
<td>Satpura Thermal Power Plant, MP</td>
<td>2011</td>
<td>0.03</td>
<td>(5180 Kcal/kg)</td>
</tr>
<tr>
<td>4</td>
<td>Anode But</td>
<td>CPP, Vedanta Resources Ltd. Odisha</td>
<td>2012</td>
<td>1.0</td>
<td>(7500 Kcal/kg)</td>
</tr>
</tbody>
</table>
Resource and Energy Intensive Industry in India

**Cement Sector:**
- No. of large plants: 183
- Production: 240 Million Tons/Annum
- Coal consumption: 40 Million Tons/Annum
- Raw Material Consumption: 400 Million Tons/Annum

**Power Sector:**
- No. of plants: 118
- Production: 1,32,000 MW
- Coal consumption: 490 Million Tons/Annum

**Steel Sector:**
- No. of major plants: 12
- Production: 45 Million Tons/Annum
- Coal consumption: 27 Million Tons/Annum
Issues related to co-processing of Wastes

- Variation in wastes characteristics leads to frequent change in operational parameters & blend ratio
- Limitation on chloride & fluoride contents in wastes need to be addressed
- Development of CO peaks at kiln inlet
- Proper storage of Hazardous Waste including preventive / control measures for fire accident
- Installation of feeding system for wastes
- Health aspect of workers
Way Forward

- Co-processing of MSW is still a challenge and need to be taken up.
- Placing the data on website related to characterization and quantification of hazardous waste generated.
- TSDF operators should come forward to provide facility to blend different kind of combustible hazardous waste to produce the homogeneous combustible hazardous waste with consistent quality commitment for use as fuel in Cement Kiln. Similarly, alternative raw material blend may also be produced.
- Cement industries may reduce green house gas emission by co-processing of waste in cement kiln and take benefit of carbon trading.
- SPCBs of other potential states to come forward to join the move.
Thank You