Perspective of CPCB on Hazardous Waste Management and Co-processing

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Central Pollution Control Board (CPCB),
Delhi

“Sustainable Hazardous Waste Management – Way Forward”
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April 25, 2012 at Mumbai, India.
HW Generation in India

- **Total generation**: 7.66 million tonnes /Annum
- **Landfillable**: 3.39 million tonnes /Annum
- **Recyclable**: 3.61 million tonnes /Annum
- **Incinerable**: 0.65 million tonnes /Annum

![Pie chart showing the percentage distribution of waste generation in India.](chart.png)
Hazardous Waste Disposal Methods

Conventional:

- Dedicated Hazardous Waste Incinerator
- Secured Land fill

Alternative:

- Co-processing of compatible HW in Cement Kiln
HAZARDOUS WASTE MANAGEMENT SCENARIO IN INDIA

Quantity of HW Generated in the country: 7.66 Million Tonnes per Annum

- Landfillable - 3.39 million tonnes /Annum
- Recyclable - 3.61 million tonnes /Annum
- Incinerable - 0.65 million tonnes /Annum

Number of Hazardous Waste Generating Units: 40,722

Major Hazardous Waste Generating States: Gujarat, Maharashtra, A.P., Chhattisgarh, Rajasthan, West Bengal, and Tamil Nadu (Total 83%)

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 MTPA) in 7 States
What is Co-processing?

Co-processing refers to the use of waste materials in industrial processes, such as cement, lime, or steel production and power stations. It is a recovery of energy or material from waste. The cement industry is the only industry which does both at the same time!

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Temperature and time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature at main burner</td>
<td>&gt;1450°C: material</td>
</tr>
<tr>
<td></td>
<td>&gt;1800°C: flame temperature</td>
</tr>
<tr>
<td>Residence time at main burner</td>
<td>≈15 sec and ≈1200°C</td>
</tr>
<tr>
<td></td>
<td>≈5-6 sec and ≈1800°C</td>
</tr>
<tr>
<td>Temperature at precalciner</td>
<td>&gt;850°C: material</td>
</tr>
<tr>
<td></td>
<td>&gt;1000°C: flame temperature</td>
</tr>
<tr>
<td>Residence time at precalciner</td>
<td>≈2-6 sec and ≈800°C</td>
</tr>
</tbody>
</table>
## Types of co-processing

<table>
<thead>
<tr>
<th>Waste</th>
<th>Substitution</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy content</td>
<td>substitution of fossil energy</td>
<td>solvents, waste oils, waste plastics</td>
</tr>
<tr>
<td>(carbon, hydrogen)</td>
<td>Energy recovery</td>
<td></td>
</tr>
<tr>
<td>Material content</td>
<td>substitution of raw material</td>
<td>used tires, used paints, industrial sludge</td>
</tr>
<tr>
<td>(CaO, Fe₂O₃, Al₂O₃, etc.)</td>
<td>Material recycling</td>
<td></td>
</tr>
<tr>
<td>Energy content</td>
<td>substitution of fossil energy</td>
<td>molding sand, blast furnace slag, fly ash and bottom ash, by product gypsum</td>
</tr>
<tr>
<td>(carbon, hydrogen)</td>
<td>Energy recovery</td>
<td></td>
</tr>
</tbody>
</table>
Firing a cement kiln means feeding continuous streams of uniform quality combustible materials.

The example of mineral coal as the generic case for all (natural and alternative) fuels:

1. Fuel sourcing
2. Fuels preparation - drying, grinding
3. Fuel proportioning to feed points

Desired characteristics of cement kiln fuels:

- Continuous availability in large quantities
- High and uniform quality
  - Low water/low ash/fineness appropriate for feed point
  - Good flowability/metrability for low excess air combustion
- Not inducing environmental damage
Fuel feed point in cement kiln systems

Precalciner firing or secondary firing (SP kilns)

Kiln inlet firing

Main firing
all mineral input turned into product

- All main and minor elements (particularly also those imported with alternative materials) are used to form clinker minerals or are incorporated in clinker minerals.

Exceptions in case of bypass dust generation:
- Incorporation in hydration products (concrete)
- Landfilling

Legend
1. Clinker
2. Limestone
3. Marl
4. Foundry sand
5. Pyrite ash
6. Coal ash
7. Lignite ash
8. Sewage sludge ash
9. Tire ash
Alternative fuel

Plastic waste (source material)  Plastic fluff (alternative fuel, after pre-processing)
Wastes co-processed in the cement industry

**Clinker Production**
- Raw Material → Clinker Kiln → Clinker → Cement

**Cement Production**
- Cement Mill → Cement

**AFR**
- **Only** Raw Material
  - Examples of AFR used primarily as alternative raw material:
    - Aluminum hydroxide residues,
    - Catalysts, foundry sands,
    - SPL refractory fraction etc.
  - Examples of AFR used in the kiln for the production of clinker primarily as alternative energy source:
    - Solvents, paint residues,
    - Hydrocarbon residues, wood,
    - Paper, sludges from industrial waste water treatment, SPL carbon,
    - Soils/plastics/textiles contaminated with hydrocarbons,
    - Pesticides, etc.

**MIC**
- **Only** Raw Material
  - Examples of MIC (mineral components) that are added to the clinker for the production of cement:
    - Ground slag (steel), fly ash (power plants), alternative gypsum sources, etc.
Assuring alternative fuels quality

Source materials (selected waste streams) qualification

- Qualification analysis
  - Waste qualification master file

Waste delivery control or AF delivery control

- Fingerprint analysis
  - Detailed analysis
    - Shipment block to sender (and notification of authorities)

Pre-processing plant

- All analyses are components of the plant QMS (ISO 9000-2000 at Holcim)

AF quality control

- AF specification analysis
Why Choose Co-processing?

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

- Reduction in Green House gas 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
Emissions from fossil fuel and waste as fuel

- Waste incineration & cement manufacturing

- Waste as fuel in cement manufacturing

Waste incinerator + Cement plant

Resources:
- Waste
- Fossil Fuels

Emissions:
- GHG

Cement plant
<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
Indian Experience of Co – Processing of Waste in Cement Kiln
### Details of various trial runs for co-processing of wastes in cement kiln

<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>Calorific Value Kcal/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ETP Sludge (BASF India Ltd., Manglore)</td>
<td>M/s Rasashree Cement, Gulbarga, Karnataka</td>
<td>January, 2005</td>
<td>5-6%</td>
<td>3039</td>
</tr>
<tr>
<td>2.</td>
<td>Toluence Di Isocyanate Tar (M/s Narmada Chematur Petrochemicals Ltd., Bharuch)</td>
<td>M/s Gujarat Ambuja Cement Ltd., Kodinar, Gujarat</td>
<td>February, 2006</td>
<td>4-7%</td>
<td>7635</td>
</tr>
<tr>
<td>3.</td>
<td>Toluence Di Isocyanate Tar (M/s Narmada Chematur Petrochemicals Ltd., Bharuch)</td>
<td>M/s Lafarge India Ltd.; Raipur, Chhattisgarh</td>
<td>May, 2006</td>
<td>5-7%</td>
<td>7635</td>
</tr>
<tr>
<td>S. No.</td>
<td>Waste Co-processed</td>
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<tr>
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</tr>
<tr>
<td>7.</td>
<td>ETP Sludge (Textile Industry)</td>
<td>M/s Grasim Industries Ltd., Aditya Cement</td>
<td>May-07</td>
<td>7%</td>
<td>1570</td>
</tr>
<tr>
<td>8.</td>
<td>Poly residue (SRF Ltd.)</td>
<td>Kymore Works, M.P.</td>
<td>Mar-08</td>
<td>3.87%</td>
<td>5818</td>
</tr>
<tr>
<td>9.</td>
<td>Plastic Waste</td>
<td>Kymore Works, M.P.</td>
<td>Mar-08</td>
<td>1.50%</td>
<td>8200</td>
</tr>
<tr>
<td>10.</td>
<td>Phosphate Sludge (Toyota, Kirloskar, Motor Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Apr-08</td>
<td>0.77%</td>
<td>830</td>
</tr>
<tr>
<td>11.</td>
<td>Chemical Sludge (Toyota Kirloskaar Motors Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Apr-08</td>
<td>2.04%</td>
<td>1212</td>
</tr>
<tr>
<td>12.</td>
<td>Phosphate Sludge (Ford India Ltd., Chennai)</td>
<td>Madukkarai, Works, TN</td>
<td>Jun-08</td>
<td>0.93%</td>
<td>135</td>
</tr>
<tr>
<td>13.</td>
<td>Chemical ETP Sludge (Ford India Ltd., Chennai)</td>
<td>Madukkarai, Works, TN</td>
<td>Jun-08</td>
<td>0.93%</td>
<td>254</td>
</tr>
<tr>
<td>14.</td>
<td>n-Butanol Salt (Jubillent Organosys Ltd., Mysore)</td>
<td>Wadi works, KA</td>
<td>Jul-08</td>
<td>1.01%</td>
<td>6517</td>
</tr>
<tr>
<td>S. No.</td>
<td>Waste Co-processed</td>
<td>Name of the Cement Plant</td>
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<td>Calorific Value Kcal/kg</td>
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<td>--------</td>
<td>-------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>15.</td>
<td>Spent Carbon (Hindustan Coca Cola Beverages Pvt. Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Jul-08</td>
<td>2.75%</td>
<td>1471</td>
</tr>
<tr>
<td>16.</td>
<td>ETP Bio Solid (Hindustan Coca Cola Beverages Pvt. Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Jul-08</td>
<td>2.46%</td>
<td>3434</td>
</tr>
<tr>
<td>17.</td>
<td>WTP Sludge (Hindustan Coca Cola Beverages Pvt. Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Jul-08</td>
<td>2.68%</td>
<td>317</td>
</tr>
<tr>
<td>18.</td>
<td>Solar Evaporation Pond Sludge (Jubillent Organosys Ltd., Mysore)</td>
<td>Wadi works, KA</td>
<td>July-August 2008</td>
<td>1.01%</td>
<td>6034</td>
</tr>
<tr>
<td>19.</td>
<td>CETP Pali Sludge</td>
<td>M/s J. K. Laxmi Cement, Sirohi, Raj.</td>
<td>Dec-08</td>
<td>5%</td>
<td>804</td>
</tr>
<tr>
<td>20.</td>
<td>Oily Rags (Ford India Ltd., Chennai)</td>
<td>Madukkarai, Works, TN</td>
<td>Dec-08</td>
<td>0.27%</td>
<td>7960</td>
</tr>
<tr>
<td>21.</td>
<td>Lead Zinc Slag</td>
<td>Grasim Ind. Aditya Cement</td>
<td>Jan-09</td>
<td>5%</td>
<td>&lt;150</td>
</tr>
<tr>
<td>22.</td>
<td>Grinding Muck (Kirloskar Toyada Textile Machinery Pvt. Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Feb-09</td>
<td>2.81%</td>
<td>784</td>
</tr>
<tr>
<td>23.</td>
<td>Grinding dust (SKF India Ltd., Bangalore)</td>
<td>Wadi works, KA</td>
<td>Feb-09</td>
<td>0.73%</td>
<td>1936</td>
</tr>
<tr>
<td>S. No.</td>
<td>Waste Co-processed</td>
<td>Name of the Cement Plant</td>
<td>Period of Trial Run</td>
<td>% Utilization</td>
<td>Calorific Value Kcal/kg</td>
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<td>--------------------------------------------------------</td>
<td>-----------------------------------------------</td>
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</tr>
<tr>
<td>24.</td>
<td>Green Mesh with Resin (Suzlon Energy Ltd., Pondichery)</td>
<td>Madukkarai, Works, TN</td>
<td>Mar-09</td>
<td>0.65%</td>
<td>8207</td>
</tr>
<tr>
<td>27.</td>
<td>Liquid Waste Mix (GEPIL, Surat)</td>
<td>M/s Ambuja Cement Ltd., Kodinar, Gujarat</td>
<td>Nov., 2009</td>
<td>14.50%</td>
<td>3863</td>
</tr>
<tr>
<td>30.</td>
<td>Spent Wash</td>
<td>M/s Rajshree Cement Ltd, Gulberga, Karnataka</td>
<td>June-July 2010</td>
<td>3.50%</td>
<td>2000</td>
</tr>
<tr>
<td>31.</td>
<td>Spent Catalyst (Oil refinerly)</td>
<td>ACC Chaibasa, Jharkhand</td>
<td>March 2011</td>
<td>3.6%</td>
<td>&lt;80</td>
</tr>
</tbody>
</table>
Cement Groups which are Co-processing Wastes

- ACC Ltd.
- Ambuja Cements Ltd.
- Lafarge India Ltd.
- Shree Cement Ltd.
- Ultratech Cement Ltd.
- Vasavadatta Cement
Product Quality - Global opinion

- Absence of any problems with substitute fuels.
- Manageable stable clinker process.
- No effect on quality of clinker.
- Process require changes in operating conditions.
- Appropriate fuel rate to maintain stable kiln quality
### 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>2006-07</td>
<td>5,191</td>
<td>1,87,305</td>
<td>1,92,496</td>
</tr>
<tr>
<td>2</td>
<td>2007-08</td>
<td>6,891</td>
<td>3,21,209</td>
<td>3,28,100</td>
</tr>
<tr>
<td>3</td>
<td>2008-09</td>
<td>12,036</td>
<td>5,57,264</td>
<td>5,69,300</td>
</tr>
<tr>
<td>4</td>
<td>2009-10</td>
<td>24,692</td>
<td>9,04,185</td>
<td>9,28,878</td>
</tr>
<tr>
<td>5</td>
<td>2010-11</td>
<td>45,995</td>
<td>18,50,018</td>
<td>18,96,013</td>
</tr>
</tbody>
</table>
Co-processing Guidelines
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/dumping

Elimination of waste
Energetic and material use 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
Selection of Feed point for AFR

- The main burner at the rotary kiln outlet end.
- The rotary kiln inlet end.
- The pre-calciner.
- The mid kiln.
- Along with the traditional raw material.
Emission Standards

- For 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 baseline emissions i.e. during pre co-processing levels
Monitoring Requirements

- For Particulate matter: Continuous measurement
- For other Pollutants: As & when asked by the CPCB

Air Pollution Control Requirements

- For Particulate matter: ESP / Bag House
- For other Pollutants: Cement industries has to ensure that emission during co-processing is not exceeding the base line emissions i.e. during co-processing
HW Management Options in Practice

- Process modifications / Clean technologies
- Minimizing waste residues or re-use within process
- Permit environmentally sound recycling faculties (for Schedule-IV wastes)
- Utilization of waste (Recovery of resource)
  - Utilization of waste by co-processing (cement kiln)
  - Utilization of waste for energy recovery (boiler/furnace)
- Destruction of waste in Captive/Common Incinerators (energy recovery..?)
- Stabilization of waste
- Secure land filling (Captive or common landfill sites)
Hazardous Waste Management Strategies

- **Online inventorization of HW with on-line data updation & retrieval system with on-line tracking system of HW movements linked with the on-line Consent/Authorisation management system**

- **Smooth Interstate transportation of HW**

- **Promotion of cleaner technologies and Development of guidelines.**

- **Measures for effective co-processing of HW**
  - setting up a phase wise percentage target of co-processing of HW in each State/UT
  - limited access to generators/users to view on-line inventorisation thereby automatically creation of concept of “waste-exchange”
  - blending of wastes either by the cement plant of its own or through TSDF operator or allowing dedicated blending facility (Pre-processing facility)
  - SPCBs/PCCs, not having disposal facility, to tie-up with cement plants in their State/UT or other States/UTs for co-processing of HW
  - Wide awareness through awareness programmes as well as communication with HW generators
Hazardous Waste Management Strategies contd...

• **Measures for effective utilization of HW**
  - Simple, effective and transparent evaluation of utilization process
  - Utilizers of HW to be given the limited permission to access the on-line inventorization of HW

• **Display of on-line real time emission parameters** by common TSDF operators and waste procurement, storage and disposal data

• **Installation of GPS in vehicles** transporting HW

• **Development of HW handling/disposal facilities** accessible or available to all the States

• **Cost of treatment at common TSDFs** to be fixed in consultation with SPCB/PCC

• **Maintaining Escrow Account** by TSDF operators
Hazardous Waste Management Strategies contd...

- **Checking Illegal Import of HW**
  - Improve verification process through customs authorities for import of recyclable, recoverable or reusable HW
  - Control and reduce transboundary movement of HW

- **Remediation of contaminated hazardous waste dumpsites**
  - Prioritization of sites for remediation
  - Creation of funds for remediation Polluter Pay Principle / Govt. Funds / PPP models
  - Scope of utilization/co-processing of waste while remediating contaminated sites.

- **Strengthening of infrastructure of Regulatory bodies**
Implementation

To ease large scale substitution of fossil fuel with wastes and biomass, a number of conditions should ideally be in place, e.g. the availability of sufficient waste materials with adequate quality, polluter-pays-principle, the right climate for investments and incentives, predictability and a level playing field, technical and environmental competence, a robust regulatory framework and flexible permitting conditions, and ideally, a price on carbon.
Way Forward

- SPCBs may place 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.

- Awareness programmes should be organised.
Thank You
aiming to conserve natural resources