Waste Co-processing in Cement Kilns:
Concepts and Benefits
Overview

- Concepts and benefits of co-processing
  - Geocycle India- waste management service provider
  - The challenge during co-processing
  - Holcim Co-processing policy
  - Experience on co-processing
  - Waste disposal facilities with Geocycle India
  - Safety: Value not priority for Geocycle Business
Waste Management Hierarchy

1. **Reduce**
   - When prevention / reuse is not feasible

2. **Reuse**

3. **Recycle - Re-processing**
   - Recycling of end-of-life cementitious products
   - Wastes as MIC and/or AR
   - When re-processing is not feasible

4. **Resources Co-processing in existing EII’s**
   - Process specific guidelines
   - Pre-processing is key
   - When co-processing is not applicable

5. **Wastes disposal activities**
   - For organics: Incineration
     - Wastes – to – energy programs
     - Energy efficiency is key
   - For minerals: Land filling

---

ACC Limited
Co-processing

- Upgrades waste management within the waste hierarchy
- Reduces global environmental impacts
- Decreases (largely) the costs of waste management
- Regional job creation in waste collection and pretreatment etc.
- Zero-emission technology
The clinker process: Main characteristics for waste co-processing

- High temperatures and long residence time
  - In all cases more than 3” > 1100 °C

- Self cleaning process
  - Lime represent > 60% in mass

- Double valorization: organic and minerals
  - Organic totally destroyed
  - Ash incorporated in the final product

- Reduction of global emissions
  - No more emission if waste is used - Global CO2 is reduced

- Existing, local industry
  - Traditional industry located close to limestone areas
Reduction of GHGs

- Waste incineration
- Cement manufacturing
- Waste used as fuel in cement manufacturing

Emissions
- GHG

Resources
- Waste
  - Waste Incinerator

Products
- Res. waste & energy
  - Cement
  - Cement plant
  - Fossil Fuels

Initiative towards lowering the carbon footprint
# Co-processing vs. Incineration

<table>
<thead>
<tr>
<th>Aspect</th>
<th>HW Incinerator</th>
<th>Cement Kiln</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>850oC – 1200oC</td>
<td>1400oC – 2000oC</td>
</tr>
<tr>
<td>Residence Time</td>
<td>&gt; 2 sec @ &gt;1200oC</td>
<td>4-6 sec @ &gt;1800oC</td>
</tr>
<tr>
<td>Gas cleaning</td>
<td>Alkaline scrubbing</td>
<td>Alkaline Env. in kiln</td>
</tr>
<tr>
<td>Residues</td>
<td>Ash / fly ash</td>
<td>In clinker product</td>
</tr>
<tr>
<td>Fuel</td>
<td>Fossil fuel used</td>
<td>Disposed within the cement process</td>
</tr>
<tr>
<td>DRE</td>
<td>99.9999 %</td>
<td>99.9999 %*</td>
</tr>
</tbody>
</table>

DRE: “Destruction and Removal Efficiency”

* Reported for PCBs in Norway and Sweden performance generally > 99.999%
Overview

- Concepts and benefits of co-processing
- Geocycle India- waste management service provider
- The challenge during co-processing
- Holcim Co-processing policy
- Experience on co-processing
- Waste disposal facilities with Geocycle India
- Safety: Value not priority for Geocycle Business
CUSTOMERS IN FOCUS
Overview

- Concepts and benefits of co-processing
- Geocycle India- waste management service provider
- The challenge during co-processing
- Holcim Co-processing policy
- Experience on co-processing
- Waste disposal facilities with Geocycle India
- Safety: Value not priority for Geocycle Business
Waste & Sustainability: The Challenge
Waste Pre-processing Activities
Overview

- Concepts and benefits of co-processing
- Geocycle India- waste management service provider
- Co-processing the challenge
  - Holcim Co-processing policy
- Experience on co-processing
- Waste disposal facilities with Geocycle India
- Safety: Value not priority for Geocycle Business
Holcim has defined a policy that will govern the Group companies’ behaviour and operations when co-processing.

**Holcim and GTZ strategic alliance**

### The 9 principles of our co-processing policy

<table>
<thead>
<tr>
<th>Elements of sustainability</th>
<th>I. Act as a partner to society by offering waste management solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>II. Keep our environment safe</td>
</tr>
<tr>
<td></td>
<td>III. Add value to our core business</td>
</tr>
<tr>
<td>What we will do</td>
<td>IV. Ensure occupational health &amp; safety</td>
</tr>
<tr>
<td></td>
<td>V. Refuse the listed “banned wastes”</td>
</tr>
<tr>
<td></td>
<td>VI. Guarantee the quality of our products</td>
</tr>
<tr>
<td>How we will do it</td>
<td>VII. Comply with the relevant regulations and promote best practices</td>
</tr>
<tr>
<td></td>
<td>VIII. Monitor and control the inputs, process, products and emissions</td>
</tr>
<tr>
<td></td>
<td>IX. Communicate transparently</td>
</tr>
</tbody>
</table>
Refuse the listed "banned wastes"

- Anatomical Hospital Wastes
- Asbestos-containing Wastes
- Bio-hazardous Wastes
- Electronic Scrap
- Entire Batteries
- Explosives
- High-concentration Cyanide Wastes
- Mineral Acids
- Radioactive Wastes
- Unsorted Municipal Garbage

ACC will refuse the aforementioned wastes for one or more of the following reasons: health & safety issues; to promote adherence to the waste management hierarchy; other treatment options or processes must be used.
## Sources of Material for Co-processing

### Identified 26 Industries that are sources of Co-processing Material Worldwide

<table>
<thead>
<tr>
<th></th>
<th>Industry Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agricultural Production - Crops</td>
</tr>
<tr>
<td>2</td>
<td>Agricultural Production - Livestock</td>
</tr>
<tr>
<td>3</td>
<td>Agricultural Services</td>
</tr>
<tr>
<td>4</td>
<td>Metal Mining</td>
</tr>
<tr>
<td>5</td>
<td>Coal Mining</td>
</tr>
<tr>
<td>6</td>
<td>Oil and Gas Extraction</td>
</tr>
<tr>
<td>7</td>
<td>Mining and Quarrying of Nonmetallic Minerals</td>
</tr>
<tr>
<td>8</td>
<td>General Building Contractors</td>
</tr>
<tr>
<td>9</td>
<td>Heavy Construction Contractors</td>
</tr>
<tr>
<td>10</td>
<td>Special Trade Contractors</td>
</tr>
<tr>
<td>11</td>
<td>Food and Kindred Products</td>
</tr>
<tr>
<td>12</td>
<td>Lumber and Wood Products, Except Furniture</td>
</tr>
<tr>
<td>13</td>
<td>Furniture and Fixtures</td>
</tr>
<tr>
<td>14</td>
<td>Paper and Allied Products</td>
</tr>
<tr>
<td>15</td>
<td>Chemicals and Allied Products</td>
</tr>
<tr>
<td>16</td>
<td>Petroleum Refining and Related Industries</td>
</tr>
<tr>
<td>17</td>
<td>Rubber and Miscellaneous Plastic Products</td>
</tr>
<tr>
<td>18</td>
<td>Leather and Leather Products</td>
</tr>
<tr>
<td>19</td>
<td>Glass Products</td>
</tr>
<tr>
<td>20</td>
<td>Primary Metal Industries</td>
</tr>
<tr>
<td>21</td>
<td>Fabricated Metal Products</td>
</tr>
<tr>
<td>22</td>
<td>Indus. and Comm. Machinery and Computers</td>
</tr>
<tr>
<td>23</td>
<td>Electronic &amp; Electrical Equipment</td>
</tr>
<tr>
<td>24</td>
<td>Transportation Equipment</td>
</tr>
<tr>
<td>25</td>
<td>Photographic Equipment and Supplies</td>
</tr>
<tr>
<td>26</td>
<td>Electric, gas, and sanitary services</td>
</tr>
</tbody>
</table>

ACC Limited
Frame Work Of Operation

Identify the Customer

Customer Interaction

Sample Evaluations

Suggest Alternative Solution

Co-processable?

Yes

Finalize Usage Plan

Clearances from Authorities

ACC and Waste Generator

No

Approval?

Submit to Authorities

Undertake Trial Burn

Trial Burn Required?

Yes

Co-processing Agreement with Customer

Yes

Initiate Regular Co-processing

No
Overview

- Concepts and benefits of co-processing
- Geocycle India- waste management service provider
- Co-processing the challenge
- Holcim Co-processing policy
  - Waste disposal facilities with Geocycle India
- Experience on co-processing
- Safety: Value not priority for Geocycle Business
AFR Feeding System - Starter Kit

- Storage Shed.
- Max. Feeding Capacity: 4 M3 Per Hr.
- Transportation of waste Material - Construction hoist/Monorail hoist
- Hopper.
- Belt conveyor
- Feeding Chute
  - Flap damper
  - Slide Gate
  - Fire sensor
  - Pressure sensor

Preheater Floor

- Construction Hoist/Monorail hoist
- Feeding Hopper
- Belt Conveyor
- Flap gate
- Fire Sensor
- Pressure Sensor
- Shut gate

Kiln inlet/Calciner

ACC Limited
AFR Feeding System – Standard Solution

- Belt Conveyor
- Large storage shed
AFR Feeding System – Liquid Handling

- For Liquid Handling
  - Storage tank
  - Pumps
    - Loading and Unloading
  - Filters
  - Piping
  - Nozzles
  - Compressed air System
  - Fire Hydrant System

Diagram:
- Storage Tank
- Compress Air System
- Unloading Pump
- Feeding Pump
- Duplex basket Filter
- Pressure Relief Valve
- Nozzle
State of the art Laboratories for waste analysis

Establishment of Laboratories & facilities for assessing co-process ability and acceptability of wastes
Overview

- Concepts and benefits of co-processing
- Geocycle India- waste management service provider
- Co-processing the challenge
- Holcim Co-processing policy
- Waste disposal facilities with Geocycle India
- Experience on co-processing
- Safety: Value not priority for Geocycle Business
Methodology for Co-processing Trial Burn

- Trial burns are being carried out to generate large amount of data base on co-processing.
  - to demonstrate the environmentally sound co-processing capability of the cement kiln
  - as a statutory measure under the guidance of State Pollution Control Board
  - as a voluntarily jointly by the Industry and ACC

- Trial burn is conducted at conditions satisfying following criteria
  - Waste generation rate at the Industry end.
  - Co-processing capability of the kiln without adversely impacting the process operation or quality of clinker.
  - OH&S considerations of the plant related to People & Process
Methodology for Co-processing Trial Burn

- During the trial burn of the waste materials,
  - the kiln process parameters are closely monitored by ACC process experts and the possible operational impacts are averted.
  - Parameters related to following are closely monitored & recorded through SPCB & CPCB approved third party.
    - Quality of Waste Material
    - Stack Emissions
    - Coal and Raw Meal
    - Clinker
  - The stack emission monitoring is carried out in 3 phases (i.e. Pre Co-processing, During Co-Processing & Post Co-processing)

During Co-processing trial Emission Monitoring is conducted by CPCB and ISO 17025 certified 3rd Party Monitoring agency
## Stack Emission Monitoring Plan

<table>
<thead>
<tr>
<th>Parameters</th>
<th>USEPA Method No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate</td>
<td>17</td>
</tr>
<tr>
<td>CO$_2$, CO, O$_2$, Moisture</td>
<td>3B</td>
</tr>
<tr>
<td>NO$_x$</td>
<td>7E</td>
</tr>
<tr>
<td>NH$_3$</td>
<td>6 A/B</td>
</tr>
<tr>
<td>HCL</td>
<td>26</td>
</tr>
<tr>
<td>HF</td>
<td>26</td>
</tr>
<tr>
<td>Heavy Metals (Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Tl, V)</td>
<td>29</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>6B</td>
</tr>
<tr>
<td>Benzene</td>
<td>NIOSH 1501</td>
</tr>
<tr>
<td>Mercury</td>
<td>29/10 1 A</td>
</tr>
<tr>
<td>Dioxins (PCDD)/ Furans (PCDF)</td>
<td>23 A</td>
</tr>
<tr>
<td>TOC</td>
<td>25 A</td>
</tr>
</tbody>
</table>
Other Parameters Evaluated

- **Waste Material** - Total Petroleum Hydrocarbon, Organo Chlorine Compounds, VOCs & Semi VOCs, Poly Chloro Phenols (PCP), Calorific Value, Proximate and Ultimate Analysis, Heavy Metals [Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Thallium (Tl), Vanadium (V), Zinc (Zn), Tin (Sn), Selenium (Se)].

- **Coal and Raw Meal** - Heavy Metals: [Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Thallium (Tl), Vanadium (V), Zinc (Zn), Tin (Sn), Selenium (Se)].

- **Clinker** – Heavy Metals: [Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Thallium (Tl), Vanadium (V), Zinc (Zn), Tin (Sn), Selenium (Se)].

- **Leaching test of the clinker for heavy metals**
## Trials conducted in ACC Works

<table>
<thead>
<tr>
<th>Industry / Source (Plant)</th>
<th>Waste material</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUL</td>
<td>Expired products</td>
</tr>
<tr>
<td>SRF Ltd.</td>
<td>Polyresidue (3 times)</td>
</tr>
<tr>
<td>ICPE</td>
<td>Plastic waste</td>
</tr>
<tr>
<td>Toyota</td>
<td>Paint sludge</td>
</tr>
<tr>
<td></td>
<td>Phosphate sludge</td>
</tr>
<tr>
<td>Coca Cola</td>
<td>Spent Carbon</td>
</tr>
<tr>
<td></td>
<td>ETP Sludge</td>
</tr>
<tr>
<td></td>
<td>WTP Sludge</td>
</tr>
<tr>
<td>Jubilient Organics</td>
<td>N Butanol Residue</td>
</tr>
<tr>
<td></td>
<td>SEP Sludge</td>
</tr>
<tr>
<td>SKF India Ltd.</td>
<td>Grinding Muck</td>
</tr>
<tr>
<td>Kirloskar Toyoda</td>
<td>Grinding Muck</td>
</tr>
<tr>
<td>Kumar Organics</td>
<td>Benzo Furan</td>
</tr>
<tr>
<td>Suzlon</td>
<td>Green Mesh Resin</td>
</tr>
<tr>
<td>Ford India Ltd</td>
<td>Chemical sludge</td>
</tr>
<tr>
<td></td>
<td>Phosphate sludge</td>
</tr>
<tr>
<td></td>
<td>Chemical ETP sludge</td>
</tr>
<tr>
<td></td>
<td>Oily rags</td>
</tr>
<tr>
<td>SKF India Ltd.</td>
<td></td>
</tr>
<tr>
<td>Kirloskar Toyoda</td>
<td></td>
</tr>
<tr>
<td>Kumar Organics</td>
<td></td>
</tr>
<tr>
<td>Suzlon</td>
<td></td>
</tr>
<tr>
<td>Ford India Ltd</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Nivea</td>
<td>Expired products</td>
</tr>
</tbody>
</table>
Overview

- Concepts and benefits of co-processing
- Geocycle India- waste management service provider
- Co-processing the challenge
- Holcim Co-processing policy
- Waste disposal facilities with Geocycle India
- Experience on co-processing

Safety: Value not priority for Geocycle Business
Risk Assessment Procedure

Chemical Sludge
M/s Ford India Private Limited

ACC Limited
Madukkarai Cement Works
P.O. Madukkarai 641 105
Dist. Coimbatore, Tamil Nadu
- Safety precautions are ensured during transportation of waste materials from Waste generation site to designated ACC Works
- Safety training is imparted to concerned personnel
- All necessary PPEs (safety shoes, helmets, hand gloves, vapor mask) are provided
- Boards displaying precautionary measures, safety signs, work procedures while handling waste material etc. are displayed at various locations

- Fire extinguishers are made available in the storage shed
Example of Workplace Label

N - BUTANOL RESIDUE

<table>
<thead>
<tr>
<th>Hazard Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>* COMBUSTIBLE, Catches fire at high temperature</td>
</tr>
<tr>
<td>* CORROSIVE</td>
</tr>
<tr>
<td>* Health hazards:</td>
</tr>
<tr>
<td>Eye contact: causes eye irritation</td>
</tr>
<tr>
<td>Skin contact: May cause skin irritation</td>
</tr>
<tr>
<td>Inhalation: Irritating to mucous membranes and upper respiratory track.</td>
</tr>
<tr>
<td>Ingestion: May be harmful.</td>
</tr>
<tr>
<td>* Decomposition products: Carbon monoxide &amp; carbon dioxide</td>
</tr>
<tr>
<td>* Incompatibility: Strong oxidising agents</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Precautionary Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Storage: Keep tightly closed. Store in covered, cool dry place.</td>
</tr>
<tr>
<td>* Fire Fighting Measures: Water spray, CO2, DCP or Foam type</td>
</tr>
<tr>
<td>* First-aid Measures</td>
</tr>
<tr>
<td>Eye contact: Immediately flush eyes (with eyelids open) with water for atleast 15 min.</td>
</tr>
<tr>
<td>Skin contact: Gently flush affected areas with soap and water. Remove contaminated clothing.</td>
</tr>
<tr>
<td>Inhalation: If inhaled, remove to fresh air. If not breathing give artificial respiration.</td>
</tr>
<tr>
<td>Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.</td>
</tr>
</tbody>
</table>

* Spill Release Procedure:
Wear appropriate personal protective equipment. Collect the spilled material and store it in labelled container and use for co-process.

* Personal Protection:
- Nitril rubber hand gloves
- Organic vapour respirator
- Chemical safety goggle
- PVC apron

- Waste Specific Workplace Label is prepared for each waste material
- These labels are displayed in both English & Local language
World Environment Foundation (WEF) has recognized the efforts made by ACC Limited in providing waste management services and the prestigious Golden Peacock Award 2008 for Eco-Innovation was awarded this year to ACC AFR Department for “Disposal of Industrial Wastes through Co-processing them in cement kiln”.

Golden Peacock Awards
GreenTech Environment Excellence Award
Thank You