Managing Hazardous and other wastes through cement kiln co-processing in a sustainable manner

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Dy Head – Geocycle India

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About Geocycle

Geocycle is the waste management brand of LafargeHolcim.

LafargeHolcim is the promoter of both ACC Limited and Ambuja Cements Limited.

The service of waste co-processing is provided in cement manufacturing process.

We apply the highest health, environment and safety standards in all our operation complying to relevant regulation.
The customers we serve

• Worldwide, we service over 10,000 customers in different countries
• Our primary clients are industrial and service companies as well as municipalities
• We work with customers to ensure they receive the tailored solution they need
• We safely manage waste from varied industries including automotive, textile, petrochemicals, steel, FMCG, pharmaceutical, packaging, chemical agrochemicals and pesticide, refineries, food, engineering and many more
Co-processing, Waste Management Hierarchy and Industrial symbiosis

- Higher in Waste Management Hierarchy
- Recovery option
- Better environmental performance
- Practiced widely on large scales globally
- Encourages circular economy.

- Conserves natural resources,
- Reduces GHG emissions.
- Approved by Basel Convention for Hazardous & other Wastes
- Recommended by Stockholm convention for disposing POPs.
What is Co-processing?

• Co-processing is…
  ▶ …based on the principles of industrial ecology and stands for the
    **usage/disposal** of waste material (as raw materials, as a source of energy or
    both) in energy intensive industries to…
  ▶ …replace natural mineral resources (material recycling) and fossil fuels such as
    coal, petroleum and gas (energy recovery) by ‘processed waste’

• Benefit of co-processing
  ▶ Provides a [permanent](#) solution to waste problems
  ▶ [Reduces](#) emissions and greenhouse gases
  ▶ [Lessens](#) reliance on fossil fuels
  ▶ [Preserves](#) natural resources
What happens to the waste in the Cement Kiln?

- Organic constituents – acts as fuel and get completely destroyed due to the high temperatures, long residence time and oxidizing conditions in the kiln.
- Chlorine or sulphur - Acid gases, HCL and SO2 are produced and neutralized by the freshly formed lime and absorbed in product phase.
- Inorganic constituents react as raw materials in the cement process and heavy metals get immobilised in the crystal phases.
Technical Characteristics of Cement Kiln

Preheater cyclones
Act like a dry scrubber for acid gases and metals

Mineral wastes:
CaO, SiO₂, Al₂O₃, Fe₂O₃

Precaliner
Gases: > 900 °C
Retention time > 3 s
Raw meal: 700 °C
Liquid, sludgy and Coarse wastes

Kiln main burner
Flame: 1800 - 2000 °C
Combustion gases: >1100 °C
Retention time > 10 s
Material: 1450°C > 15 min.
Liquid, fine, solid particles

Clinker: Thermal, macro-molecular immobilization of metals

Lumpy wastes

Mineral by-products
Zero Impact of Co-processing On Emissions

Output products
Cement Quality
On final products

Sb+Cr+Cu+Pb+V
As+Co+Ni+Se+Te
Cd+Hg+Tl

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Zero Impact On PCDD/PCDF Emissions

Source VDZ

Emissions in ng I-TEQ/m³

Measurement No.

regular fuel

with secondary fuel

with secondary raw material

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No Leaching of Pollutants from Concrete

Trough tests on mortars

Lime-dissolving carbonic acid

Doped mixing water

Concentrations in the eluate are significantly below the limit values
Co-processing and Incineration
Reduction in GHG Emissions

Co-processing and Landfill
Prevention of Methane*
Emissions

* Methane has 21 times more global warming potential than CO2

The same argument is valid for all other emissions too.
Geocycle initiatives for demonstrating superiority of cement kiln co-processing for wastes in India

- About 10,000 TPY (2006) to about 700,000 TPY (2014).
- Hazardous and non-hazardous
- Solids, Liquids, Sludge and Gases
- Simple plastics to RDF from MSW to expired FMCG products to complex hazardous wastes such as benzofuran etc.
- >50 successful demonstration trials
- Disposal of large quantity of obsolete CFCs (ODS)
- Technical guidelines for management of spent wash and FRP / SMC materials.
- Six world class waste pre-processing facilities to convert wastes into AFRs
- 4 co-processing facilities spread across the country to provide solution at the nearest location.
Examples of Waste Pre-Processed and Co-Processed

- Expired products
- Damaged toys
- Expired seed
- Damaged beans
- Plastics
- Packaging materials
- Rubber wastes
- Textile waste
- Refinery wastes
- Bleaching earth
- Lime sludge
- bottom ash
- Mill scale
- Blasting grit
- Diatomaceous earth
- Paint wastes
- Used oil & grease
- Scrap tires
- Wood chips
- Solvents
- Carbon fines
- Oil filter fluffs
- Coking wastes
- Shipping wastes
- RDF fluff & pellets
- Acid Tar sludge
- Filter cake
- Refinery catalyst
- Calcium fluoride
- Foundry sand

- AND MANY MORE
Our Clientele

- FMCG
  - Hindustan Unilever Limited
  - Nestlé
  - Cadbury
  - Coca-Cola
  - Pepsi
  - Nestle

- Food Products
  - ITC Limited

- Paper & Pulp
  - Tata Steel

- Steel
  - Tata Steel

- Toys
  - Mattel

- Footwear
  - Nike

- Machinery
  - JFGL

- Chemical
  - Tagros

- Government
  - Directive

- Pharmaceutical
  - Johnson & Johnson

- Automobile
  - Toyota
  - Volvo
  - Tata Motors
  - Ford

- Petroleum
  - Indian Oil
  - MRPL

- Petrochemicals
  - Narmada
  - Chematur

- Chemical
  - Syngenta
  - Tagros

- Machinery
  - KEC

- Other Industries
  - Petrochemicals
  - Pharmaceuticals
  - Automobile
  - Footwear
  - Machinery
  - Chemical
Large scale coprocessing - Pre-Processing Activities
Utilisation of wastes in cement kilns as fuels

TSR (%) achieved in cement kilns by countries

- Austria: 72%
- Germany: 64%
- Norway: 60%
- Czech Republic: 60%
- United Kingdom: 49%
- Switzerland: 48%
- Poland: 47%
- France: 32%
- Belgium: 30%
- Sweden: 29%
- Spain: 27%
- Luxembourg: 25%
- Philippines: 22%
- Brazil: 18%
- USA: 16%
- Thailand: 14%
- Italy: 13%
- Canada: 12%
- Morocco: 10%
- Egypt: 7%
- India: 1%
Mining urban areas

HW - >7 Mio TPA

MSW - >60 Mio TPA

NHW - ????? Mio T
What is required to utilise larger quantum of wastes?

**Recognition for co-processing**
- Recognition of co-processing as a preferred technology for waste management

**Modifications in the Regulatory framework**
- Hassle free Interstate movement of wastes and clear guidelines to avoid any disputes
- Mandate in MSW Rules for producing RDF suitable for cement plant co-processing

**Generic permissions for pre & co-processing facilities**
- Generic Permit for Co-processing to cement plants adhering to Pre-qualification criteria
- Uniform permitting procedure for Hazardous and non-hazardous wastes at all SPCBs
Existing regulatory framework

• Principle of “disposal” as against desired principle of “sustainability”.

• Mandatorily diverts wastes to landfill or incineration facilities.
  ▶ Drains available resource value present in the wastes.
  ▶ Increases waste foot print in the environment.

• Instantaneous permit for landfill or incineration and more than one year for co-processing.

• Generic permit for landfill and incineration facilities and waste by waste permit for co-processing option.

• No demonstration trial for landfill or incineration but an elaborate demonstration trial for co-processing.
## Perceptions and facts related to co-processing

<table>
<thead>
<tr>
<th>Perception</th>
<th>Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each waste stream has a very definite characteristics and a <strong>trial of every waste stream is necessary</strong>. The same is <strong>not necessary</strong> for landfill or incineration options</td>
<td><strong>False.</strong> Co-processing is a recovery process, has proven better environmental performance than incineration or landfill options and is higher in the waste management hierarchy than landfill and incineration operations. The characteristics of wastes change from time to time and batch to batch. The variation range is observed to a level of more than 1000 times as well.</td>
</tr>
</tbody>
</table>
### Perceptions and facts related to co-processing

<table>
<thead>
<tr>
<th>Perception</th>
<th>Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>By granting co-processing permission based on the demonstration trial of a waste stream, the <strong>environmentally sound disposal of that waste stream is always ensured.</strong></td>
<td><strong>False.</strong> The chemical composition of the mix material in the kiln also depends upon other input materials entering the kiln along with the waste.</td>
</tr>
<tr>
<td>Chemical characteristics of the waste ‘<strong>may</strong>’ influence cement kiln emissions and emit large quantum of toxic gases.</td>
<td><strong>False.</strong> No negative influence has been observed on any of the emission parameters while co-processing wastes in the cement kiln.</td>
</tr>
<tr>
<td>Cement product quality ‘<strong>may</strong>’ get impacted by varying characteristics in the waste.</td>
<td><strong>False.</strong> No negative influence has been observed on the product quality while co-processing wastes in the cement kiln.</td>
</tr>
</tbody>
</table>
Assessment of approved co-processing trials conducted by ACC and ACL

- No. of HW Categories: 20
- Waste streams: 44
- Trials conducted: 32
- Clinker Production:
  - Min – 1200 TPD
  - Max – 6940 TPD
- Single waste trials – 20
- Mixed waste trials - 12
- Waste Feed rates:
  - Min – 1 TPD
  - Max – 72 TPD
- 11 No. Different Kilns
### Range of variation in the characteristics of the approved wastes 
*(AS RECEIVED BASIS)*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>0.60</td>
<td>67.4</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.96</td>
<td>98.70</td>
</tr>
<tr>
<td>VM (%)</td>
<td>0.3</td>
<td>94.9</td>
</tr>
<tr>
<td>FC (%)</td>
<td>0.1</td>
<td>45.7</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.4</td>
<td>75.6</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>0.2</td>
<td>9.1</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0</td>
<td>15.5</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.1</td>
<td>22</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0</td>
<td>76.3</td>
</tr>
<tr>
<td>GCV (Kcal/Kg)</td>
<td>80</td>
<td>7960</td>
</tr>
<tr>
<td>NCV (Kcal/Kg)</td>
<td>114.8</td>
<td>6042</td>
</tr>
<tr>
<td>Mineral matter</td>
<td>3.5</td>
<td>34.5</td>
</tr>
<tr>
<td>Chloride as Cl (mg/kg)</td>
<td>0</td>
<td>14200</td>
</tr>
<tr>
<td>Fluoride as F (mg/kg)</td>
<td>0</td>
<td>20.1</td>
</tr>
<tr>
<td>VOC (mg/kg)</td>
<td>4.20</td>
<td>207.0</td>
</tr>
<tr>
<td>SVOC (mg/kg)</td>
<td>BDL</td>
<td>0.2</td>
</tr>
<tr>
<td>PCB (mg/kg)</td>
<td>0.00</td>
<td>0.5</td>
</tr>
<tr>
<td>PCP (mg/Kg)</td>
<td>BDL</td>
<td>1.4</td>
</tr>
<tr>
<td>TOC (%)</td>
<td>0.00</td>
<td>66.0</td>
</tr>
<tr>
<td>Cadmium (mg/kg)</td>
<td>0.10</td>
<td>27.6</td>
</tr>
<tr>
<td>Chromium (mg/kg)</td>
<td>0.20</td>
<td>36,229.7</td>
</tr>
<tr>
<td>Copper (mg/kg)</td>
<td>1.00</td>
<td>8,848.6</td>
</tr>
<tr>
<td>Cobalt (mg/kg)</td>
<td>0.10</td>
<td>176.4</td>
</tr>
<tr>
<td>Manganese (mg/kg)</td>
<td>0.10</td>
<td>7,800.0</td>
</tr>
<tr>
<td>Nickel (mg/kg)</td>
<td>0.10</td>
<td>9,300.0</td>
</tr>
<tr>
<td>Lead (mg/kg)</td>
<td>0.10</td>
<td>633.3</td>
</tr>
<tr>
<td>Zinc (mg/Kg)</td>
<td>1.00</td>
<td>22,000.0</td>
</tr>
<tr>
<td>Arsenic (mg/kg)</td>
<td>0.10</td>
<td>8.1</td>
</tr>
<tr>
<td>Mercury (mg/kg)</td>
<td>0.10</td>
<td>3.8</td>
</tr>
<tr>
<td>Selenium (mg/kg)</td>
<td>0.00</td>
<td>8.2</td>
</tr>
<tr>
<td>Antimony (mg/kg)</td>
<td>0.10</td>
<td>9.4</td>
</tr>
<tr>
<td>Vanadium (mg/kg)</td>
<td>1.00</td>
<td>82,400.0</td>
</tr>
<tr>
<td>Thallium (mg/kg)</td>
<td>0.10</td>
<td>1.0</td>
</tr>
<tr>
<td>Tin (mg/kg)</td>
<td>0.00</td>
<td>145.6</td>
</tr>
</tbody>
</table>
Current Waste by waste permitting process is not relevant!

- The approved wastes had **large variations** in their characteristics.
- It is **not necessary** for wastes to have similar characteristics for environmentally sound co-processing.
- A mix of two or more approved waste streams **does not produce** a waste having approved waste characteristics.
- Cement kilns have **large capacity** to manage wastes in an environmentally sound manner.
- Compliance to prescribed emission norms based permitting process is an appropriate permitting process.
Conclusions!

- **Zero waste** residue
- **Zero Liability** once the waste is co-processed
- **Safe, secure and environmentally sound** way of waste disposal
- **100% compliance** with local environmental regulations and the setting of best practices

Co-processing is, therefore, a local & desired route to manage wastes with zero waste, zero liability and zero environmental impact addressing all concerns of sustainable development.