Sustainable Growth

Supplementary Cementitious Materials

By
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Manager of Supplementary Cementitious Materials
What are SCM?
Supplementary Cementitious Materials

Substitution of clinker in cement by another material which has Cementitious properties
Global Cement Producers

Goals
- Providing environmentally friendly sustainable products
- Lower Fuel Consumption
- Lower Operating Costs
- Lower Capital Costs

Barriers
- Traditional methods have limitations

Usage
- Estimated 10-15% consists of SCMs
Limitations

Natural SCMs
- Limited quantities
- Regional variability

Synthetic SCMs
- Knowledge
- Experience
- Technology

Waste Materials
- Fluctuating chemistries
- Unwanted components
Fly Ash
Fly Ash
Clays - Kaolins

- Considerations
  - Wet “Lumpy” material
  - Specific temperatures
  - “Off-color” products
  - Inconsistent quality

- Traditional Technology
  - Inefficient cooling
  - Not evenly heated
  - Discoloration
Clays - Kaolins
Synthetic Pozzolan Productions

- Product
  - High pozzolonic activity
  - Color similar to cement
  - Lower fuel consumption
Advantages to This Approach

- Product quality allows for increased use of pozzolan in cement blends
- Color similar to cement
- Lower fuel consumption than existing methods
- Few moving parts – Lower Maintenance / Operating costs
- Compact design – less than 1500 m² footprint of Pyro Process Equipment
Further Implementations
Patent Pending
EFFECT OF DIFFERENT CALCINING PROCESSES

- Cement strengths after 28 days by substitute 30% of cement with limestone and calcined clay.
**Side-By-Side**

<table>
<thead>
<tr>
<th>Kiln</th>
<th>Calciner</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td><strong>Equipment</strong> - $16 M USD</td>
<td><strong>Equipment</strong> - $12 M USD</td>
</tr>
<tr>
<td><strong>Installation</strong> - $16 M USD</td>
<td><strong>Installation</strong> - $12 M USD</td>
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<tr>
<td>680 kcal/kg</td>
<td>640 kcal/kg</td>
</tr>
<tr>
<td>12 kw/t</td>
<td>15 kw/t</td>
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<tr>
<td>Maintenance - $3 per ton</td>
<td>Maintenance - &lt;$1 per ton</td>
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<tr>
<td>20-25% Substitution</td>
<td>35-40% Substitution</td>
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<tr>
<td>18-24 months</td>
<td>15-18 months</td>
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<tr>
<td>ROI – 3.5 years</td>
<td>ROI – 2.5 years</td>
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CO₂ Reduction by Making Pozzolan Cement

Assume: 0.94 Kg CO₂/Kg Clinker, and 0.256 Kg CO₂/Kg Pozzolan

**CO₂ OPC:**

\[
0.94 \frac{\text{Kg CO₂}}{\text{Kg clinker}} \times 0.95 + 0.0 \frac{\text{Kg CO₂}}{\text{Kg clinker}} \times 0.05 = 0.893 \frac{\text{Kg CO₂}}{\text{Kg Cement}}
\]

**CO₂ POZ:**

\[
(0.256 \frac{\text{Kg CO₂}}{\text{Kg Pozzolan}} \times 0.4 + 0.94 \frac{\text{Kg CO₂}}{\text{Kg Clinker}} \times 0.6) \times 0.95 = 0.601 \frac{\text{Kg CO₂}}{\text{Kg Cement}}
\]
CO₂ Reduction by Making Pozzolan Cement
Assume: 0.94 Kg CO₂/Kg Clinker, and 0.256 Kg CO₂/Kg Pozzolan

CO₂ OPC:

\[ \frac{0.94 \text{ Kg CO}_2}{\text{Kg Clinker}} \times 0.95 \quad \text{plus} \quad 0.0 \quad \frac{\text{Kg CO}_2}{\text{Kg Clinker}} \times 0.05 \]

A reduction of 33%

CO₂ POZ:

\[ (\frac{0.256 \text{ Kg CO}_2}{\text{Kg Pozzolan}} \times 0.4) \quad \text{plus} \quad \frac{0.94 \text{ Kg CO}_2}{\text{Kg Clinker}} \times 0.6 \times 0.95 \]

= \[ \frac{0.601 \text{ Kg CO}_2}{\text{Kg Cement}} \]

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CO₂ Reduction by Making Pozzolan Cement

Assume: We use 700 Kcal/Kg Clinker in the process

Fuel Savings:

\[
\frac{700 \text{ Kcal}}{\text{Kg Clinker}} - \left( \frac{700 \text{ Kcal}}{\text{Kg Clinker}} \times 0.6 \right) + \frac{540 \text{ Kcal}}{\text{Kg Pozzolan}} \times 0.4
\]

= \frac{64 \text{ Kcal}}{\text{Kg Clinker}}

A savings of 9.1%
Direct Substitution

Strength Summary
30% Substitution

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Blended Cements

- Clinker is engineered for Ordinary Portland Cement
- Blended Cement can mimic Ordinary Portland Cement
- High substitution rates require different parameters
- Optimization of physical and chemical properties required

Blended Cements ~ Ordinary Portland Cement
Pozzolan Testing

Laboratory Study – Synthetic Pozzolan

With the objective of identifying potential to produce a synthetic pozzolan from a given clay, FLSmidth will perform/provide the following:

- Sample Preparation
- Chemical and mineralogical characterization
- Physical testing
- Activation utilizing calciner process
- Color control of product
- Grinding and physical testing of synthetic pozzolan
  - Compressive strength testing at three substitution rates (20, 30 and 40%)
Concept / Advancement

- Mobile Plant
  - Pilot scale Pozzolan Calciner System
  - 5 MTPD capacity
  - Fully integrated / Self-sustainable (Plug-and-Play concept)
  - Simple set-up & operation

- Advantage
  - Hands-on experience
  - Product produced with available raw materials
  - Capacity to achieve consumers acceptance

- Investment
  - Weekly Rental - ~$45,000 USD
  - Investment credited to purchase of full-scale system
Proof of Concept
Thank You