Non destructive tests for Refractories

TC 11 – Düsseldorf Oct 2018

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The Ground Penetrating Radar is a Non-Destructive Testing used mainly for the concretes survey or soils analyses. It consists into the use of electromagnetic pulses to determine the structure of nonconductive material.

2 physical properties of the material impact the GPR response:

1. **Electrical conductivity**: The Radar is suitable for inspection of any material with low electrical conductivity.
2. **Dielectric constant**: Descriptive number that indicates how fast radar energy travels through a specific material. 
   \[ v = \frac{c}{\sqrt{\text{Dielectric constant}}} \]
Refractory quality by NDT (Ground Penetrating Radar)
Voids detected in step bottom paving (inspection at supplier)

Step block n° 730 rejected due to voids

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GPR – bottom structure – longitudinal scans

AZS 32% 120mm
Concrete 2 x 50mm

AZS 41% 200mm

AZS 41% 200mm

Glass infiltration
50mm
50mm

Bubblers blocks lifted up
Refractories inner structure - GPR in workshop

Challenge: define specification for GPR
Residual thickness

Glass/Refractory interface can be detected by GPR at room temperature
Residual thickness (hot)

Silica crown
(regenerator +/- 1490°)

Clear visibility of the refractories thicknesses
(insulating & silica)
Ultrasonic tests
Typical results & discussions

**US speed (m/s) on width vs on thickness**

<table>
<thead>
<tr>
<th></th>
<th>On Thickness</th>
<th>On width</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>3861</td>
<td>3875</td>
</tr>
<tr>
<td>STDEV</td>
<td>226</td>
<td>205</td>
</tr>
<tr>
<td>MAX</td>
<td>4440</td>
<td>4360</td>
</tr>
<tr>
<td>MIN</td>
<td>3262</td>
<td>3323</td>
</tr>
<tr>
<td>QTY</td>
<td>61</td>
<td>61</td>
</tr>
</tbody>
</table>

**All blocks**

**shape1**

**shape 2**

US on silico aluminous TBB

US on CA TBB
US comments

- US is used to evaluate the consistency of the production
- US depends not only upon the material but other parameters must be taken into account:
  - Press type (hydraulic, friction…)
  - Process (uniaxial – isostatic – casting…)
  - Firing conditions
  - Room temperature (specifically if below 0°C), however not recommended to inspect the refractories at this T°C range

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Dry concrete</th>
<th>Wet concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°C – 30°C</td>
<td>1.0 (No correction)</td>
<td>1.0 (No correction)</td>
</tr>
<tr>
<td>60°C</td>
<td>1.05</td>
<td>1.04</td>
</tr>
<tr>
<td>40°C</td>
<td>1.02</td>
<td>1.02</td>
</tr>
<tr>
<td>0°C</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>-4°C</td>
<td>0.98</td>
<td>0.92</td>
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</table>

Table by Proceq