IMPREGNATED RESISTAL BRICKS WITH SUPERIOR ALKALI RESISTANCE

1. Background

Alternative or waste derived fuels constitute an important aspect in the continuous efforts to reduce costs in the cement making process. When compared with traditional fuels, the majority of alternative fuels contain significantly lower levels of sulphur, thereby shifting the alkali/sulphur ratio of the kiln atmosphere to the alkaline side. With excess alkali, it is primarily the alumina lining of the preheating zone that is chemically attacked.

It is well known that fireclay products are quite resistant to alkalis. Fireclay is, however, limited in its refractoriness and cannot be used in the preheating zone of modern preheater kilns. Trials to line the preheating zone of kilns with an excess of alkalis with magnesia spinel bricks have proven unsuccessful because chlorine, another typical minor constituent of alternative fuels, combines readily with the alkalis and condenses as alkali chloride within the lining. This can lead to large-scale spalling when the kiln is stopped, even after a short operation time.

2. Technical Description

RHI Refractories has developed a unique technology to make alumina bricks fit for alkali excess in the kiln atmosphere. The technology consists of impregnating burned alumina bricks with a special solution containing nano-sized oxide particles of high refractoriness and high alkali resistance. It is important to note that due to the minute size of the refractory particles the impregnation is 100 per cent down to the core, i.e. not just limited to the surface of the bricks. After removing the impregnation liquid by controlled drying, the refractory nano-sized residue fills the pores without affecting the physical and thermal properties of the alumina bricks. This technology is protected by German Patent DE 10035728 C2.

To cover all areas of a cement kiln line where alkali attack can occur, impregnated bauxite and andalusite bricks with 55, 60 and 75% Al₂O₃ are available (Tab. 1). Specially impregnated alumina bricks are characterized by “IS” after the brand name (e.g. RESISTAL B50ZIS).

<table>
<thead>
<tr>
<th>Brand</th>
<th>RESISTAL</th>
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<tr>
<td></td>
<td>B50ZIS</td>
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<tr>
<td>Raw Materials</td>
<td>fireclay, bauxite</td>
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<tr>
<td>Bulk density g/cm³</td>
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<tr>
<td>Open porosity vol%</td>
<td>14.5</td>
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<tr>
<td>Cold crushing strength N/mm²</td>
<td>70</td>
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<td>Refractoriness under load t₀,₅</td>
<td>1450°C</td>
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Table 1: Composition and properties of specially impregnated alumina bricks

It is recommended to install specially impregnated alumina bricks wherever alkali attack has to be expected: in the preheating zone of the rotary kiln, riser duct, calciner, kiln hood and the cooler front wall.

3. Results from Practical Operation

3.1. The first installation with impregnated RESISTAL bricks was carried out in Poland in a 8,000tpd kiln where in the cooler front wall life time of conventional andalusite bricks was not more than three months. RESISTAL B50ZIS bricks

Fig. 1: Cooler front wall lined with RESISTAL B50ZIS after 5 months operation where conventional andalusite bricks had failed after 3 months.
which replaced the conventional andalusite bricks showed no signs of alkali reactions or spalling after five months operation (Fig. 1). This lining achieved a life time of 48 months.

3.2. In a French 3,800tpd precalciner kiln life time of conventional alumina bricks in the preheating zone was six months, due to severe spalling caused by alkali compounds. The situation could not be improved by installing magnesia spinel bricks. With RESISTAL SK60CIS bricks, after six months operation only a few spalled brick heads could be observed without need for repair or patching (Fig. 2). Total life time is expected to be at least two years.

3.3. In a British 2,100tpd precalciner kiln RESISTAL SK60CIS brick installed in the safety zone surprisingly proved coating repellent (Fig. 3). A coating free lining in the safety zone is of great importance for continuous operation because coating in this kiln easily progresses into rings that obstruct the material flow. Starting with a trial section in 2003, the RESISTAL SK60CIS section has been progressively enlarged and covers now the whole safety zone.

3.4. In a German 4,800tpd precalciner kiln residual thickness of RESISTAL B50ZIS in the inlet zone after two years operation was 180 mm (annual wear rate 20 mm, Fig. 4). Mineralogic examination showed that K₂O infiltration and formation of leucite (KAlSi₂O₆) at the hot face was limited to the uppermost 5 mm. During the same period an alkali resistant competitor’s material suffered an annual wear rate of 50 mm and was not further considered for this section.

4. Conclusion

Since 2001 specially impregnated, alkali resistant alumina bricks have been installed in more than 50 kilns in more than 20 countries all over the world. Three types of impregnated RESISTAL bricks are available: B50ZIS (55% Al₂O₃), SK60CIS (60% Al₂O₃) and B75ZIS (75% Al₂O₃).

Results so far have surpassed all expectations, life times even in critical zones could be more than doubled. Firing of waste derived fuel with high alkali load thus does not present any more a problem for alumina bricks.