New type of partition walls in a pelletizing plant

A thermo mechanical finite element analysis
RHI at one glance

Key facts

- Focus on production, sale and installation of high-grade refractory products
- Revenues of € 1.75 bn and operating result of € 124 m in business year 2015
- Over 30 production sites and more than 70 sales and service sites, roughly 7,900 employees
- Global partner for over 10,000 customers in more than 180 countries
- Technology leadership with close to the market R&D facilities and tailor-made products

Selected key customers

<table>
<thead>
<tr>
<th>Steel</th>
<th>Cement</th>
<th>Glass</th>
<th>Nonferrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcelorMittal</td>
<td>Cemex</td>
<td>ArdaghGlass</td>
<td>GlencoreXstrata</td>
</tr>
<tr>
<td>Severstal</td>
<td>Holcim</td>
<td>SCHOTT</td>
<td>bhpbilliton</td>
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<td>RioTinto</td>
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</tbody>
</table>
From Source to Application – with **ONE** Partner!

- **Raw-Material Industry**
- **Refractory-Industry**
- **Customer Industries**

- **Refractory Brick**
- **Unshaped Refractories**
- **Functional Products**

- **Lining/Installation**
- **Maintenance/Service**

- **Steel**
- **Cement / Lime**
- **Non-Ferrous-Metals**
- **Glass**
- **Environment-Energy-Chemical**
Organizational Structure divided into Business Units

- **BU**
  - Steel & Flow Control
  - Cement and Lime
  - Non-ferrous Metals
  - Glass
  - Environment Energy Chemical

**Customer Industries**
RHI Group – 2013 external revenues

- Raw Material 2%
- Industrial 35%
- Cement 11%
- Nonferrous 11%
- Glass 8%
- EEC 4%

**Responsibility of BU EEC**

- all technical processes / applications in:
  - Environmental Industry
  - Energy Industry
  - Chemical & Petrochemical Industry
  - Pelletizing Plants, Coke Ovens

RHI Dinaris GmbH.
Wiesbaden /Germany
BU EEC: Fields of Activity – Oil & Gas

- Incinerator
- Catalytic Cracker
- Sulfur Recovery
- Steam Cracker
- Gasifier
- Primary/Secondary Reformer
- Carbon Black
- Waste Heat Boiler
BU EEC: Fields of Activity – Energy & Waste

Municipal Waste Incinerator

Special Waste Incinerators

Circulating Fluidized Bed Reactor

Incinerators for gaseous and liquid Waste

Stationary Fluidized Bed Reactors
BU EEC: Fields of Activity – Iron Ore Pelletizing

High Temperature Areas:

- Burner with sidewall
- Suspended brick roof
- Baffle-wall with/without water-cooling
Modular Solution System – Maximum of Flexibility and Reliability

A. Engineering:
- Basic Engineering
- Detail Engineering
- Engineering PLUS (Modeling & Simulations)

B. Material:
- Production
- Packing
- Transportation
- Warehousing

C. Site Management:
- Installation
- Supervision
- Site-Organization
- Dry-Out

D. Maintenance:
- After sales service
- Inspection Services incl. technical reporting
- Maintenance work
Partition walls in a pelletizing plant

Traveling grate furnace

Available designs
- Bone brick design
- Water cooled designs
- New design
Partition walls in a pelletizing plant

Available designs

- New design

- Feasibility study with finite element analysis
Thermo mechanical finite element analysis

Finite element analysis of refractories

- Stress based loads:

\[ \sigma = \frac{F}{A} \]

[1] Schacht, C (Editor); Refractories Handbook, Marcel Dekker, Inc. 2010
[2] Schacht, C; Refractory linings, themomechanical design and applications, Marcel Dekker, Inc. 2010
Thermo mechanical finite element analysis

Finite element analysis of refractories

- Stress based loads:
  \[ \sigma = \frac{F}{A} \]

- Strain based loads:
  \[ \sigma = E \varepsilon_{th} \]

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Thermo mechanical finite element analysis

Finite element analysis of refractories
- Stress depending on material description
Finite element analysis of refractories

- Stress depending on material description
Finite element analysis of refractories

- Material properties of refractory materials are complex, nonlinear, time and strain rate dependent.

- These properties are hardly describable in Finite Element Analysis programs, hence absolute conclusions could not be expected.

- Based on relative comparisons:

  Finite Element Analysis is a powerful tool for the refractory industry to support the development of optimum solutions in close cooperation with our customers.
Partition walls in a pelletizing plant

Finite element analysis of partition wall concepts

- **Results:** First principal stress
Partition walls in a pelletizing plant

Finite element analysis of partition wall concepts

- Results: Horizontal forces depending on deformability of supporting structure
Partition walls in a pelletizing plant

Finite element analysis of partition wall concepts

- **Results:** Vertical displacement
Partition walls in a pelletizing plant

Finite element analysis of partition wall concepts

- Conclusions:
  > Finite element analysis (FEA) of refractory structures is despite of the challenges a very useful tool.
  > The FEA evaluation of deformations provides guidelines for the design of the wall ensuring a significant clearance in between the partition walls and the travelling grate.
  > The FEA evaluation of the stresses indicates a reduced risk of the formation of cracks influencing the stability of the arch type wall compared to the bone brick type wall.

**The new arch type design is a feasible alternative** to water cooled or bone brick type design.
Partition walls in a pelletizing plant

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We hope to welcome you a the RHI booth at the ECIC 2016

Disclaimer

Models presented here are designed to answer specific questions and are based on necessary simplifications and assumptions. Any interpretation of the results beyond the original scope of the model might lead to wrong conclusions and RHI is not responsible for any consequences.

Based on the complex material behaviour of refractory materials including time and temperature dependent effects like relaxation and creep, models have to be based on simplifications. Therefore all results shown in this presentation are valid for the comparison of the lining concepts but must not considered as absolute values. Hence the finite element simulations presented here are not able to provide a proof that the discussed designs will work.

Therefore RHI AG is not liable for any damages that might occur by the application of the designs presented in these slides.