

Steel meets Refractory

A new platform for technical exchange in Germany

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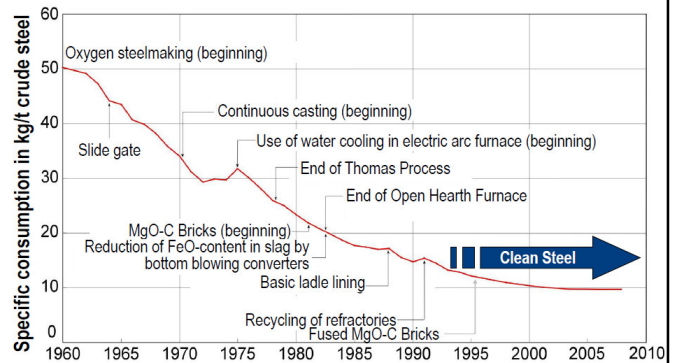
Content

- Historical Development
- New Platform “Steel meets Refractory”
- Experiences
- Outlook
- Acknowledgement

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Historical Development

- Strategic role of refractories for steel making companies
- Two major trends:
 - Reduction of specific refractory consumption
 - Higher performance and quality refractories


 Statistisches Jahrbuch der Stahlindustrie, www.stahl-online.de

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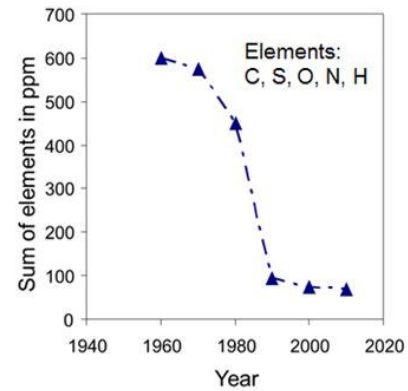
Historical development 1960-1970s

- Refractory companies, departments, and laboratories in steel companies
- Refractory committee of German Steel Association VDEh
- Topics as example:
 - BOF bricks
 - Refractories testing for industrial application
 - Wear of BF runner mix
 - Refractories trend in European steel industry
 - Refractory lining for steel ladle

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Historical development 1980-1990s

- Advanced steel technology and refractories
- Focus on core business in steel
- Sale resp. closure of refractory companies, departments, and labs in steel companies
- Reinforce VDEh refractory committee with experts from suppliers



Achievable contents after secondary metallurgical treatment 1960 - 2010

Fandrich et al., stahl und eisen 131 (2011), no. 6/7, 75-89

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Historical development

- Topics as example:
 - Refractories for ladle metallurgy
 - Refractories and raw materials for steel production in Europe
 - Trends in clean steel technology and refractories engineering
 - Perspective on refractories products and requirements in steel
- 2017 Stop of all technical committee work incl. refractories of VDEh

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New platform Steel meets Refractory

- Value of technical exchange
 - < 2% refractories cost in steel making
 - Small # of refractory engineers in steel
 - No “lone-fighter-show”
 - Technical competent partners for suppliers
 - Economic aspects of refractories “value in use”

process benefits	Reliability(predictability/safety) Steel quality Capacity benefits Steel energy loss
related costs	Purchasing/QC/R&D and storage Drying/heating cost Breakouts/incidents repairs Mechanical repairs (lip ring etc.) Health, environment and safety actions
direct costs	Refractory material Transport supplier to steel plant Installation of the refractories

Siebring et al., Refractories Worldforum 9 (2017), no. 3, 71-75

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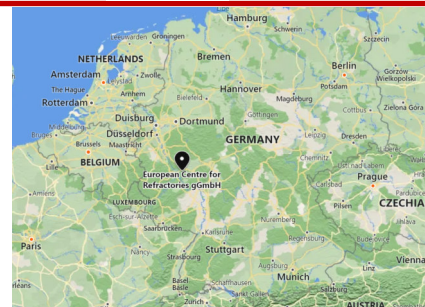
New platform Steel meets Refractory

European
Centre for
Refractories



Rheinland-Pfalz
 MINISTERIUM FÜR
 WIRTSCHAFT, VERKEHR,
 LANDWIRTSCHAFT
 UND WEINBAU

- Network of refractory experts
- German Refractory Association
- Patronage support from Ministry
- Technical-scientific exchange
- Compliance
- Start in 2019



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New platform Steel meets Refractory

General thematic areas:

- Environmental, Health & Safety
e.g. classification of refractory products
- Technical problems and challenges
e.g. recycling of refractory products, purging in steel ladles
- Innovation
e.g. drying and heating of monolithic installations, digitalization

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Experiences

Meeting format

- Invitation through GRA
 - Member companies
 - Refractory engineers from steel industry
 - Refractory experts from institutes
- About 50 participants and 1/3 from steel industry
- 1st meeting August 2019 in Koblenz incl. plant visit Steuler KCH
- 3 online meetings 2020 & 2021
- April 2022 in Höhr-Grenzhausen

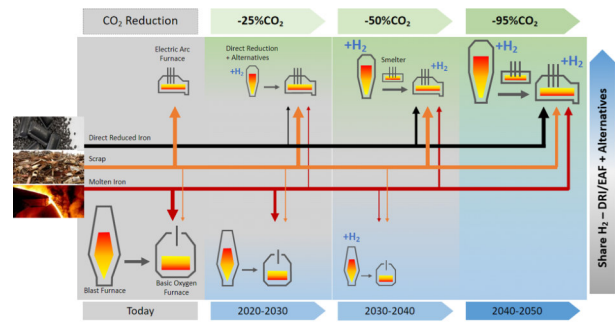


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Experiences

Green Deal and CO₂ reduction

- EU -55% CO₂ by 2030 and climate neutrality by 2050
- EU 28 (incl. UK) 60% of steel production blast furnace route
- Iron-ore reduction by coal ≈ 90% of CO₂ emission
- Roadmaps of 7 European steel companies
- Impact on refractory linings, e.g. stability in H₂ cont. atmosphere



Transformation from carbon to hydrogen based steel production

L. Rebouillat, CESAREF project proposal Nov. 2021

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Experiences

Green Deal and CO₂ reduction

- Influence of refractories on energy efficiency in steel making
 - Graphite containing ladle bricks vs. C-free materials 10-20 K higher temperature loss in steel ladle ≈ similar cost as for refractory lining
 - Shorter heating up procedures for sol-bonded monolithics
 - Examples for continuous casting
 - Part of value in use
- Life cycle analyses, CO₂ emission, GHG Protocol
 - Refractories scope 3 for steel production
 - Relation product carbon footprint vs. effect in application (scope 1)
 - Vesuvius global scope 1 + 2 CO₂ emission ≈ 2 hours steel production globally*

Scope 3
Indirect
Upstream
Downstream

Scope 2
Electricity

Scope 1
Direct

*J. Richaud, SMR, 14 Sep 2021

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Experiences

Climate road maps of tile, ceramic, lime, and cement industries

- Coal ash and blast furnace slag to phase out as clinker replacement

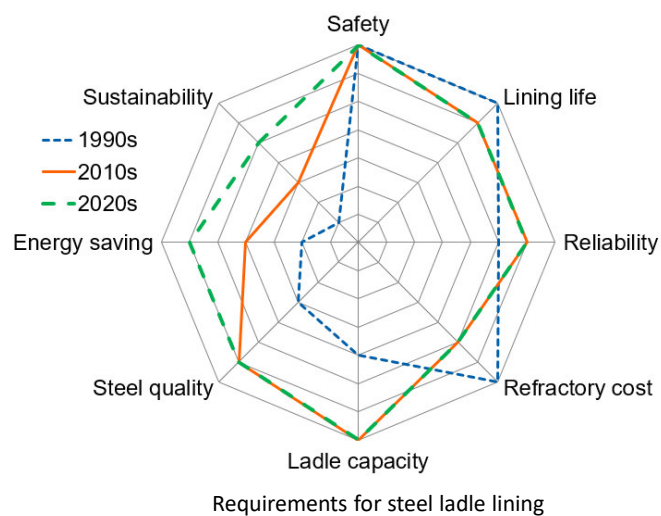
Sustainability and recycling

- Recycling of BOF or EAF bricks for steel ladle bricks
 - JV Refratechnik and Horn & Co in Germany
 - voestalpine Linz, Austria MgO/C ladle bricks
- Tata Steel IJmuiden, NL spent Al-Sp bricks for AMC ladle bricks
- Regional value chains essential
- Close cooperation and short distances

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Experiences

Sustainability as new factor for lining design



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Experiences

Refractories classification

- Safety data sheet – acc. to REACH for mixes but not (shaped) products, high administrative effort
- Expectations from steel companies, e.g.
 - (Respirable) crystalline silica
 - Cr⁶⁺
 - Organic binders and additives (PAH,...)
 - Radioactivity (of ZrO₂ materials)
- Mutual approach between suppliers and users for future solution?

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Experiences

Digitalization

- World Refractory Association task force
Refractory Exchange Data Standard
- Standardized data sets and format for digitalized information exchange between ERP systems of supplier and customer
 - Refractory product information
 - Logistic information
 - Process data from application
- Qualified feedback from steel engineers in SMR

ERP = Enterprise Resource Planning

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Outlook

- Value of new platform for participants
- Complexity of refractory business in steel making process
- Challenges:
 - Decarbonization of the industry
 - Sustainability
 - Digitalization
 - and more ...
- Work for engineers for decades!
- Close cooperation between suppliers and customers as basis for successful solutions

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Acknowledgement

- Ministry of Economics from Federal State of Rhineland-Palatinate
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- German Refractory Association
Thomas Kaczmarek



Ceramics Museum Westerwald

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Steel
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Thank you for your attention!
