

Materials in the furnace and product quality Research and development analysis and findings

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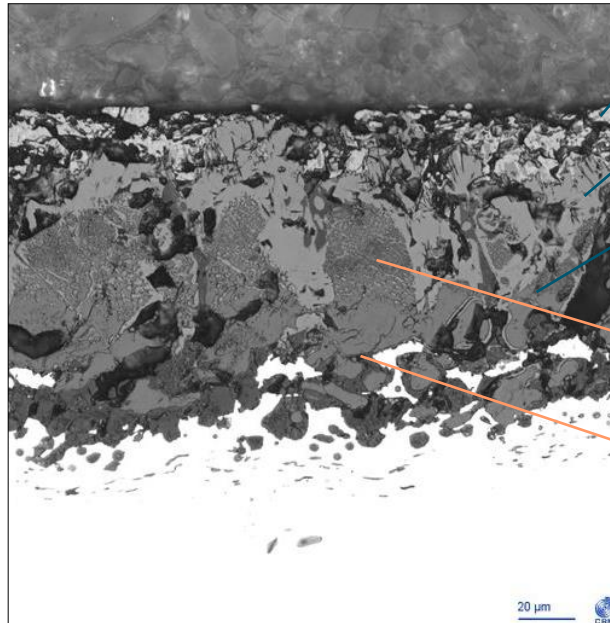
- **Focus of investigations and review**
- **Research of past 25 years**
- **BAT-analysis and future-concept**
- **Relevant new technologies**



- Focus of investigations in reviewing *Materials in the furnace and product quality* : Surface properties: decarbonization + scale + interface + Defects
- Research of past 25 years
 - Scale growth: Constox, Oxmapro, ScaleControl, ...
 - Descaling: Hides, ReduHeatLoss, ...
 - Application of coatings: HiperScale, ...
- Success-story:
 - Definition of critical parameters (e.g. atmosphere, chemistry)
 - Interaction with descaling
 - Possible application of coatings



Typical primary scale composition



Hematite (H%)

Magnetite (M%)

Wüstite (w%)

Decomposed
Wüstite (Dw%)

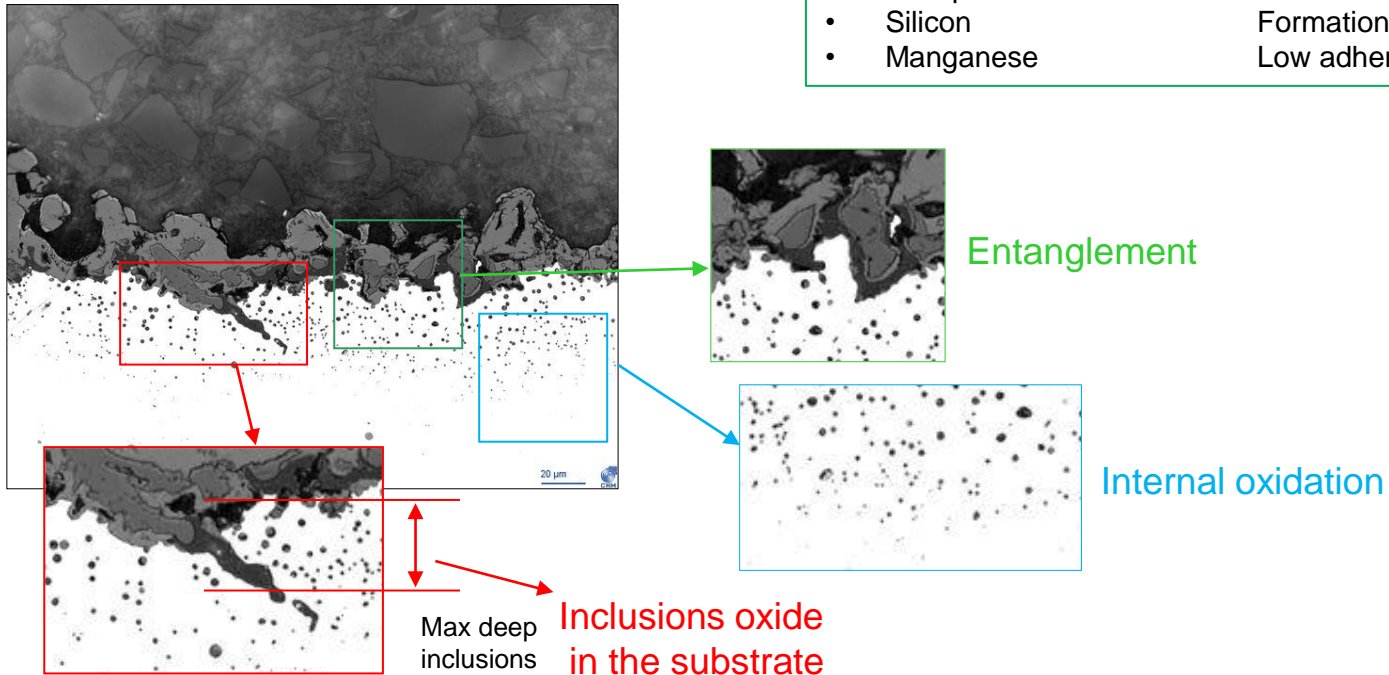
Retain
Wüstite (Rw%)
Dark areas

- Scale growth is required to clean the steel surface after casting !
- Scale growth is loose of material: 1-2%, up to 1,5 euro/t of steel loss
- Main influencing parameters :
 - Temperature
 - Duration
 - Oxygen content
 - Humidity
 - Alloying elements

Understanding of scale growth

Impact of alloying elements :

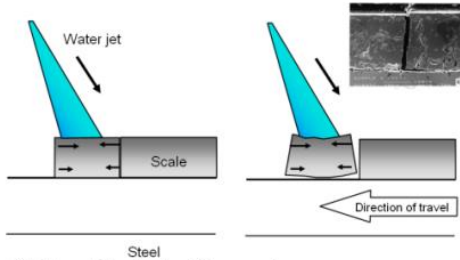
- | | |
|--|-----------------------|
| The elements with a very high effect on scale are: | |
| • Carbon | Porous and blisters |
| • Aluminium and Chromium | Reduction oxide |
| • Nickel | Metallic particles |
| • Phosphorous | Blisters |
| • Silicon | Formation of fayalite |
| • Manganese | Low adherence |



Scale growth ⇔ Descaling

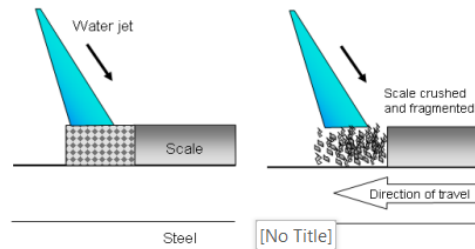
High Pressure Water Descaling

Mechanisms of HPW descaling – Thermal gradient within scale (1)



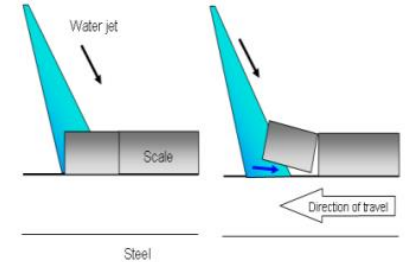
Differential Thermal Contraction $f(\text{time, scale thickness/diffusivity, etc.})$

Mechanisms of HPW descaling – Mechanical impact (2)



Mechanical Impact $f(P, \text{nozzle}) \Rightarrow$ Impact pressure IP
Key role of pre-cracks/scale thickness/porosity/interface

Mechanisms of HPW descaling – Shear-delamination (3)



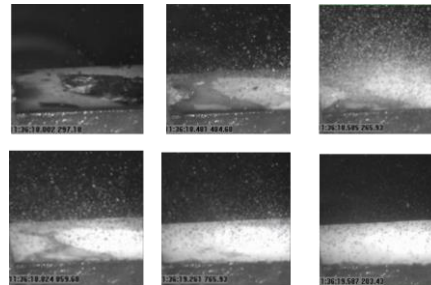
Shear at Scale - Steel Interface
Key role of temperature (ductile transition), interface (Fayalite, Ni, etc.)



Rotary Descaling



Shot blasting



Water descaling	Reheating	Reheating + Water descaling	Reheating + Water descaling + Hot rolling 20%
Shot blasting	Reheating	Reheating + Shot blasting	Reheating + Shot blasting + Hot rolling 20%

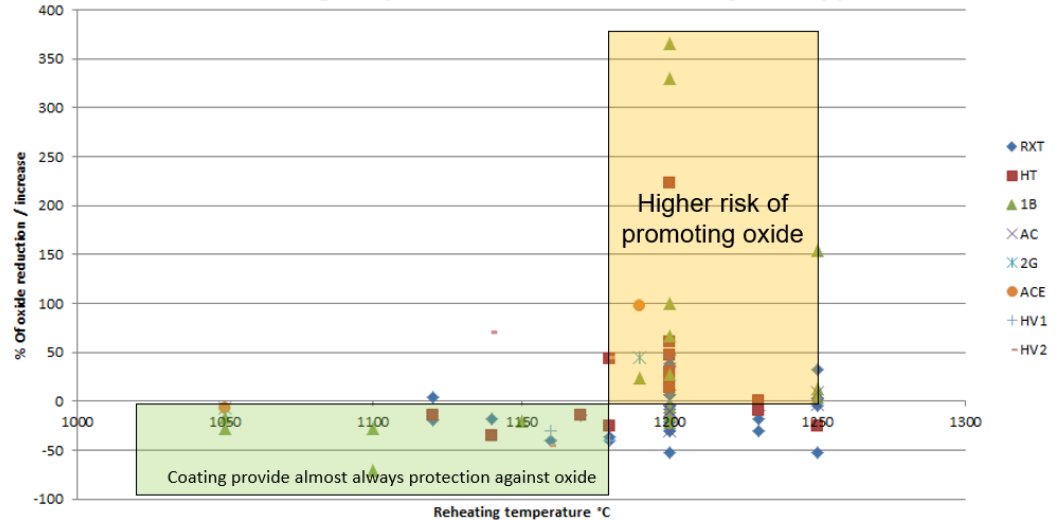


Coating application

Powder or liquid spraying



Effect of reheating temperature on oxide formation / cold application



In general, when the reheating temperature increases, coating will promote oxide. The temperature limit is around 1177°C, which is the fayalite temperature. For materials with high Si, the limit could be around 1080°C

- Limit alloying elements (e.g. Al, Si, P, B, Cr, Mo, Ti, Nb, Cu, Ni, Sn, As, Sb)
- Limit reheating temperature
- Limit duration in the furnace, especially at high temperature
- Limit oxygen content
- Limit humidity
- Limit transfer time between furnace and descaler
- Assure an optimum descaler performance related to the rolled grade
- Apply coating to avoid decarbonisation depending on product and grade. Higher scale formation rates are beneficial for reducing decarburization, as decarburised regions are removed by the oxide layer. For some materials decarburization was not detectable when Stopoxy was used.





Thank you for the attention!

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