Ceramics in the furnace

SKYREC-SEMINAR 2011

Speaker Introduction

Laboratory manager at University of Oulu, laboratory of process metallurgy.1998->

Some relevant studies concerning refractories:

-MSc thesis: refractory material selection to FeCr converter 1994 Outokumpu steel mill Tornio

-Autogenous lining for steel ladle, study Rautaruukki steel mill Raahe 1996

-Black liquor injectors holes areas refractory material 1997-2000 Ahlström

- Cyclone separator material study 2001 Foster wheeler

-R.A. Mattila, J.P. Vatanen and J.J. Härkki. Chemical wearing mechanism of refractory materials in a steel ladle slag line. Scandinavian journal of metallurgy (Denmark), vol.31, no.4, pp.241-245, Aug. 2002.

- Refractory study for lime mud reburning kiln Ahlström 1998,Andritz 2008,2010,2011

Definitions in this research

- Furnace= Soda recovery boiler
- Ceramics=Soda recovery boilers manhole and black liquor injectors holes areas refractory material
- Plant trials place = Stora Enso's Oulu Mill

Previous research

- Laboratory scale was used
- Chemical attack, Sodium components NaCO3,Na2S, cup test
- Chemical attack, rotary drum test
- SEM/EDS,microstructure analysis
- Thermal shock tests
- 1997-2000
- Importance of preparation and installation is vital
- =>the best material available

Previous study

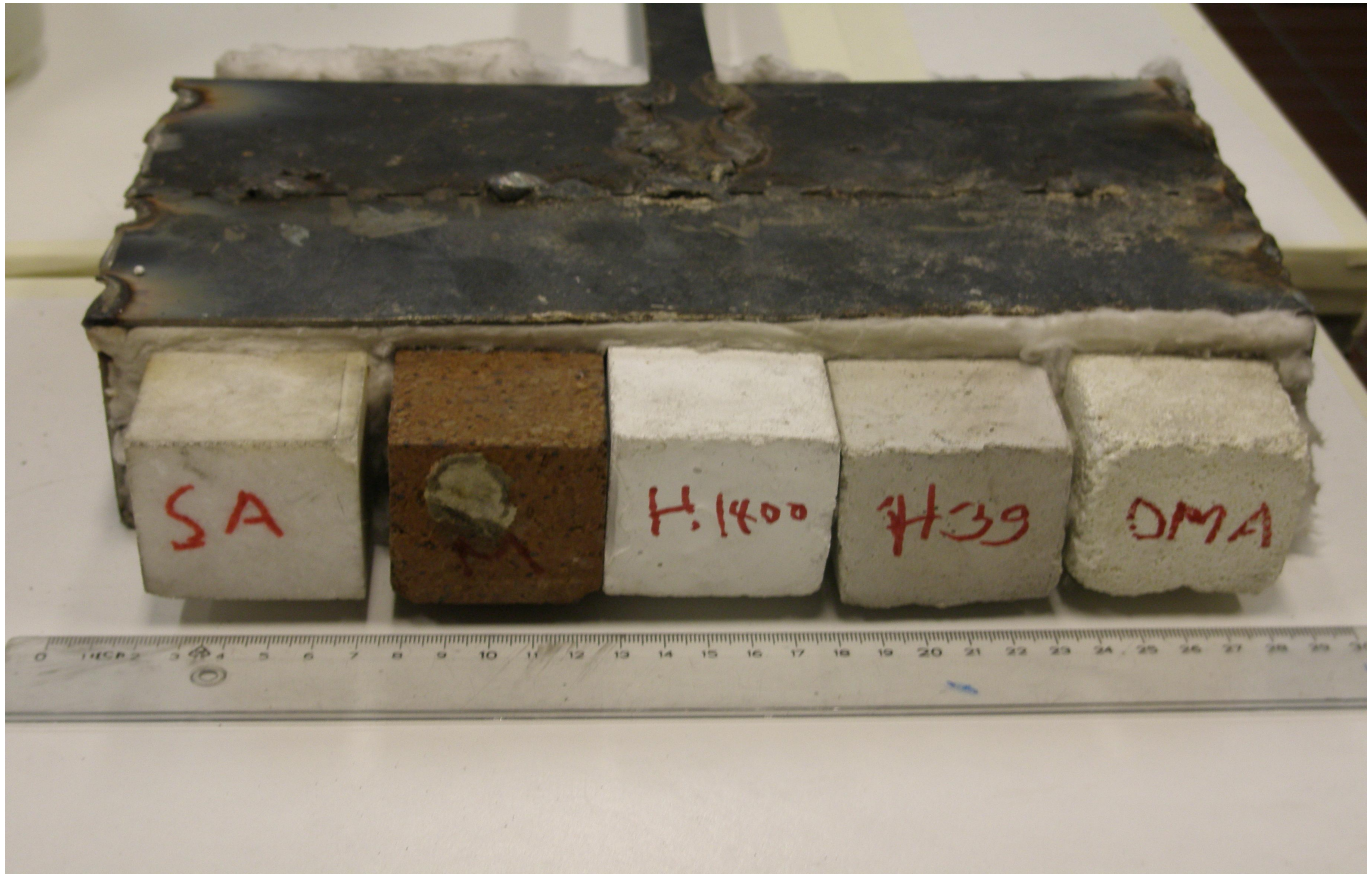
- New material literary study 2005
- =>Zirconium oxide and magnesia-alumina spinel might have potential
- =>Plant trial includes gas effect
- Short plant trial 2005
- => selection of promising materials for longer plant trials

Study plan and materials

- Mehod developed in 2010
- Testing via Injection port
- Refractory steel frame support for ceramic testing materials
- Two frames in different sides of the furnace
- => preliminary tests 2010
- => best materials Hassle D39A lc castable and MgO-iron brick
- => homemade castables were not strong enough mecanically

Test pieces

Test frame



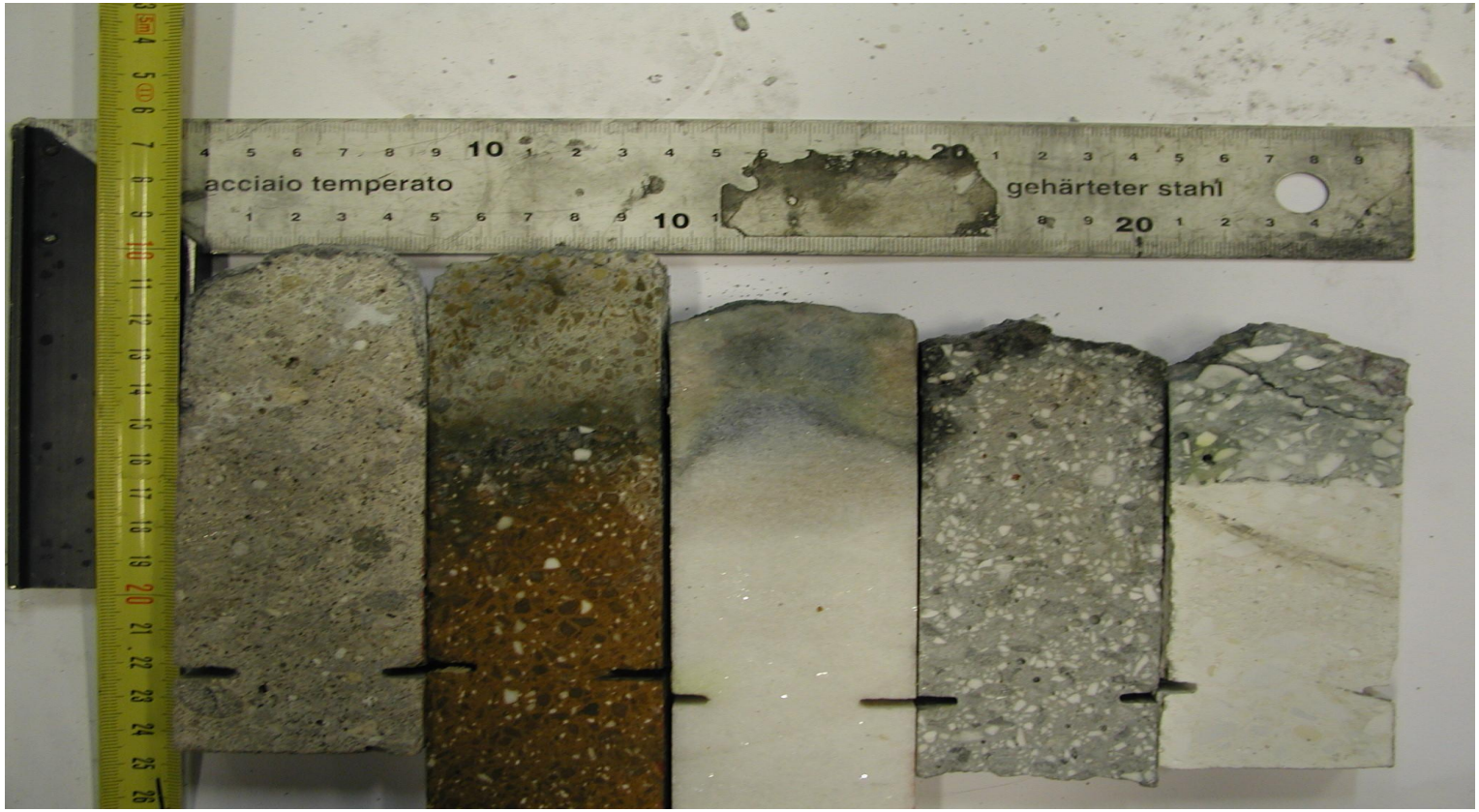
After 7 days, ZrO2 castable broke off

After 7 days, homemade castable spinel broke off

Results 2010

Frame position	Test material	Wear off
1	Hassle D39A	8 mm
2	Betker spinel forming castable	18 mm
3	*Forsterite* (Mg2SiO4) castable	45 mm
4	ZrO2 castable, broke off	60 mm
5	Ankoflo spinel forming castable	20 mm
A1	Hassle D39A	9 mm
A2	Dense Al2O3	15 mm
A3	MgO-iron brick	9 mm
A4	CeO2 included castable	42 mm
A5	Ready made spinel castable, broke off	50 mm

Results 2010



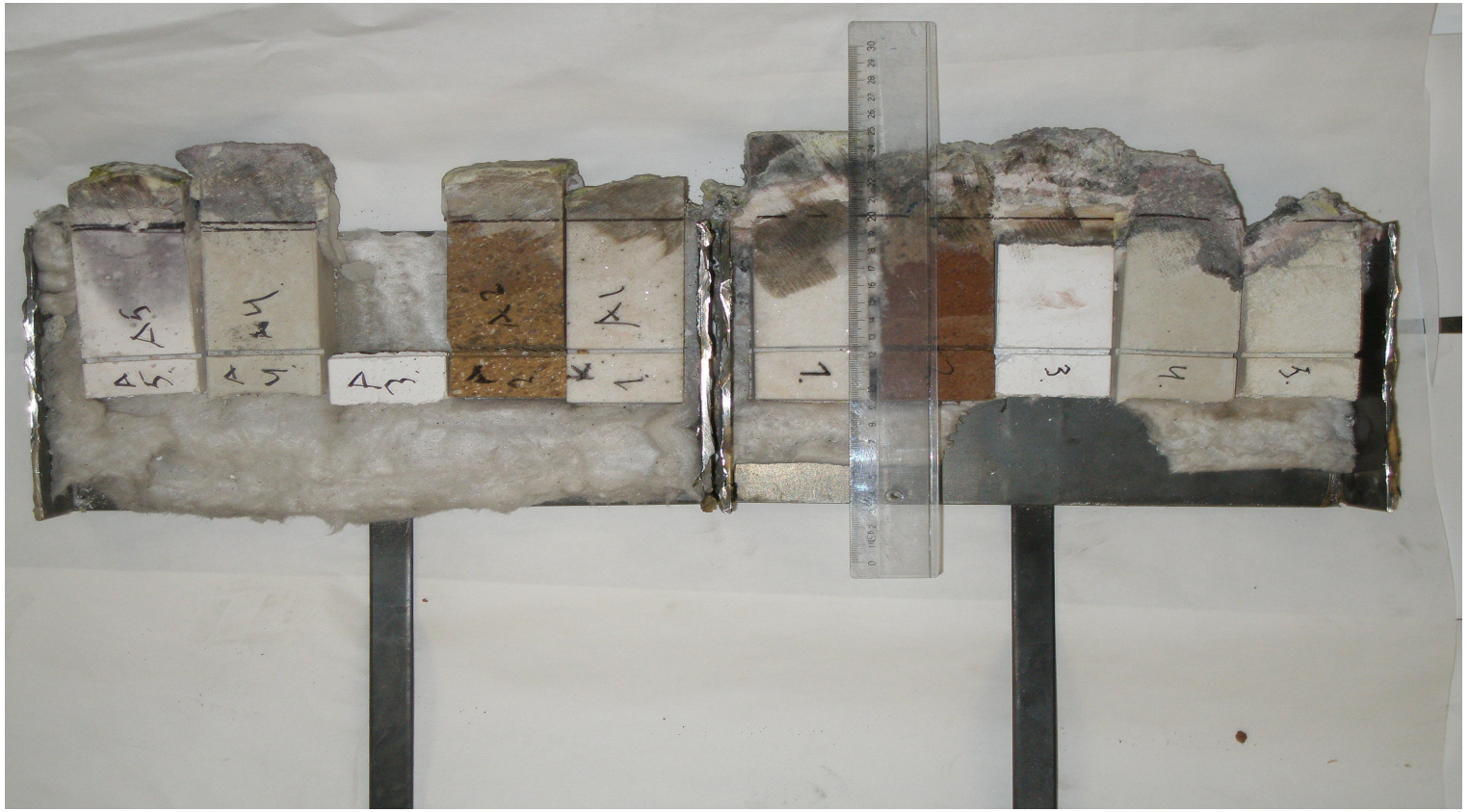
Findings 2010

- Castables need to be stronger but fewer sement
- Wear off is similar this time in different sides of the furnace
- Dense materials were quite good

Improvement to next trial

- Market search for harder ZrO2 castable failed, there was none
- Trying to improve spinel and other castables bonding to be more chemically resistant by nanospinel failed because, nanospinel manufacturing failed due to laboratory accident
- Decided to use best from 1st test and some new Hassle castable

Second test 2011

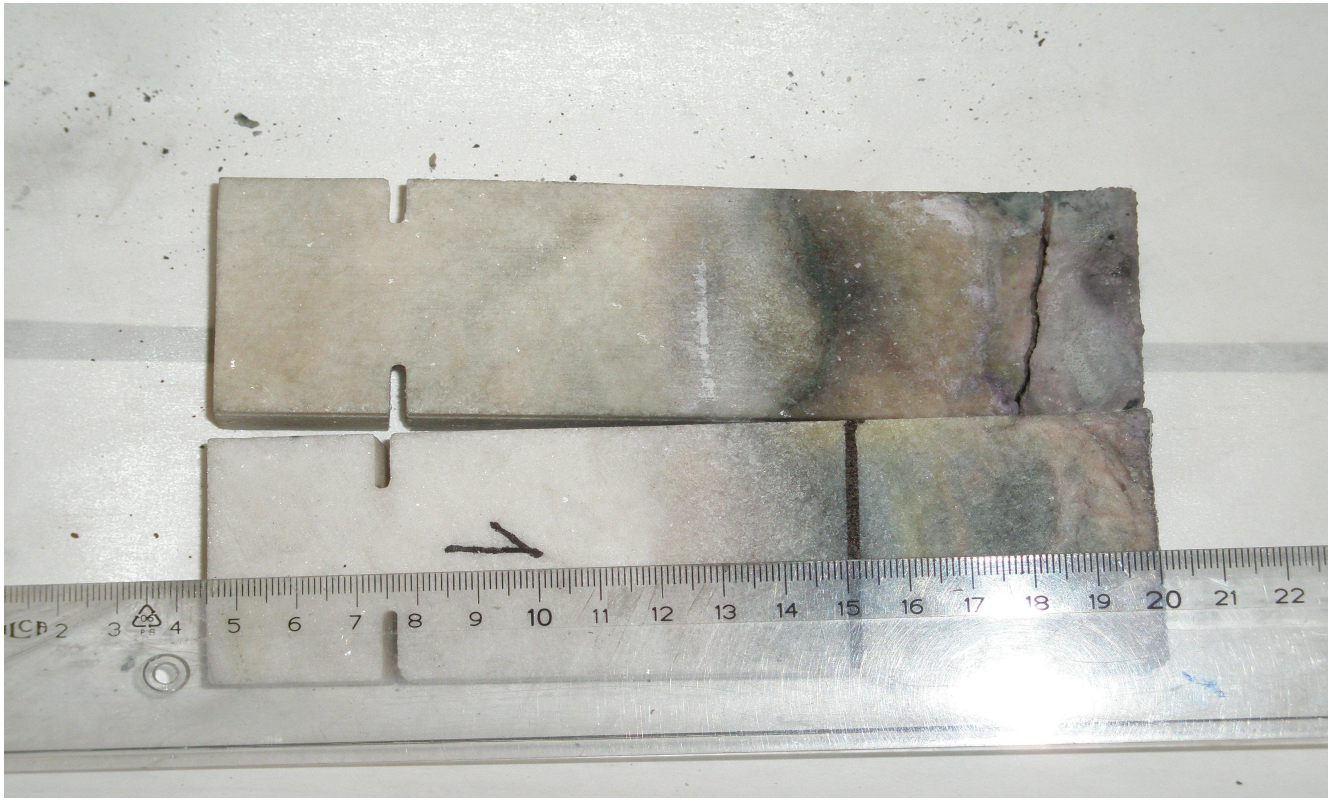


Second test 2011

Results

Frame position	Test material	Wear off
1	Dense Al2O3	0-0 mm
2	MgO-iron brick	5-13 mm
3	Hassle B1800 castable	+5-10 mm
4	Hassle D39A castable	10-20 mm
5	Al2O3*MgO spinel castable	30-48 mm
A1	Dense Al2O3	25-32 mm
A2	MgO-iron brick	10-18 mm
A3	Hassle B1800 castable, lost in funace	-
A4	Hassle D39A castable	2-5 mm
A5	Al2O3*MgO forming castable	10-19 mm

Dense material wear off by thermal shock



Best material?

- Dense materials like bricks and dense Al2O3 form cracks easily so Wear off numbers are a bit missleading
- Wear off is 10 times more on the other side of the furnace, if compared Hassle D39A

Findings

- Best material Hassle D39A castable is already in use
- ZrO_2 castable could have the potential, but they lacking manufacturers
- Full spinel castable, the same applies to these
- $MgO*Cr_2O_3$ brick potential?
- Some more preliminary laboratory test need to be made before next plant trial to ensure quality and potential against Hassle castable

Thank You !

Questions ?