BRIQUETTING AT ELKEM ICELAND

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November 2016

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Content

- The development of the briquettes
- The production of the briquettes
- Types of the briquettes
- Future work

The development of the briquettes

In May 2013 Elkem Iceland initiated a project of producing mill scale briquettes. Objective was to increase use of mill scale - reduce cost.

The innovation process and principles

- Keep it simple - make use of known technology
- Keep fixed head and movable tail

- In the fall of 2013 a BS student project about briquetting mill scale was established. The student at Reykjavik University finished the project in the end of 2013.
  - Experimental design setup
  - 40 different recipies with cement as a binder
  - Test briquettes cast in ice cube forms at our lab

- In the beginning of 2014 the results from the BS project were used for further development in cooperation with *Iceland Innovation Center*. Final mixes were established.

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Challenges and solutions

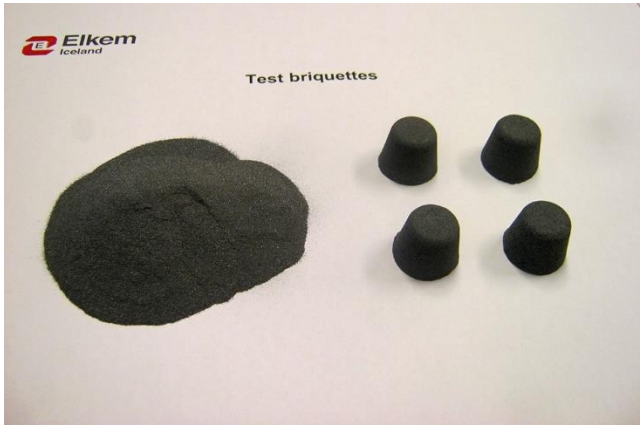
Problems connected with the use of a Portland cement binder:

- Chemistry.
- Considerable amount of cement needed for bonding.
- Long curing time.
- Low heat tolerance – the cement starts to disintegrate above 600 °C.

Focus on solutions:

- Development of a method of casting briquettes with minimum need for a binder.
- Use of correct additives to reduce need for a binder and shortening the curing time.
- Advanced composition to gain high heat tolerance.

Initial laboratory work



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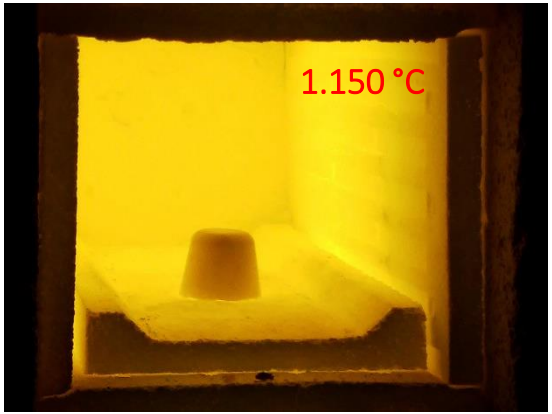
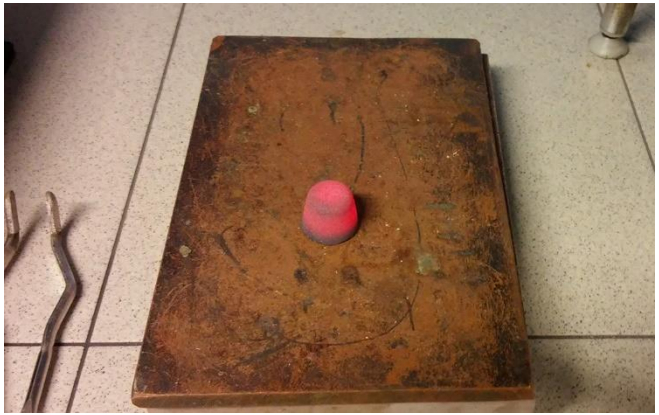
Laboratory testing

- Chemistry
- Strength
- Heat tolerance





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The production of the briquettes

From innovation to full scale production

- The solution was at our feet
- In the spring of 2014 an agreement was made with the company *Steypustöðin* to carry out large scale testi of casting briquettes made from mill scale, Microsilica and cement.
- Some 350 mt were produced in July 2014 and tested in furnace operation with great success

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Types of briquettes

Mill scale briquettes

5.600 MT annually; Alternative sourcing. Considerable savings. Improved Microsilica

Briquettes of waste quartz

Quartz fines that otherwise would end as landfill.

Briquettes containing radiclone dust (waste silica fume)

1.300 MT of radiclone dust to landfill. Net value 0,9 MNOK besides cost of disposal

Briquettes of Si and FeSi fines

Briquettes of FeSi fines for re-melting and direct marketing.

Carbon briquettes

Low cost alternative reducing agent

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The production of the briquettes

Briquettes at Elkem Iceland

Briquettes to be exported

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Types of briquettes

Mill Scale and radiclone dust

Quartz

The briquette has been heated at 1.150¨°C for two hours

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The production of the briquettes

On the upside

- Low cost – simple production process
- Well known technology
- Access to well equipped, automated and flexible production plant
- Ample capacity
- Close co-operation with the furnace team at Elkem Iceland - interest and enthusiasm for full scale furnace testing of new raw materials

The production of the briquettes

On the downside

- Some limitations due to the use of Portland cement (Ca to the furnaces)
- Logistics - transportation cost

The innovation process and principles

- Keep it simple - make use of known technology
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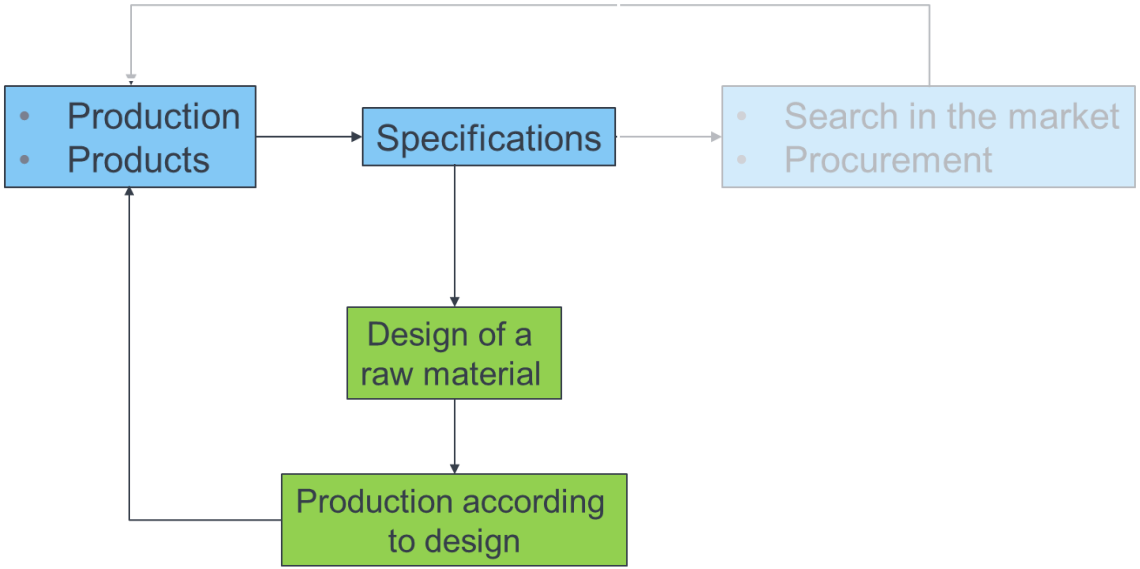

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Future work

- Co-operation with the Iceland Innovation Centre
- Optimal binder system:
  - Other types of cement
  - Less cement - lower Ca content
  - Increased use of radiclone dust (waste silica fume)
- Total Ca balance for the furnaces - maximize volume of briquettes
- Logistics - briquetting plant at Grundartangi
- Other types of briquettes - for Elkem or customers outside Elkem
  - Si, FeSi, process products for direct marketing or re-melting
  - HP quartz - Zircon sand
  - Carbon Material
  - Refining slag for external customers
  - ???

Flexible technology - endless possibilities

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