Silica Refractories

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Topics

- Basics:
  - Silica refractories
  - What are the alternative refractories?
- Testing of worker PEL
- What can we do?

Common Refractory Aggregates

Magnesia (MgO) 2700-3300°F

Steel Coreless
Channel Inductors

Alumina (Al_2O_3) 800-3300°F

Channel Furnaces, Ladles,
Coreless (Steel, Cu, Al, Zn)

Silica (SiO_2) 1800-3000°F

Coreless Furnaces (Iron, Cu)

Silica Refractories

<u>Most widely used and discussed:</u>

Quartz-based dry vibratables

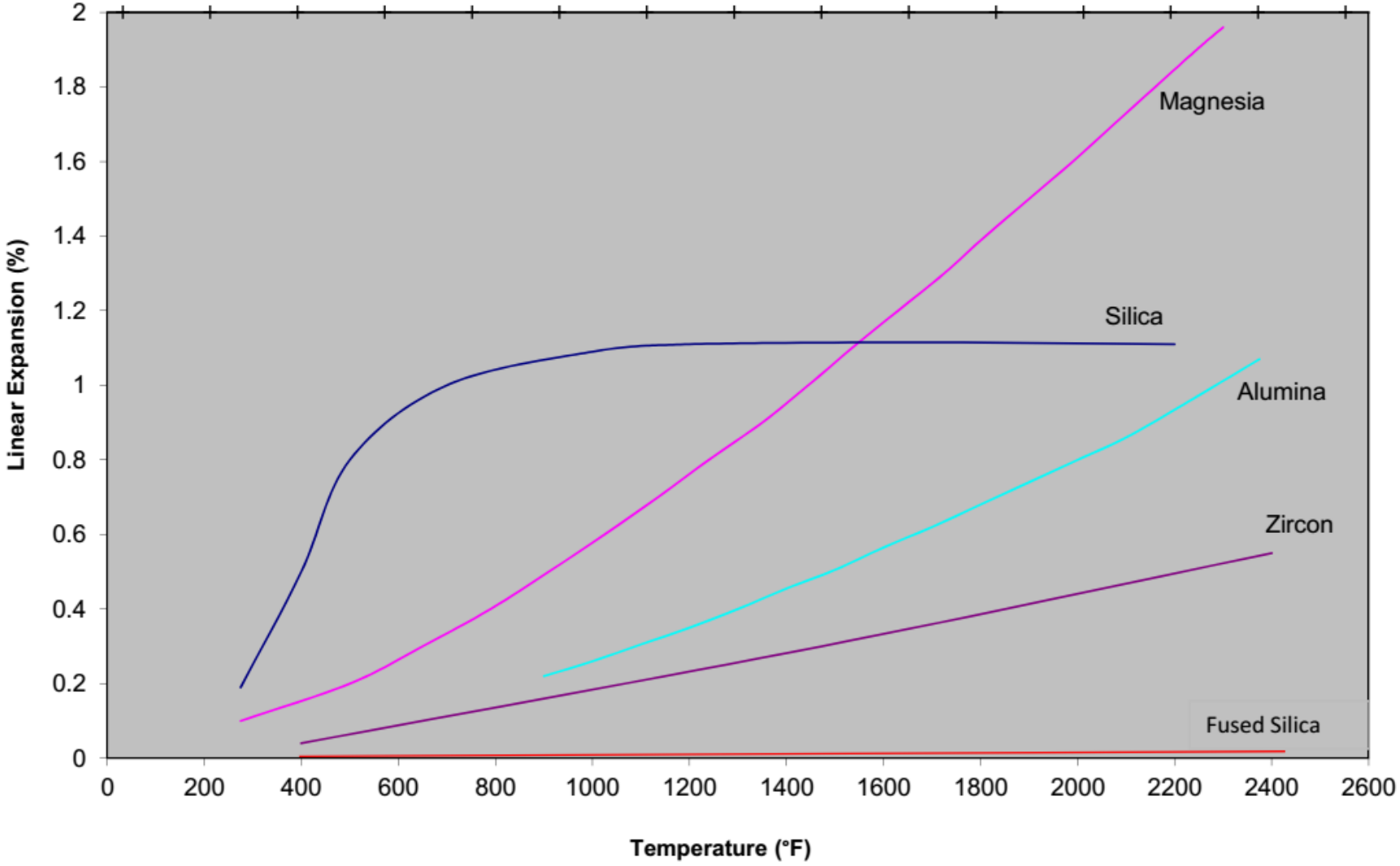
Nom. 99% SiO_2 content

0-2% addition of boron based binder

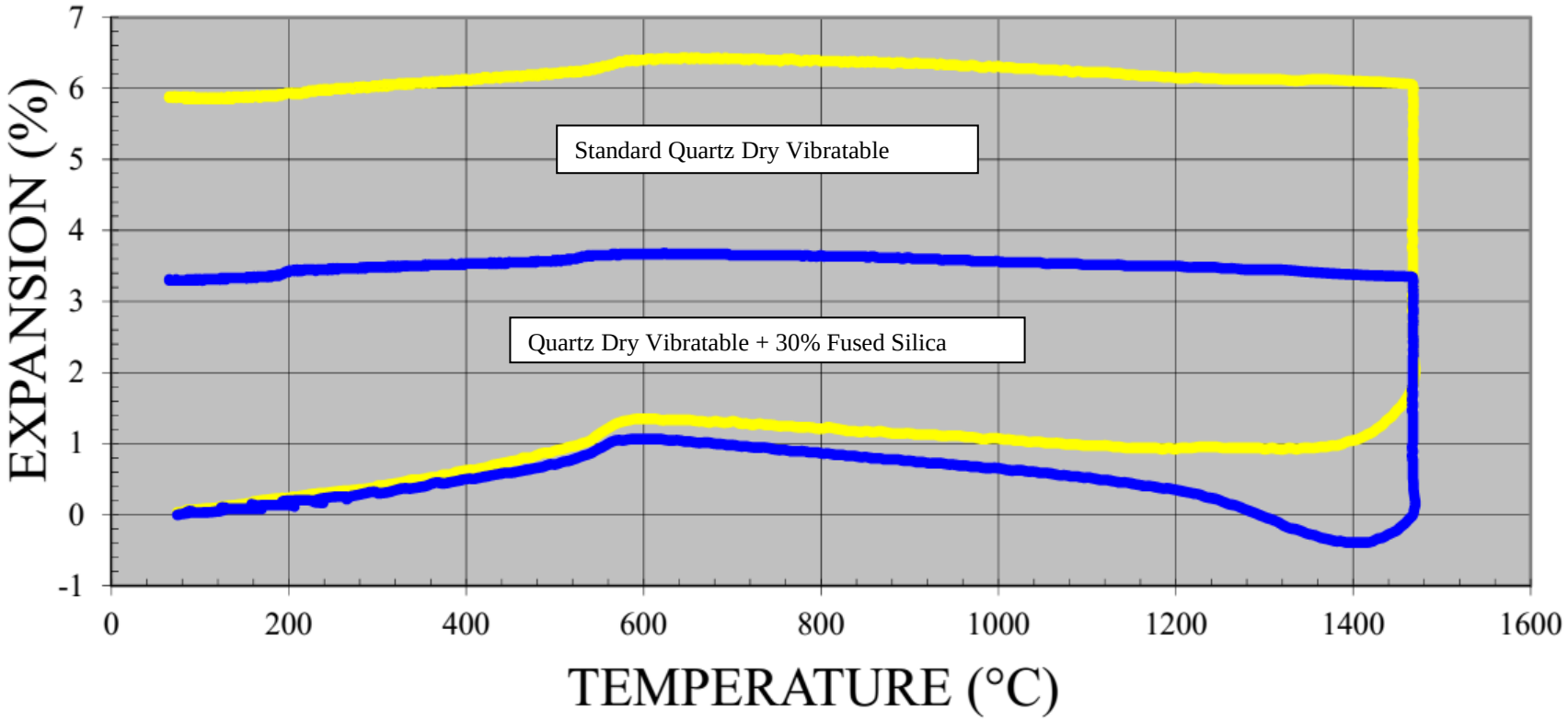
Why is silica used?

- Total Cost (mineral cost and lower density)
- Excellent thermal shock resistant
- Non-wetting to iron and slags
- Glass forming properties impede zinc and other vapors
- Lower thermal conductivity

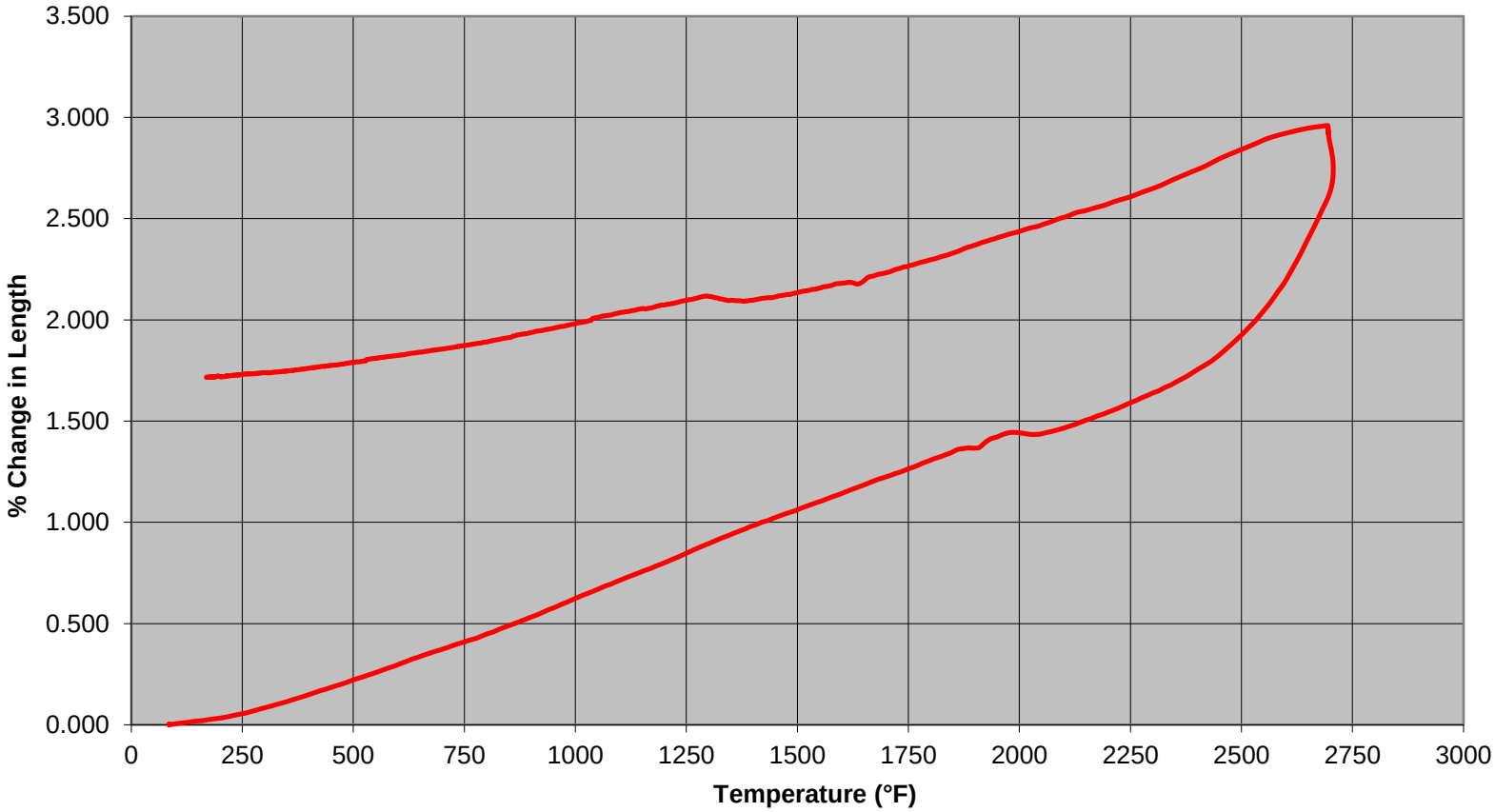
Reversible Expansion Properties



Dilatometer Data



Dilatometer Curve – Spinel



Silica Forms

Quartz Form

- Polymorphs
  - Alpha-quartz – <1000°F
  - Beta-quartz – 1000° – 1600°F
  - Tridymite – 1600°-2700°F
  - Cristobalite – 2700°-3100°F
- Fused silica >3100°F

Other refractories that contain SiO_2

- Clay-ganister gun mixes (cupola and arc furnace
- Cupola bottom materials (silica and fireclay blend)
- All clay-alumina refractories contain some portion of silica.

Other Minerals

Clay gannister and fireclay deposits

- 50 – 85% SiO_2

Clay used in plastics, castables, rams, gunning materials

Refractory Minerals

- Tabular Alumina
- White Fused Alumina
- Brown Fused Alumina
- Fused Magnesia

Steel DRI-VIBEs
< 1.0% SiO_2

Castables/Plastics/Gun

- Bauxite 10 – 15% SiO_2
- Mullite 30 – 35% SiO_2
- Andalusite

What are the alternatives to reduce silica exposure in refractory applications?

- Reduce or eliminate silica from source
  - Change refractory types
    - Spinel forming
    - Andalusite/mullite
- Dust collectors
- Dust suppressants
- Packaging
- Automated installation equipment

Can we use alternative (non-quartz) lining materials?

- High alumina spinel forming materials are used extensively in steel foundries (Cost is about 5 – 10 times that of SiO_2 lining)

- In some high volume ductile iron applications (heel melting, 24/7 operations) andalusite lining is utilized in a cost effective manner.

Andalusite, The Mineral

- Silicate
- Al_2SiO_5
- Same composition
  - Kyanite
  - Sillmanite
- First samples thought to be from Andalusia, Spain

Advantages of this mineral

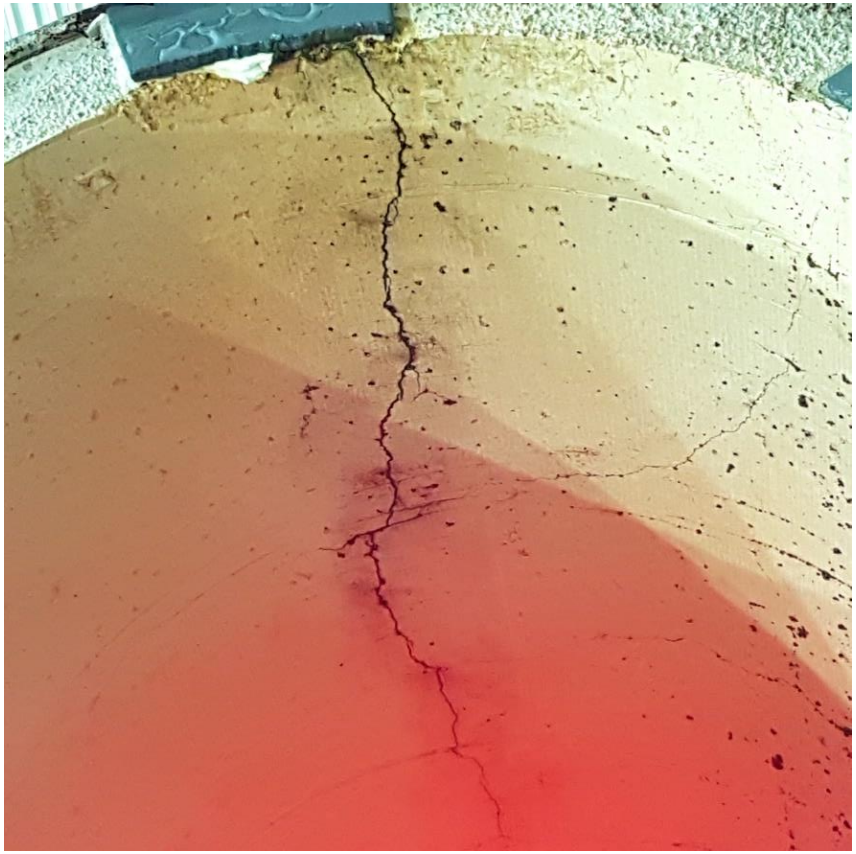
- Best thermal shock resistance of aluminosilicates
- Excellent creep resistance
- Low residual tramp elements

Comparison of Grain Structure

Cross section of traditional Silica-based lining

Cross section of andalusite-based lining

Cracking/Finning



Concern with Cracking/Fins

What are the regulations?

Exposure to employees over a full shift (time weighted average)

Testing is for overall dust as well as crystalline silica

Regulations

- Overall limit for dust is 5.0 mg/m^3
- Crystalline Silica
  - 0.05 mg/m^3, down from 0.10 mg/m^3
- Into effect June 23, 2018

Testing

- Employees wear monitoring device during there entire shift
- Device samples are cyclonic and designed to filter out large particles and to capture the remaining smaller particles
- The remaining dust is then tested by XRD (X-Ray diffraction) to determine portion of crystalline silica

Testing

- Testing should be completed to establish baseline and what actions to be taken

- Cannot assign administrative controls until engineering controls have been utilized.

Other Actions

- Dust collectors
- Dust suppressants
- Packaging
- Automated installation equipment

Administrative Controls

- Half mask respirator – 10 X the effectiveness of no respirator
- Full face respirator – 50 X the effectiveness of no respirator
- Supplied air respirator – > 50 X the effectiveness of no respirator

Summary

- Alternatives exist to replace silica refractories, but total cost will be higher
- Improvements to the process can be made with changes/optimization
- Testing for baseline is the first step

Stay Safe!