

Fluoride emissions from furnace and relevance of slag fluoride capacity

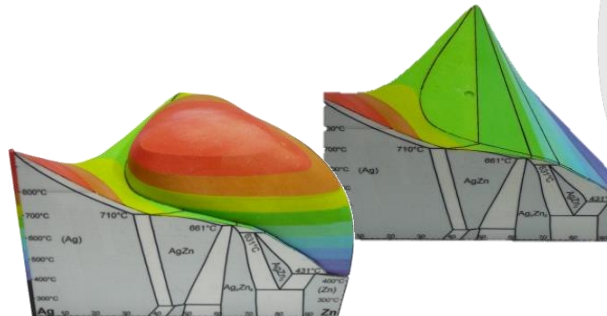
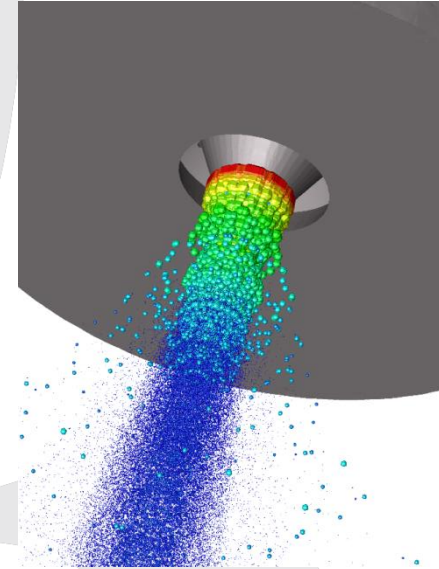
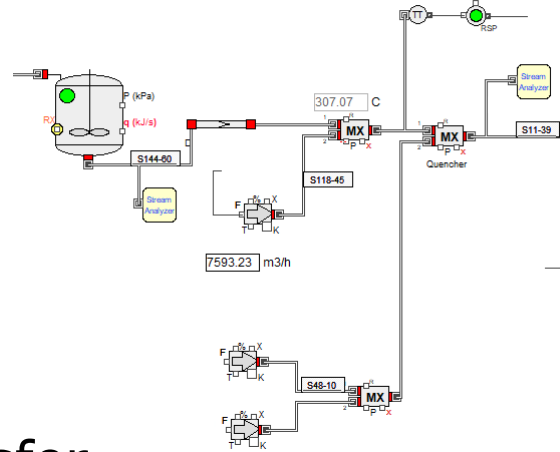
Sander Arnout, Jolien Debehets, Els Nagels

InsPyro

A large, stylized flame graphic in light gray, positioned on the right side of the slide, extending from the top to the bottom. The flame has several upward-pointing tongues, with the largest one on the left and smaller ones to its right.

InsPyro

- Consultancy company
- 10 years
- Strong tool set & team
 - Thermodynamics & phase diagrams
 - Flowsheet modelling
 - CFD: flow and heat transfer
 - Experiments at high T
 - Characterization



Fluoride sources

- Fluoride is present in metallurgical processes due to the use of
 - Coal, containing F (20-500ppm)
 - Fluorspar, CaF_2
 - Low melting fluxes (NaF , NaAlF_4 , Na_2SiF_6 ...)
 - Recycled scraps containing enamel
 - Recycled flue dust
- Sometimes obvious track down, sometimes not



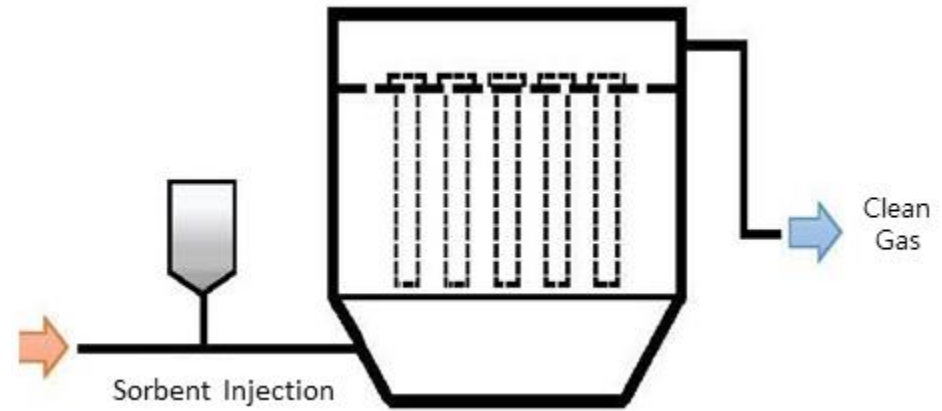
Fluoride emissions

- Emissions can be particulate or fumes
- Largest concern is HF gas
- Typical limits exhaust gases:
 - 5 mg/Nm³
 - Sometimes +amount
 - Power plants: g/MWh
- Typical limits worker exposure:
 - 3 ppm (2.5 mg/Nm³) legal limit US
 - Recommended values even lower
 - Odor limit 0.04 ppm



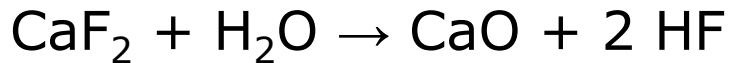
HF abatement

- Wet gas scrubber
- Alkaline scrubber
- Small installations typically:
 - Lime injection
 - Bag filter (large area)
 - 95% removal efficiency



Thermodynamic calculations

- Main concern: HF formation by pyrohydrolysis

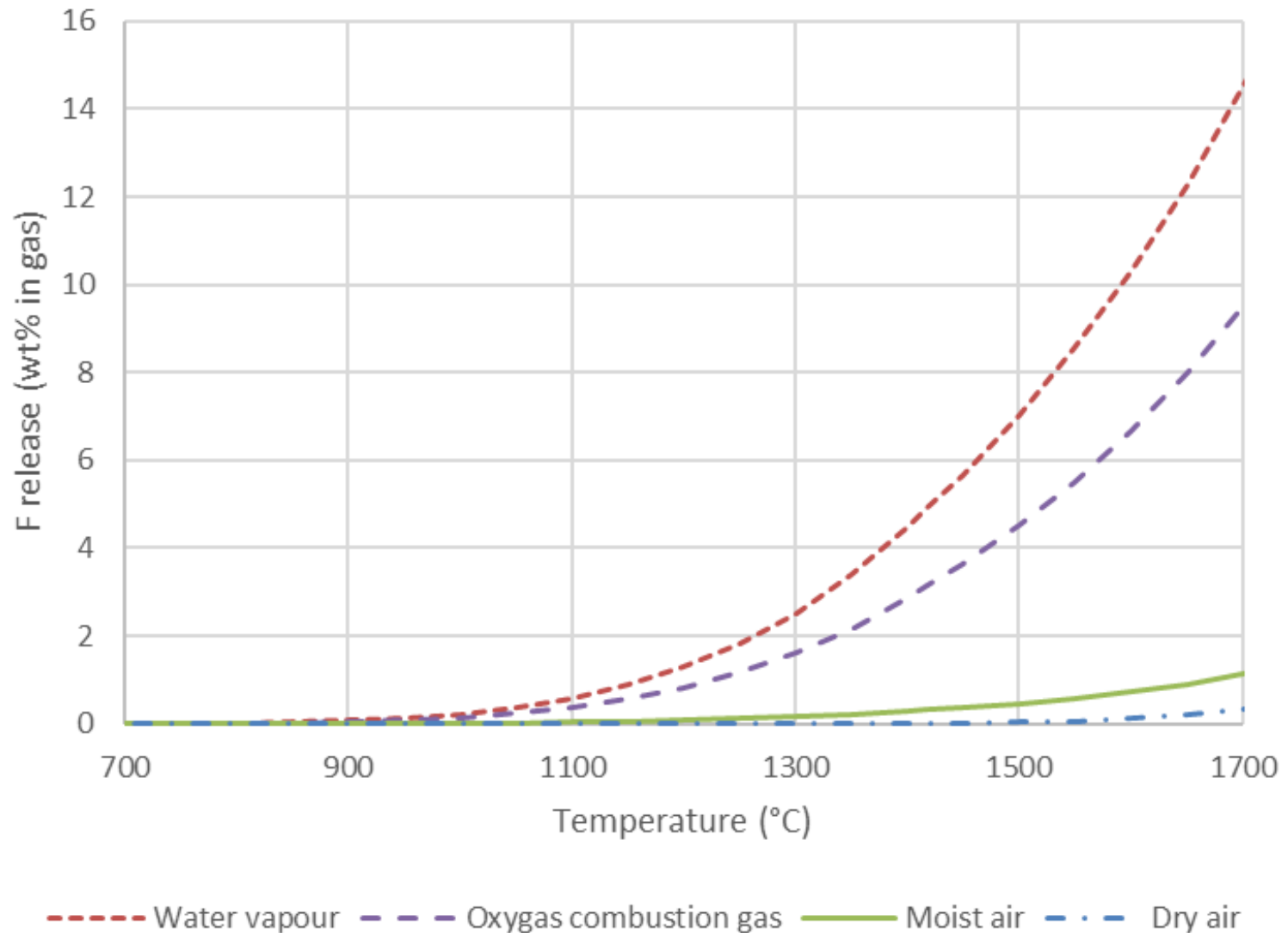


- Fluoride can stay in slag, or volatilize



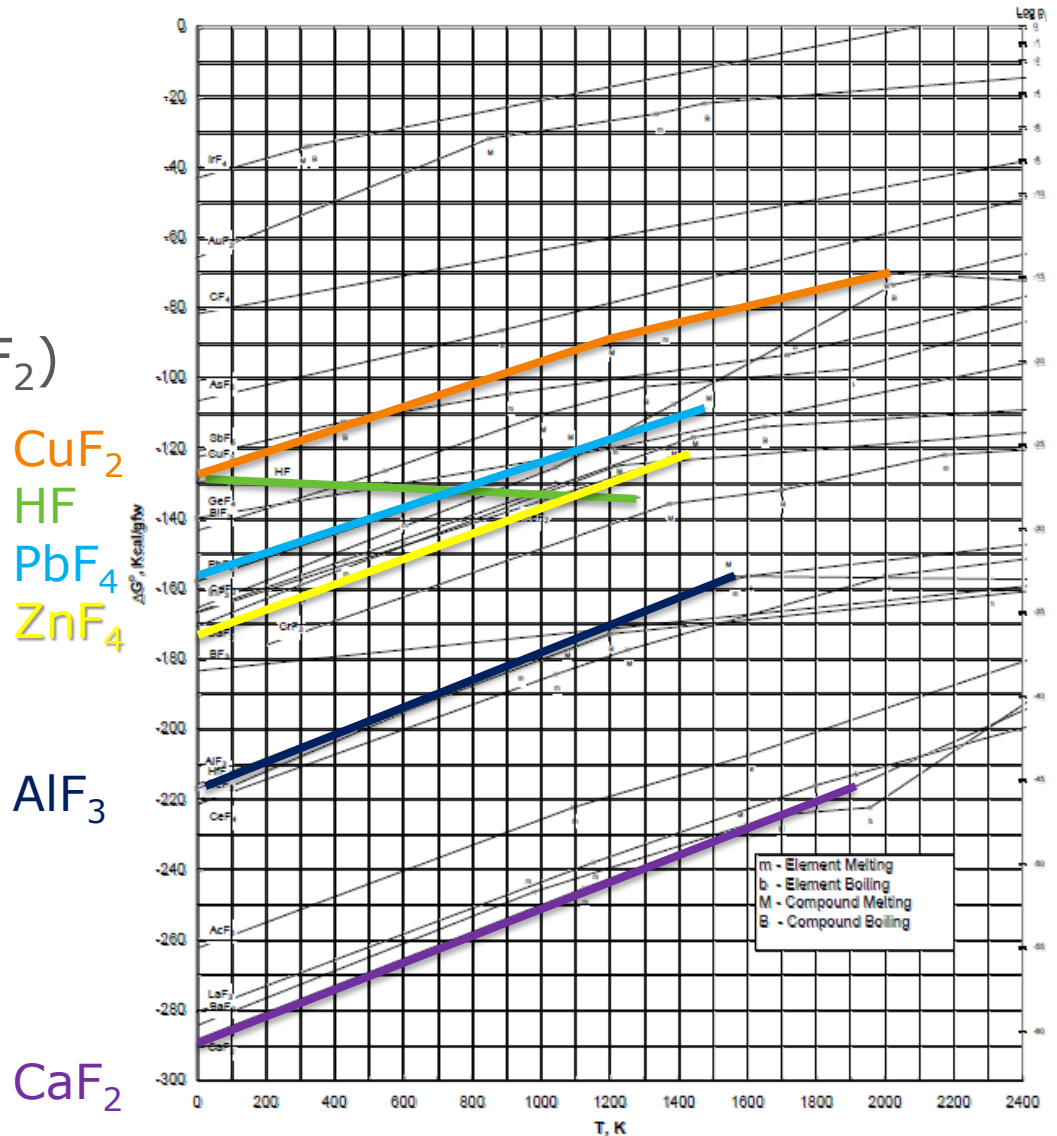
- Both depend on the type of fluoride
- Is composition of the slag, hence activity of fluoride, relevant?

Importance of gas composition (CaF_2)

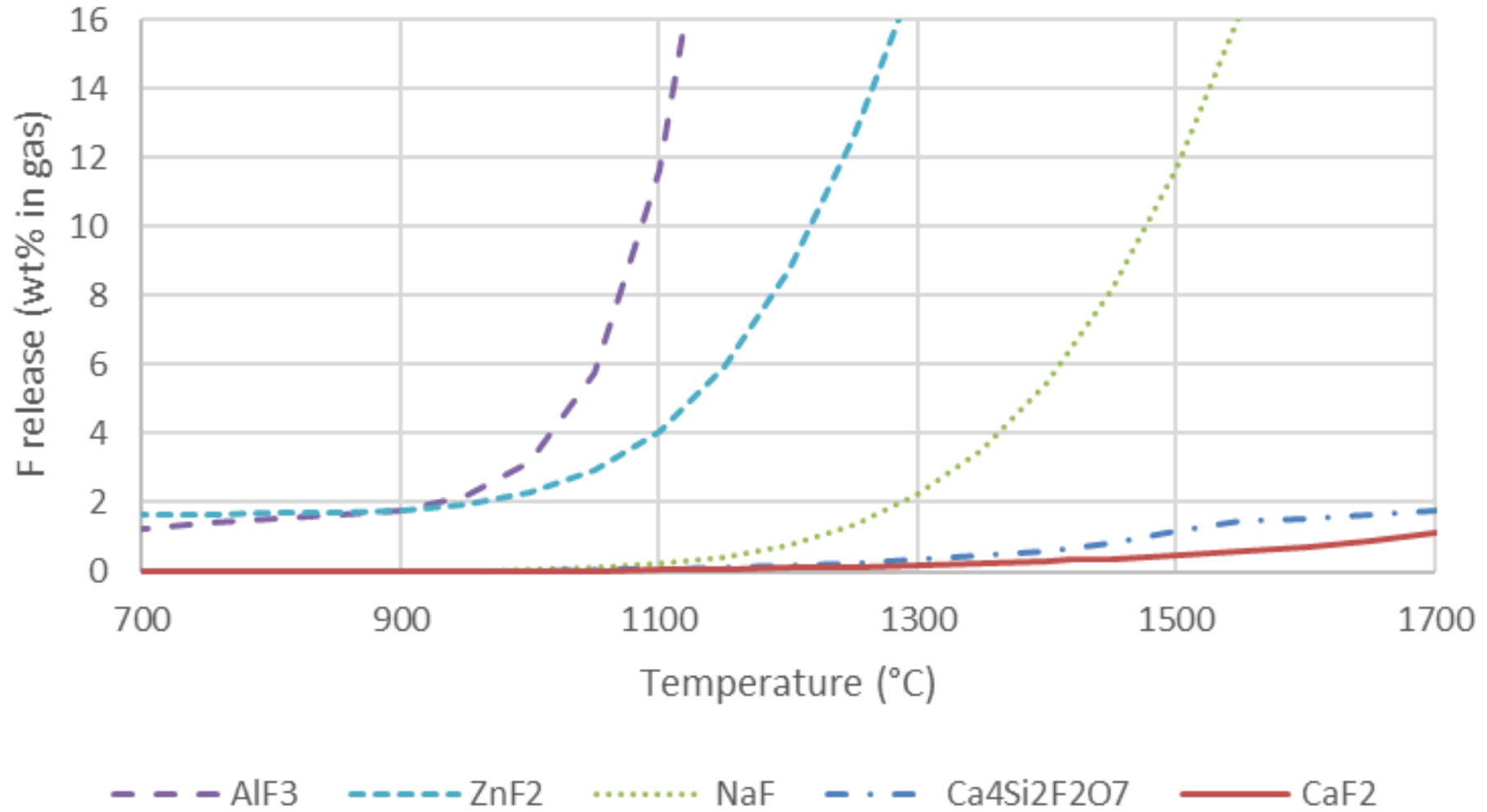


Stable vs. unstable fluorides (Ellingham)

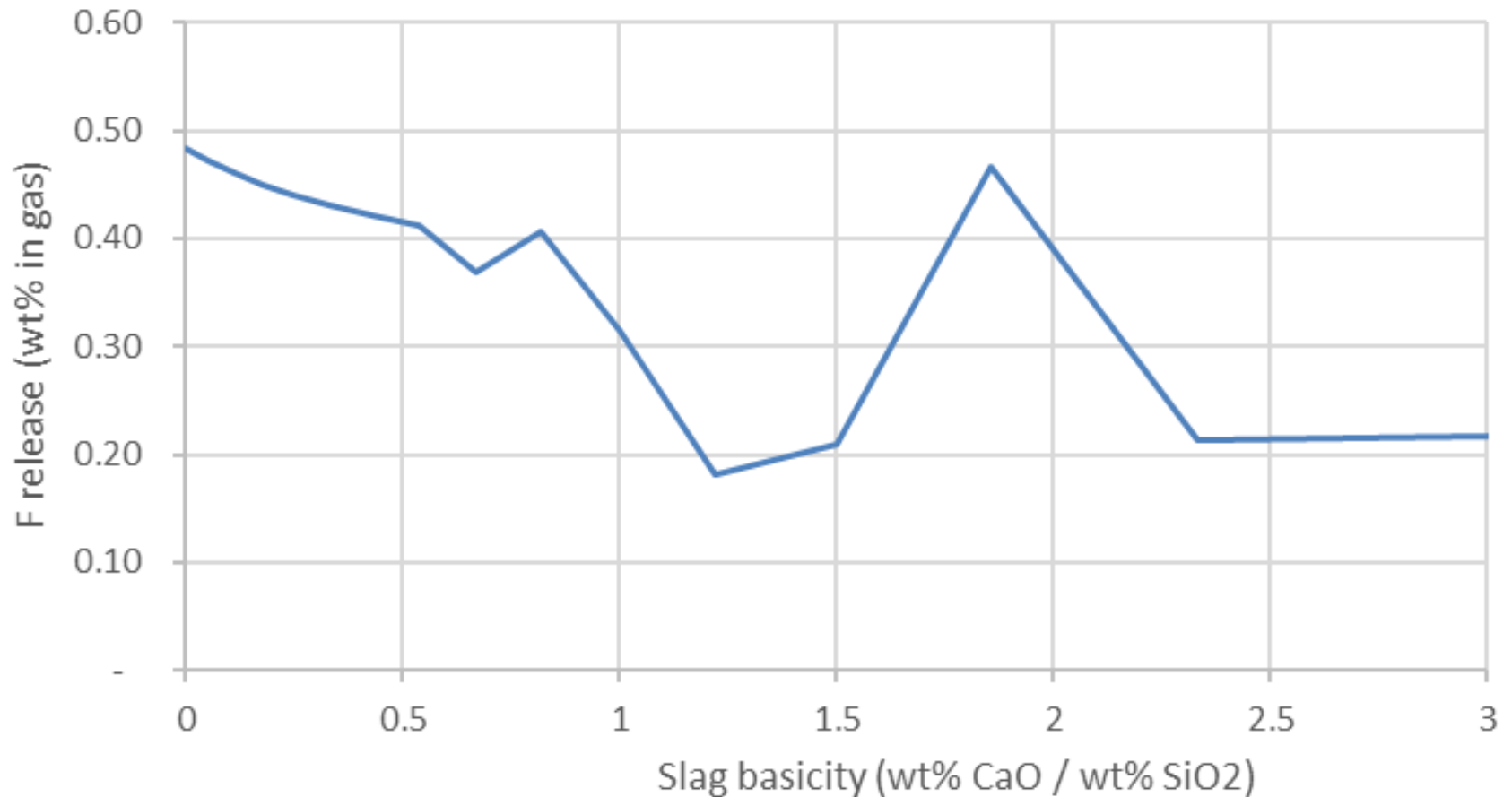
- Most stable most likely to form
- Stability vs. element, in practice often vs. oxide (e.g. $\text{CaO} + 2\text{HF} = \text{H}_2\text{O} + \text{CaF}_2$)
- CaF_2 most stable overall



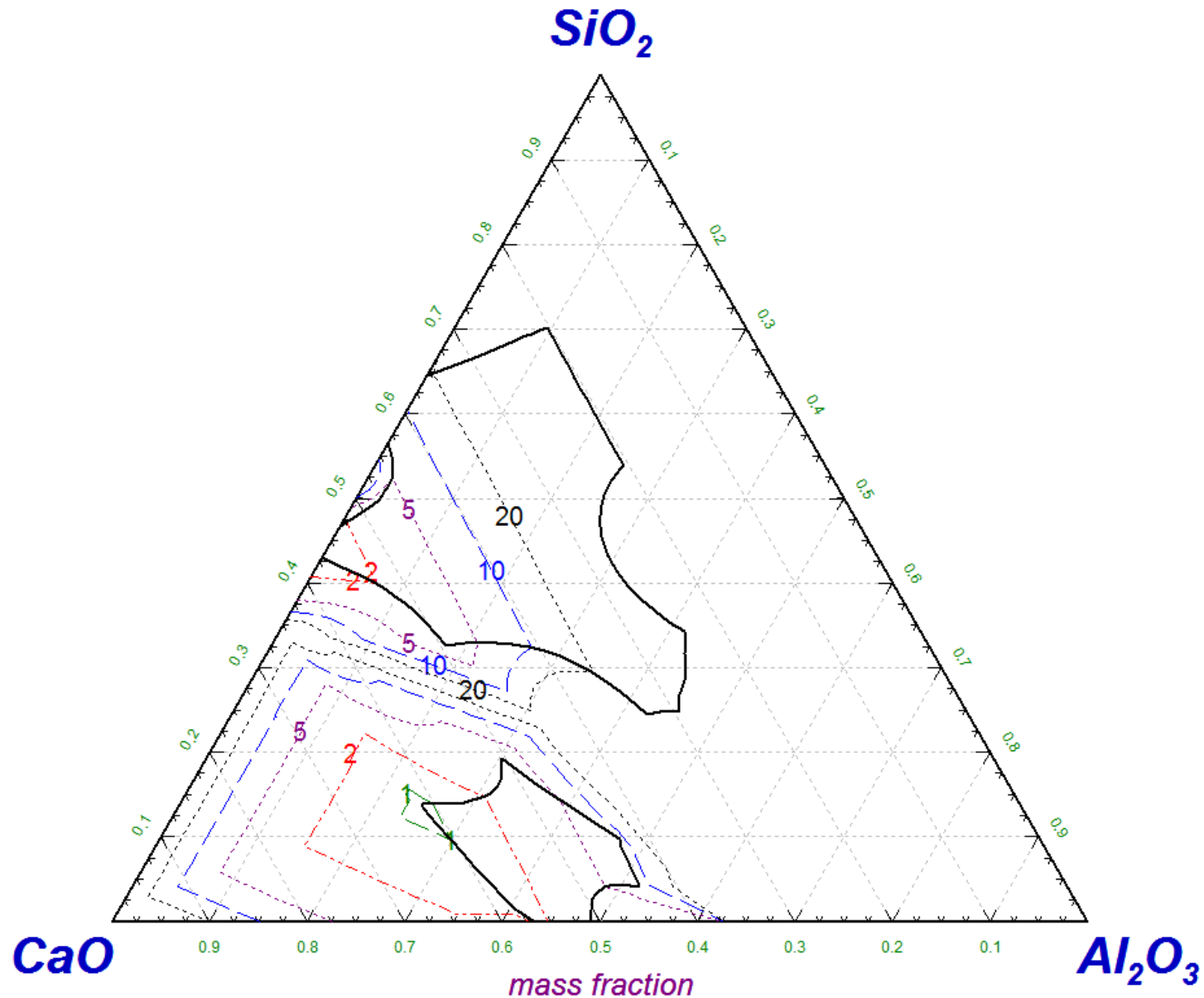
Volatility of different fluorides (moist air)



Basicity CaO-SiO₂ system (CaF₂, moist air)



Indicator of F capacity: CaF_2 vapour pressure



Conclusions

- Presence of fluorides with low vapour pressure is a risk
 - Will react with lime, but possibly not yet during heating
- Moisture (also: combustion gas) is a risk
- Presence of lime improves stability of fluoride, but the effect is much lower than that of moisture
- Raw materials selection (workplace+emissions) and gas abatement (emissions only) crucial

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