WP 3

Improvement and impact on oxyfuel calciner

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Public Workshop, VDZ Düsseldorf

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Accelerating CCS Technologies

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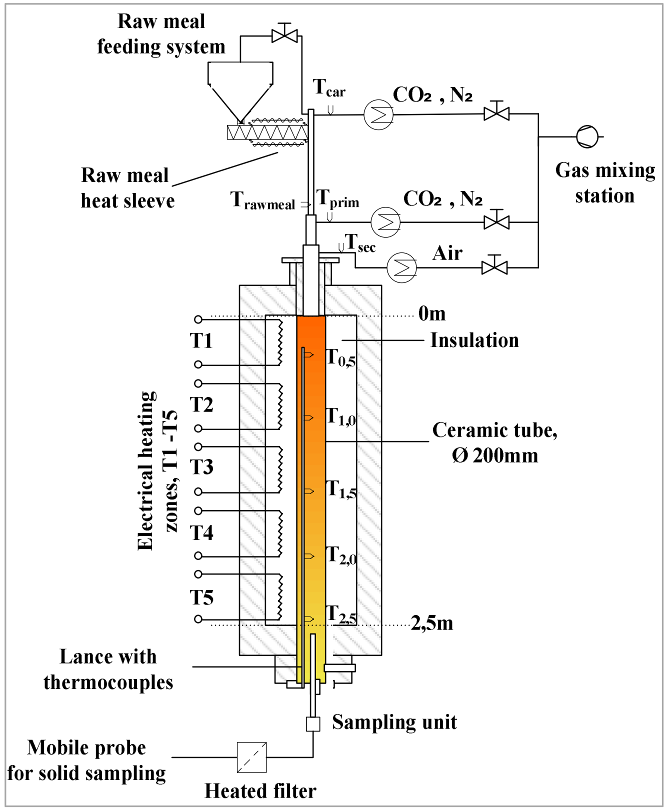
ifk Air Liquide thyssenkrupp

Objectives of WP 3 – oxyfuel calciner

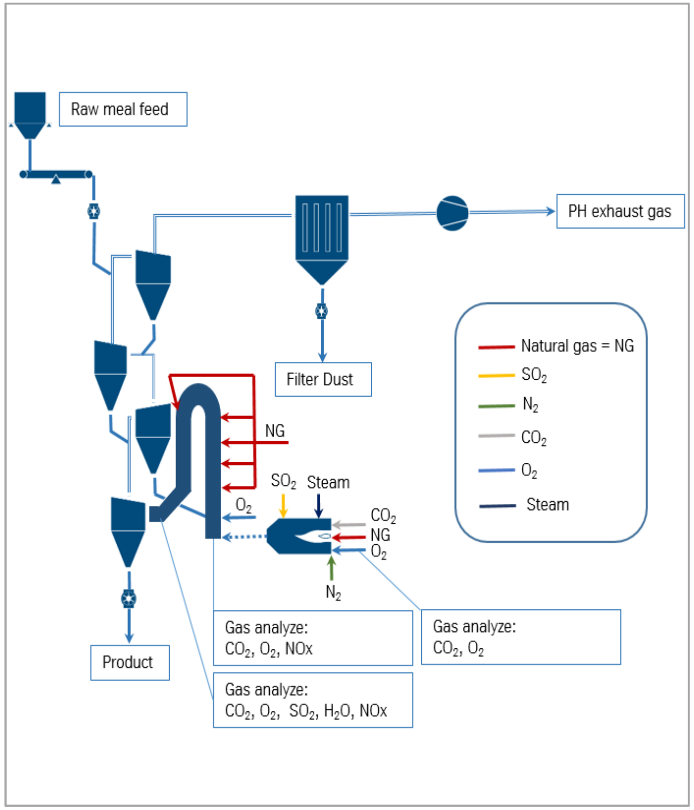
- Evaluation of the **role of the flue gas moisture level** in the calciner **to reduce and control the calcination temperature.** Theoretical and experimental calcination tests will be preformed up to pilot-scale in a process relevant environment (TRL 6).
- Based on the results a **moisture injection concept** and **process control strategy** for retrofitted and new-build cement plants will be developed
- The impact of the process conditions and flue gas **impurities like sulfur** and **chlorine** on calcination reaction will be evaluated at technical- and pilot-scales
- Evaluation of oxyfuel calcination process with up to **100% alternative fuel combustion** in an oxyfuel calciner

WP - Partner	USTUTT	University of Stuttgart
	AL	Air Liquide
	TITAN	TITAN Cement Company S.A.
	VDZ	VDZ gGmbH
	tkIS	thyssenkrupp Industrial Solutions AG

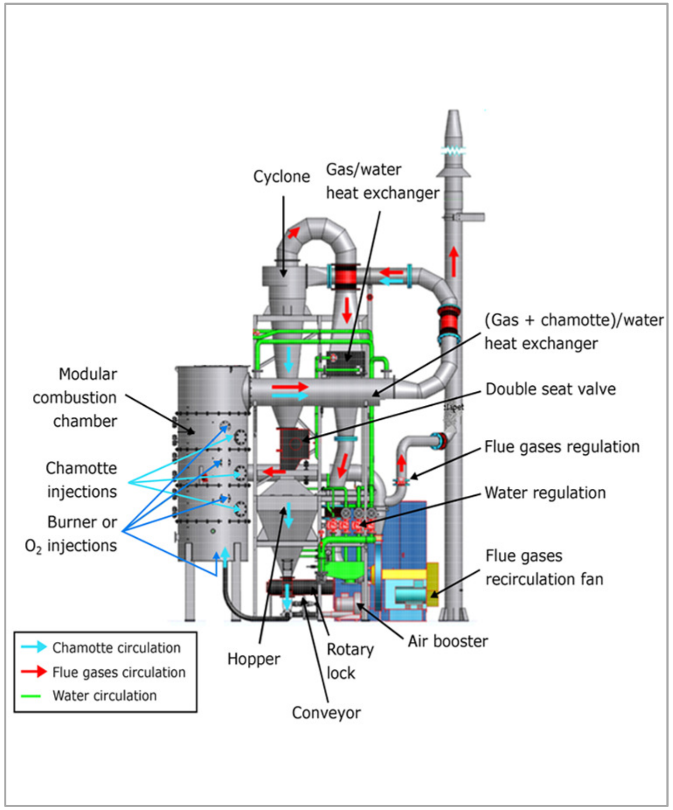
Technical- and pilot-scales facilities for calcination test



USTUTT: Technical scale

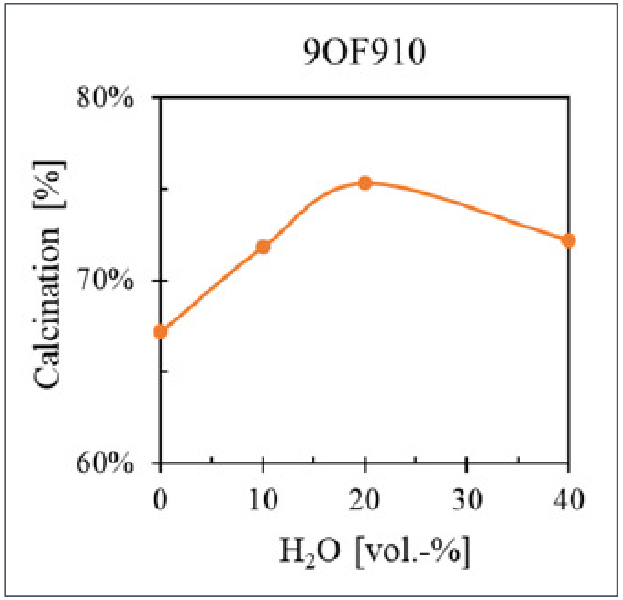


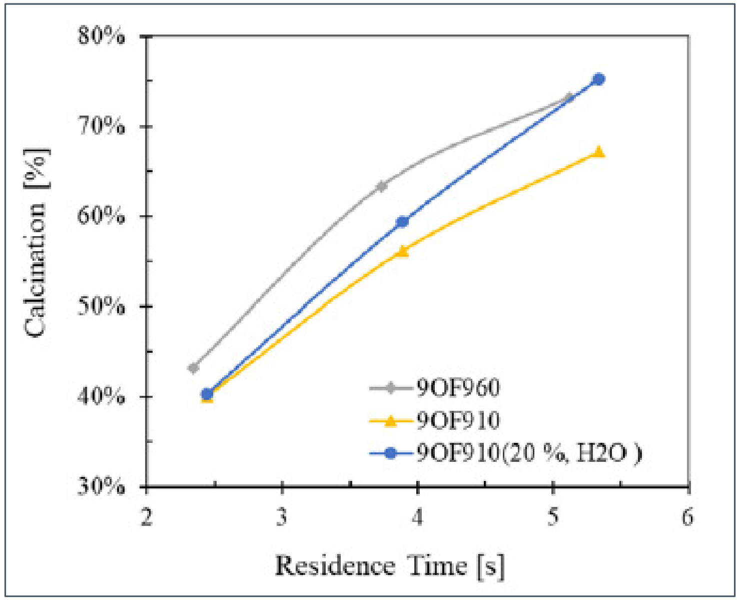
tkIS: Pilot scale



AL: Pilot scale

WP3.1 Technical scale - Influence of moisture content on degree of calcination



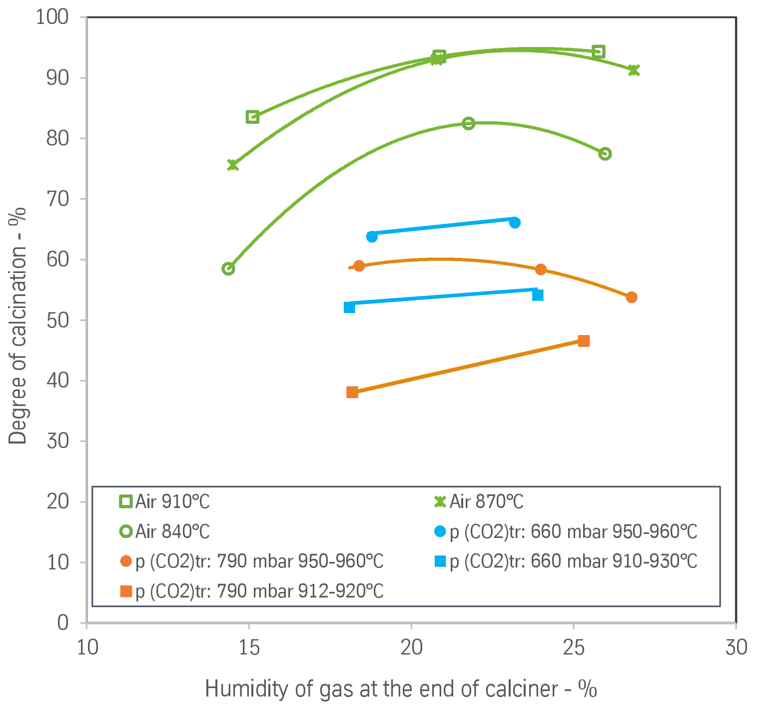


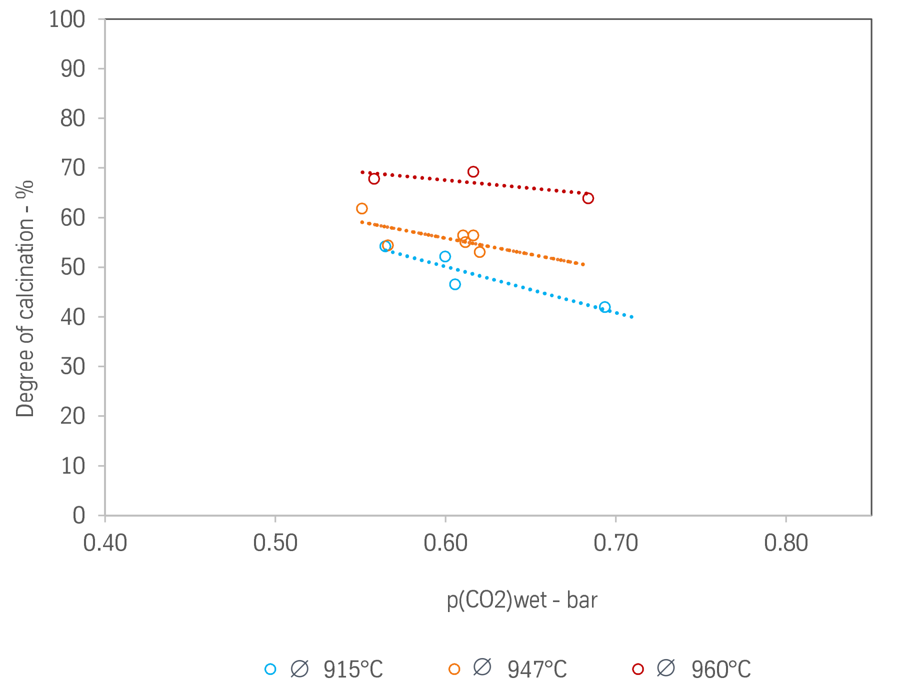
- up to 10% increase in calcination with add. water-vapour
- positive influence appears to have certain threshold of moisture content

- with addition of 20% water vapour: 50°C lower calcination temperature to reach same calcination degree

WP 3.2 Pilot scale - Influence of moisture content on degree of calcination

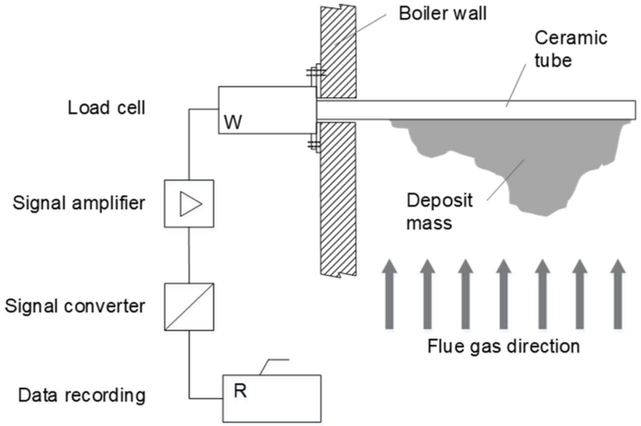
Retention time in calciner: ~0.8s

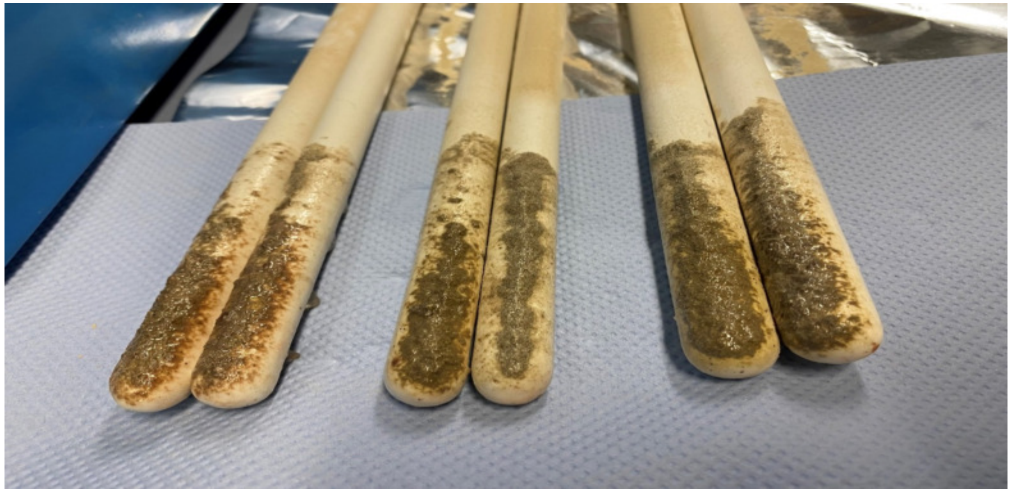




CONCLUSION: The experimental results of both test setups showed that an additional increase in gas moisture, above that already provided by the combustion of coal and alternative fuels (16-24%), is not reasonable.

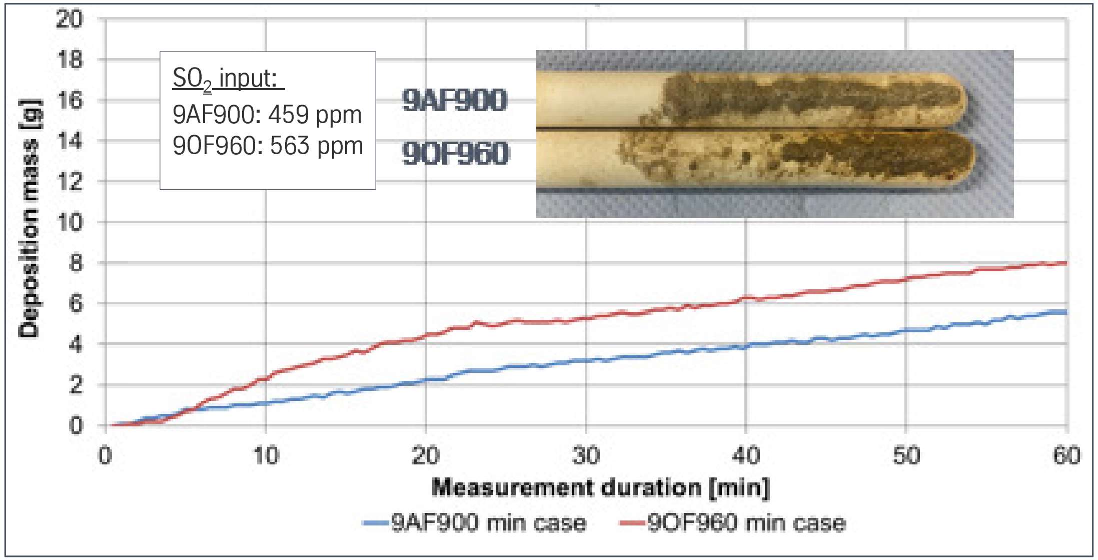
WP3.1 Technical scale – Impact of impurities (sulfur and chlorine)



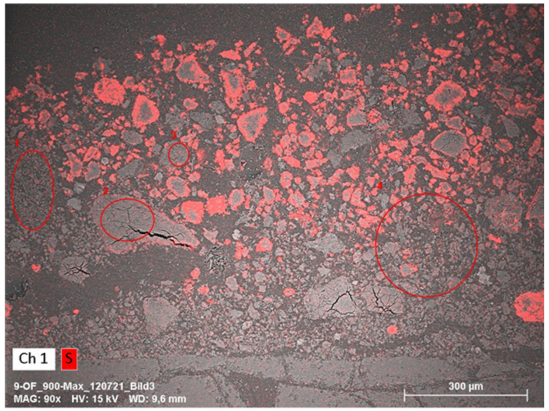


<u>Adding:</u> KCl (4%wt) and SO_2 (0.16-vol-%) to calciner environment

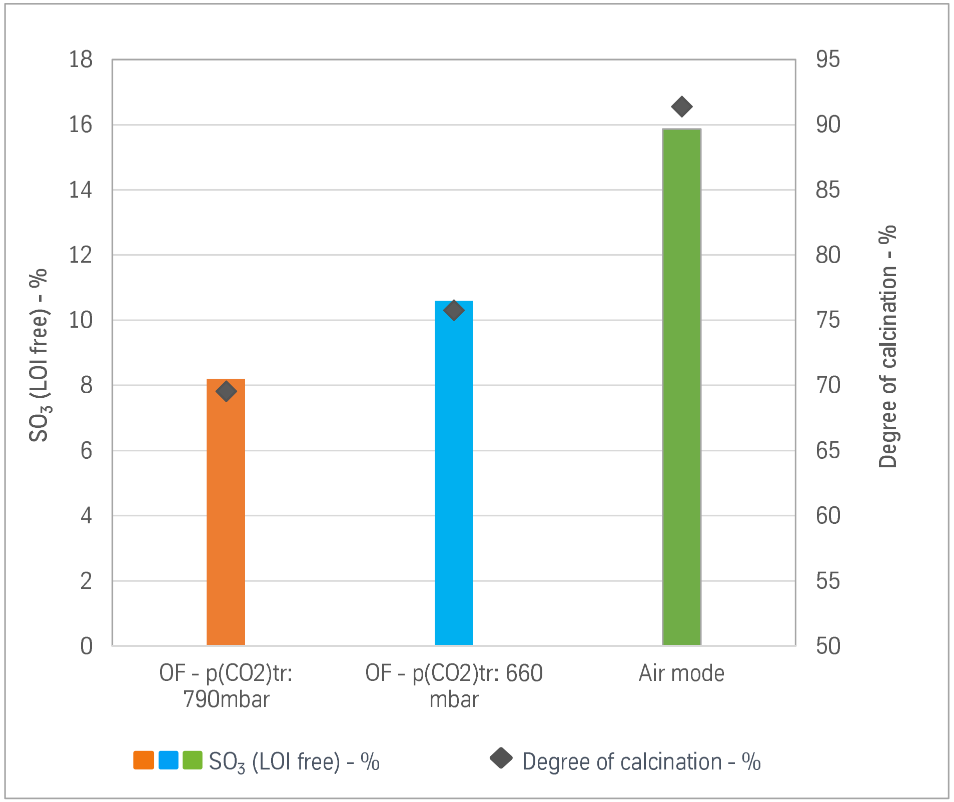
WP3.1 Technical scale – Impact of impurities (sulfur and chlorine)

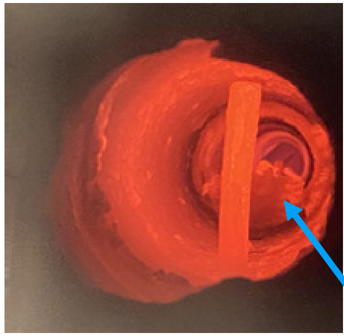


- Oxyfuel cases show higher mass accumulation than corresponding AF cases, probably relate to temperature
- ~99% SO_2 capture for both cases (AF, OF) with SO_2 load indicated in the diagram
- Sulphur was observed mainly around Ca-rich particles
- Chlorine- or Potassium compounds were not observed in particles



WP 3.2 Pilot scale - Impact of impurity (sulfur)





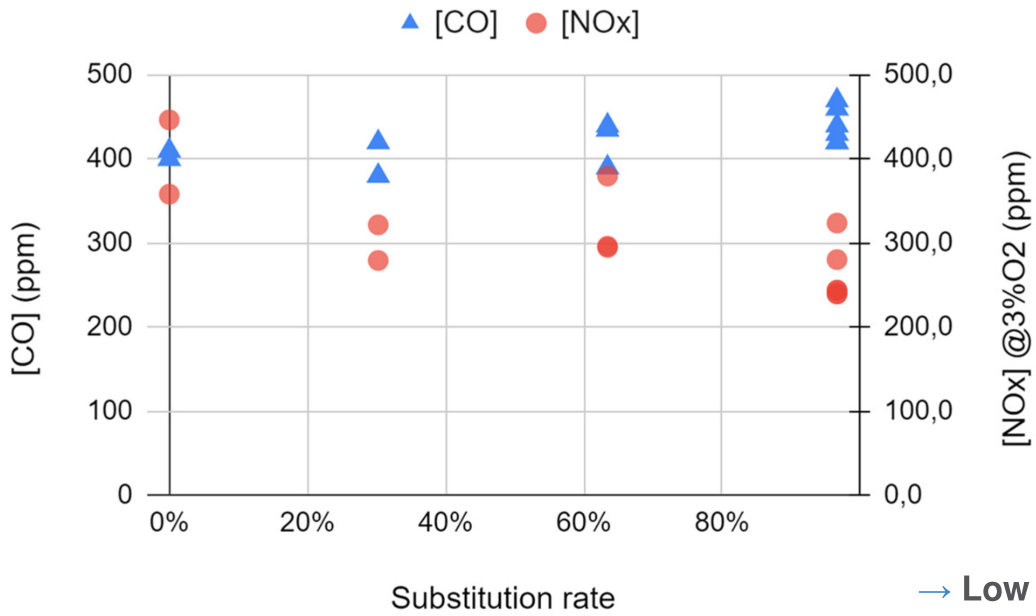
coating ►

Mineralogical analysis

Quantitative X-ray Diffraction Analysis (Rietveld evaluation)

Phase	Notation/Formula	
% Sum		100
% Quarz	SiO2	2
% Orthoklas	KAlSi3O8	
% Hämatit	Fe2O3	1
% Free Lime	CaO	0.3
% Gehlenite	C2AS	8
% Plagioklas	NaAlSi3O8	
% Akermanite	Ca2MgSi2O7	4
% Belite	C2S	19
% Periklas	MgO	2
% Spurrit	Ca5(SiO4)2CO3	
%Merwinit	Ca3MgSi2O8	9
% Ternesite	$Ca_5[SO_4\|(SiO_4)_2]$	36
% Yeelimite	$Ca_4Al_6[O_{12}\|SO_4]$	4
% Arcanite	K2[SO4]	1
% Langbeinite	$K_2Mg_2[SO_4]_3$	2
% Anhydrite	$CaSO_4$	12

WP 3.3 Pilot scale – Alternative fuel – oxyfuel calciner

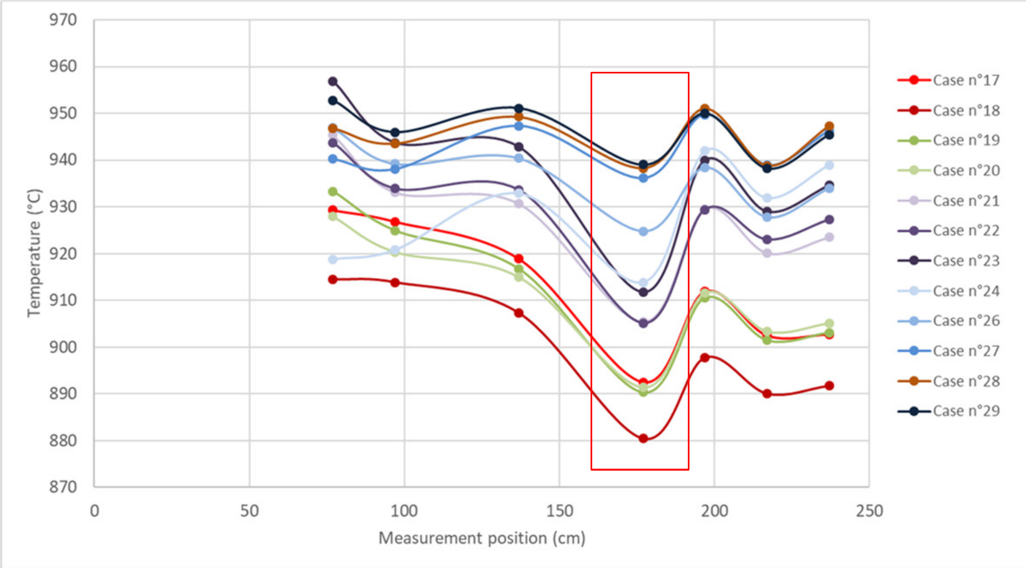


→ **Low** CO increase, due to CO_2 presence

→ NOx decrease

→ Combustion **completed**, no AF present in the ashes

WP 3.3 Pilot scale – oxyfuel calciner usage of alternative fuels



→ Acceptable temperatures for a precalciner

☒ Thermocouple position at 175 cm to be improved

→ **100% of AF substitution** with good condition in the combustion chamber, only a small change in the thermal profile

→ Combustion **stability**

Conclusions of WP 3 – oxyfuel calciner

- Evaluation of the **role of the flue gas moisture level** in the calciner **is done** (TRL 6).
- **Moisture injection concept:** The experimental results of both test setups showed that an additional increase in gas moisture, beyond the level already obtained by burning coal and alternative fuels (16-24%) is not reasonable.
- The impact of flue gas **impurity - sulfur:**
  - It can be assumed that, for the same degree of calcination, the sulfur incorporation in the calciner in the oxyfuel case is similar to that in the conventional operation.
  - Due to higher calciner temperature in oxyfuel process, the risk of deposit formation increases.
- In industrial oxyfuel plants, the arrangement of the **meal split** and **fuel split** plays an important role in avoiding hot spots and reducing the risk of deposits.
- Up to **100% of AF (RDF)** can be used in an oxyfuel-precalciner

→ for AF with a lower quality more test have to be done

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- **French Environment & Energy Management Agency (ADEME), France**


Thank you for your attention!
Questions?
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