WP6 Oxyfuel modelling

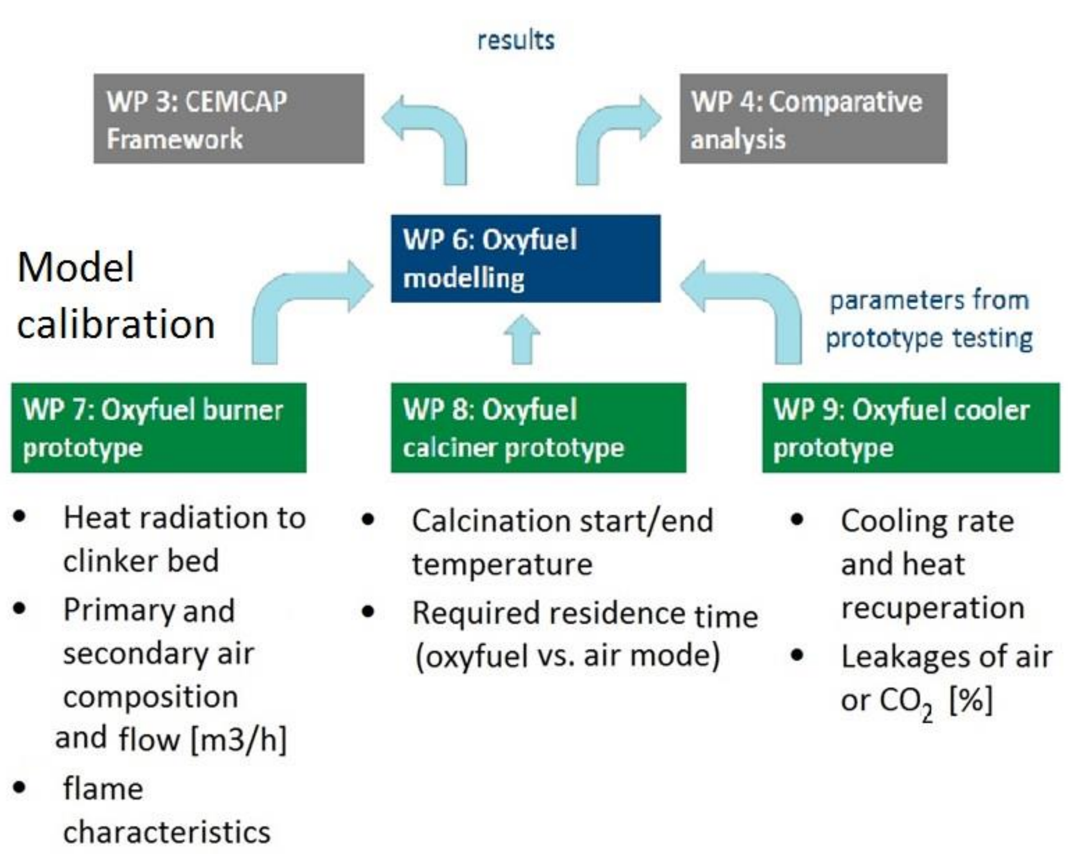
CEMCAP

CEMCAP is a Horizon 2020 project with the objective to prepare the grounds for cost- and resource-effective CCS in European cement industry.

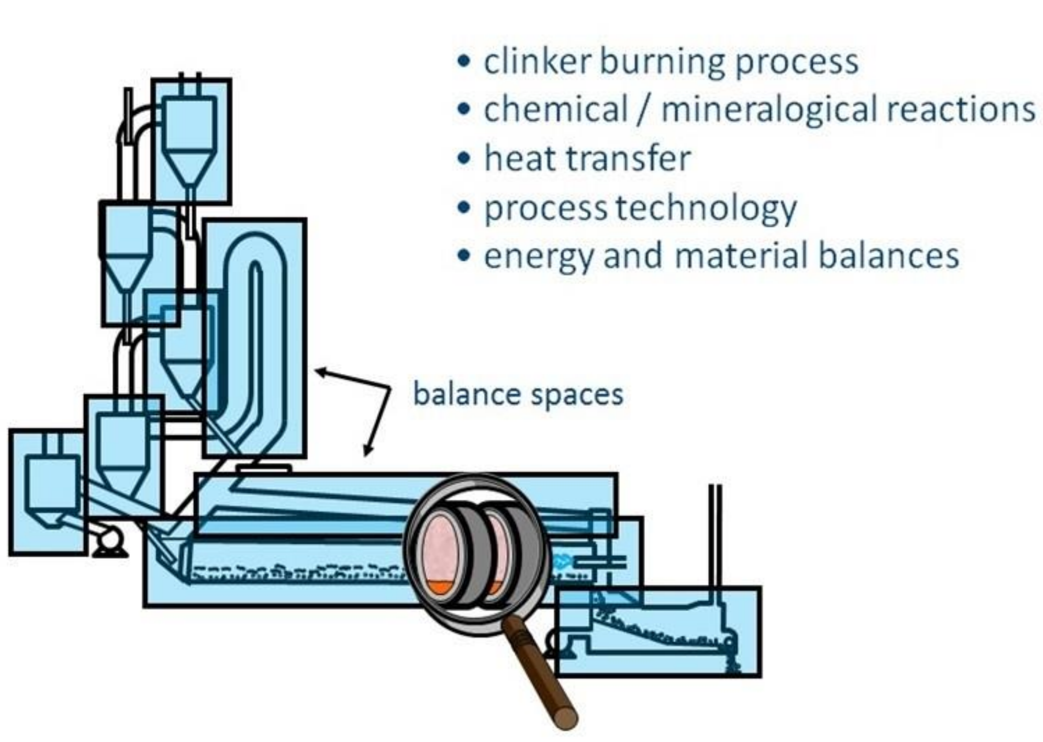
Key conclusions

- Modelling of the oxyfuel cement clinker production process confirms: High quality clinker can be produced
- Oxyfuel process can be optimised by adaptation of process parameters for burner set-up, calcination temperature shift and enhanced cooling rates
- False air ingress leads to additional electrical energy demand in the CO_2 purification unit (CPU) according to an exponential relation: Careful maintenance is important.

Integration of WP6 in CEMCAP project

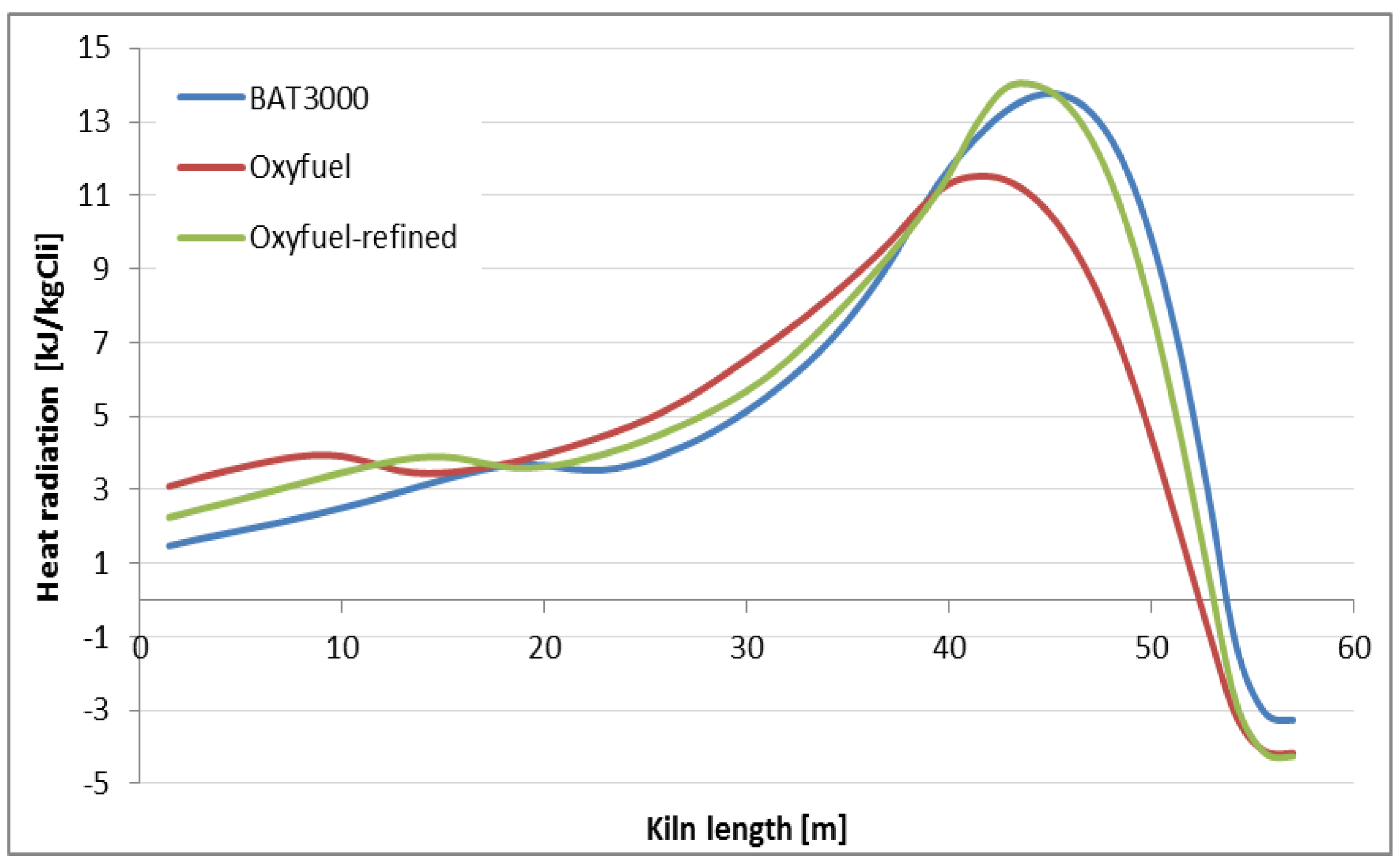


VDZ process model



WP6 Research

Oxyfuel burning process



- The heat radiation profile in the refined oxyfuel model could be matched to the reference air case (BAT3000) by switching the oxygen supply from secondary to primary gas .
- The coating behaviour of the material in the kiln and the thermal load of the rotary kiln is similar for these both cases and therefore fulfil the optimum operational mode.

Oxyfuel calcination process

Higher calcination temperatures require to reduce slightly the degree of calcination at kiln inlet for equipment protection and to avoid coating in the calciner.

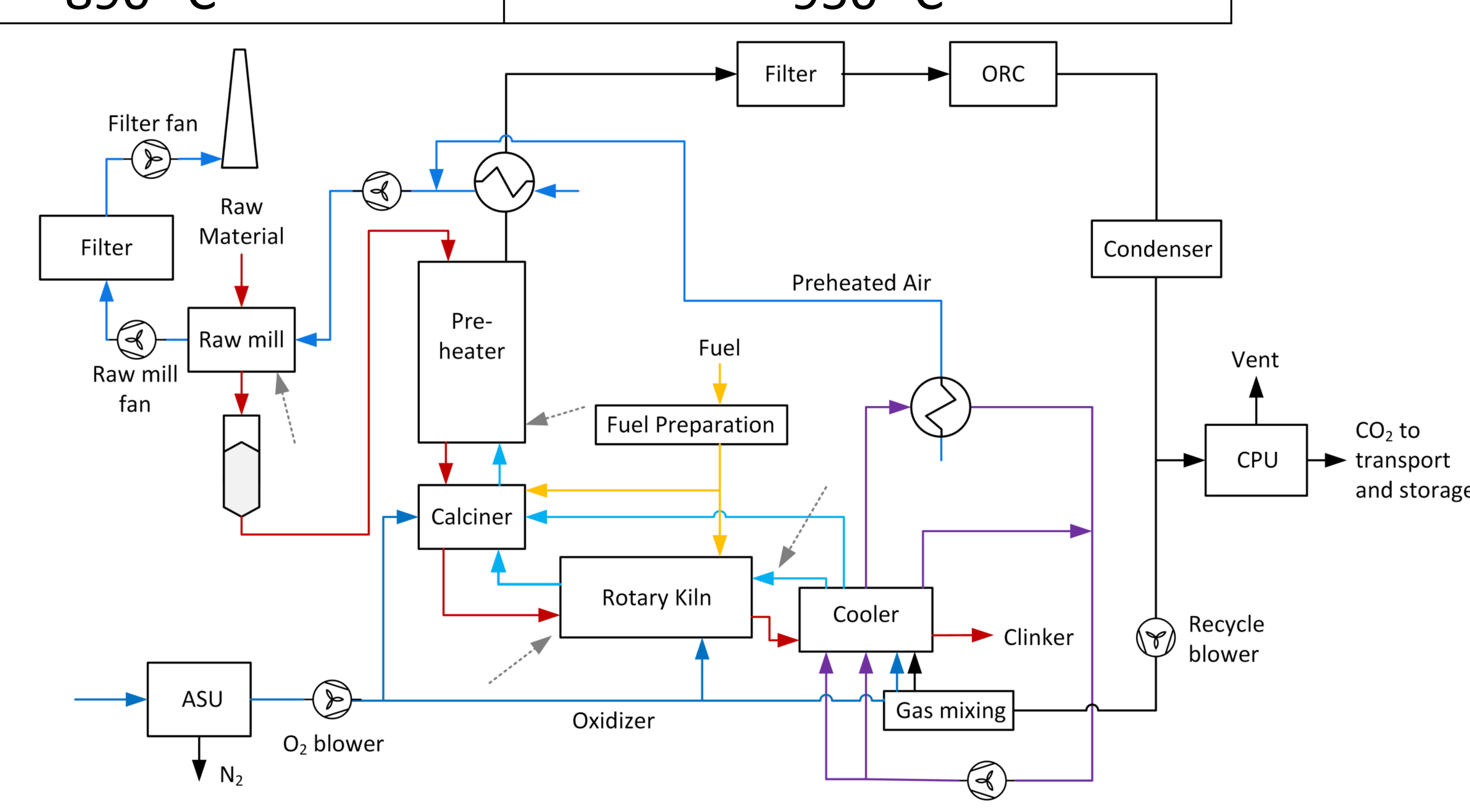
→Limestone dissociation will be completed in the first few meters of the rotary kiln.

Experimental results	Air (20% CO_2)	Oxyfuel (80% CO_2)
Calcination start-temperature	610 °C	610 °C
Calcination end-temperature	890 °C	950 °C

Oxyfuel cooling process

The cooler performs even better under oxyfuel conditions due to the increased heat exchange between the hot clinker and the recirculated CO_2 rich gas.

However, the cold clinker extraction is a focal point for limiting false air ingress to the oxyfuel gas recirculation.



Modelling of increased false air ingress

False air ingress [vol.-%]	Flue gas CO_2 content [vol.-%]	Thermal energy [kJ/kg$_{clinker}$]	Electrical energy [kJ/kg$_{CO2}$]
4.6	80	3,114	407
6.3	77	3,140	418
8.1	74	3,182	432

The electrical energy demand for the CPU rises exponentially with increasing of false air ingress and therefore regular maintenance will be essential to reduce false air ingress in the oxyfuel clinker burning process.

Heat Integration Model

Oxyfuel refined (Base case)		
False air	%	6.3
Clinker prod	t/h	125
O_2 flow	t/h	31
ORC	MWe	2.9
CO_2 purity	%	97.3
CO_2 captured	t/h	98.8
CO_2 emissions	t/h	11
Rec. rate	-	0.55

The CO_2 capture rate of the refined oxyfuel process was calculated as between 85-90 % at 97 % product (CO_2) purity.

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