Innovative Sustainable Approach to Calcination

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Background & Motivation

❖Mineral industry sector contributed $179B to the Australian economy (9.5% of GDP) and 16% of greenhouse gases[1,2].

❖Lime/Cement and Alumina production contribute the majority of CO_2 in the sector.

❖Calcining a ton of lime produces 640kg of CO_2 [3 ,4].

❖Calcining a ton of Gibbsite produces 165kg of CO_2 [5].

❖Dry calcination is very common while steam calcination has advantages, as shown in Table 1.

Aim & Objective

❖The aim of this research is to investigate the advantages of using steam as a heat carrier in the flash calcining process under practical industry-relevant conditions.

❖The project objective is to investigate the key parameters affecting the calcination process (particles size, turbulent mixing, calcination temperature, residence time and diluent gases to steam ratio) when using steam as a product of hydrogen combustion.

Table 1: Calcite calcination experiments with three different mediums [6].

	N_2		CO_2		H_2O	
Temperature (˚C)	Conversion (%)	Time (mins)	Conversion (%)	Time (mins)	Conversion (%)	Time (mins)
600					8.78	30
700	52.29	30			73.22	30
800	96.32	25.5	7.58	30	96.94	30
900	99.39	12.5	20	30	100	25
950	99.31	10	72.89	30	100	19.16
1000	100	10	92.95	30	100	10

Experimental Apparatus

❖A vertical furnace of 60 kW capacity, with a cross section of 260 x 260 mm^2 and length of 1200 mm, as shown in Figure 1.

❖The furnace walls, co-flow temperature and gas composition and particles flow rates are controlled .

❖Particles, with different diameters (25 - 200) μm, are injected into the furnace using a carrier gas through the in-

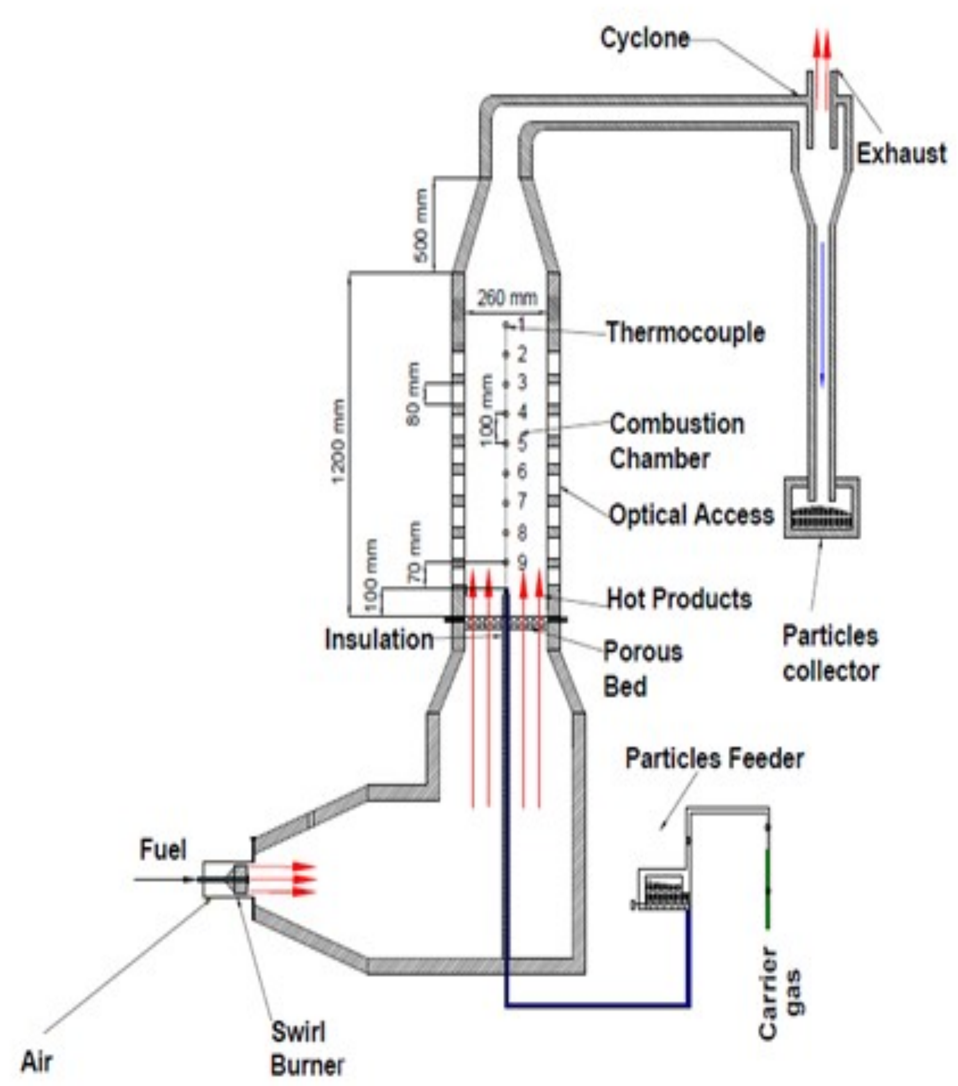

Figure 1: Adelaide university vertical

Process simulation

❖Using Aspen Plus software, to analyse the proposed steam calcination system and the viability of CO_2 capture.

Heat In kW	$CaCO_3$ kg/hr	CO_2 Produced kg/hr	CO_2 Captured By mass
40 KW	10	3.57	0.93

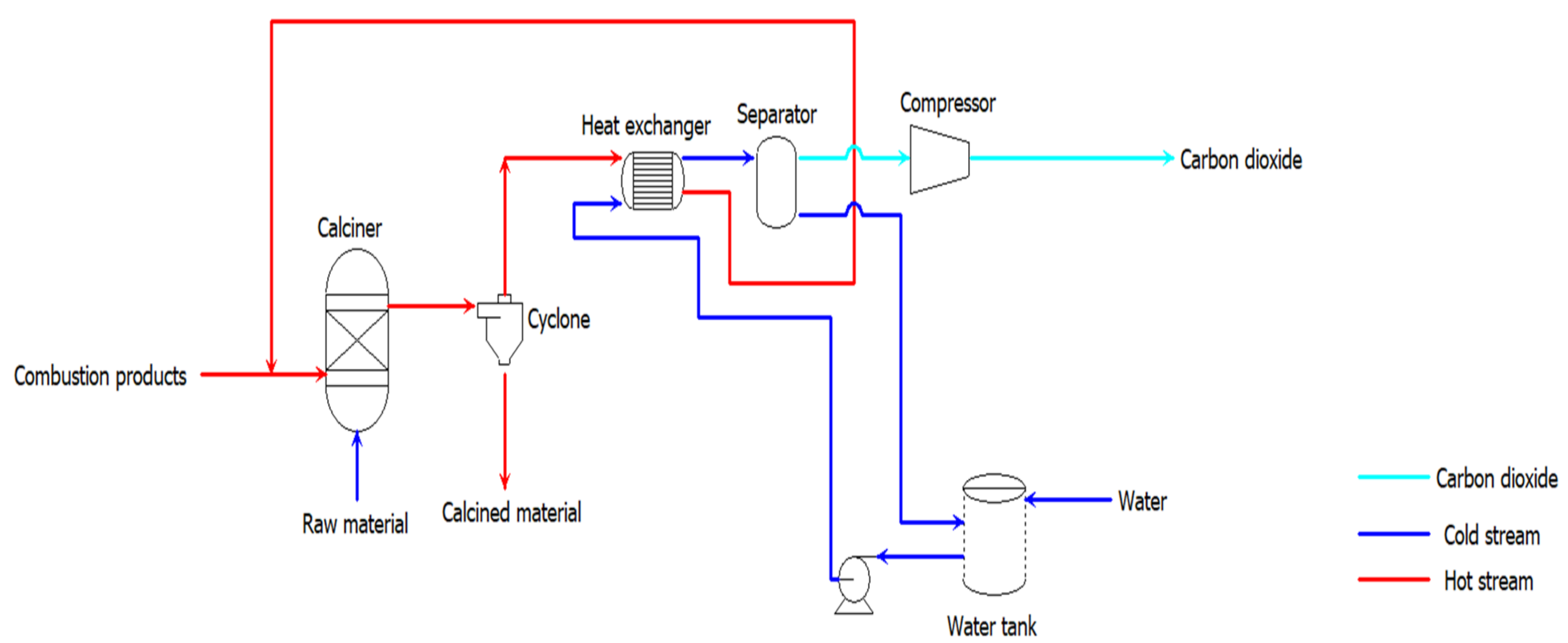

Figure 2: Process flow diagram

Computational Fluid Dynamic (CFD)

❖Steam calcination at different temperatures and uniform particles diameter, 100 μm, shown in Figure 3 (left). Steam calcination at different particles sizes and a 1200K temperature (right).

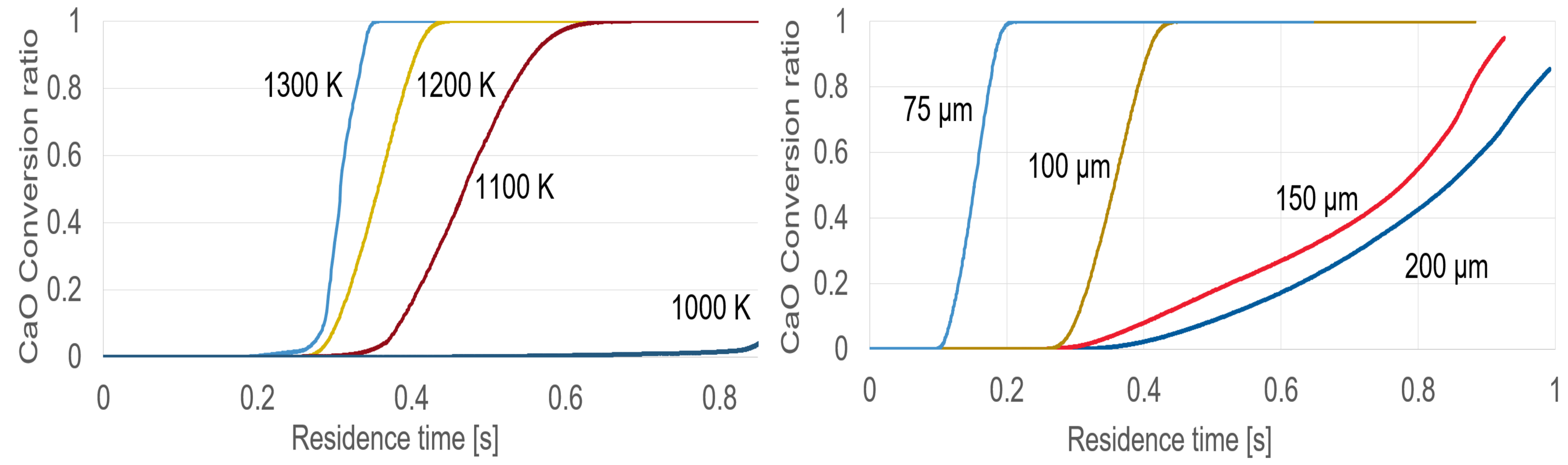

Figure 3: parametric study for steam calcination

❖Figure 4, Calcination using Nitrogen as a medium compared to steam, in both cases temperature was 1300K and Particle's diameter was 100 μm.

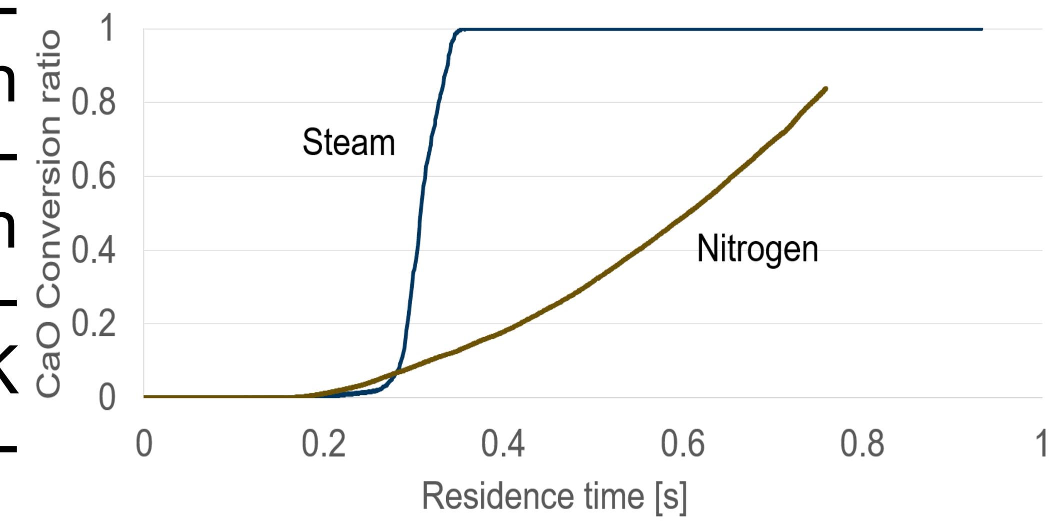

Figure 4: N_2 vs Steam Calcination

Conclusions

❖Higher conversion ratio achieved when using steam as a calcination medium.

❖Up to 93% of CO_2 from steam calcination can be captured.

❖Using particles size smaller than 150 μm is preferred in the calcination process.

Acknowledgment

The authors acknowledge the financial support of the ARC (Discovery project), and ARENA (RND:054), Integrating CST into the Bayer process.

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CET Research Day Program - 2020

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