Proof of Concept of a Solar Sinter

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18 - 19 JULY 2019
STERG
SOLAR THERMAL ENERGY RESEARCH GROUP

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Mintek (Established 1934)

- Government-owned minerals research organization
- Employs ~700 people (250 professionals)
- Annual budget of ~R500m (US $35m)
- State & corporate funding (50:50)

Core expertise

- Electric smelting – especially DC arc furnaces
- Large-scale piloting and process demonstration
- Development of new processes

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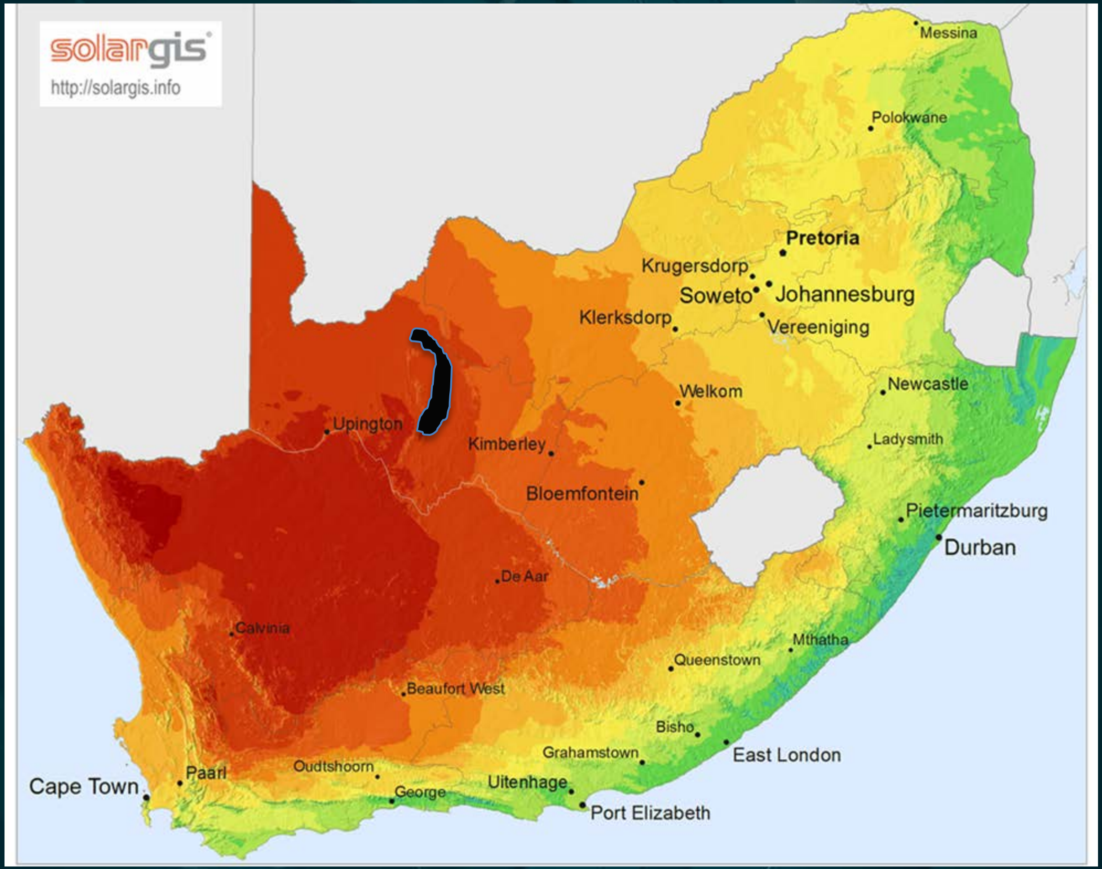
Kalahari Manganese Fields



Manganese exports are 94.7% of total sales

Transnet tests world's longest manganese production train

11TH OCTOBER 2018 SAVE THIS ARTICLE EMAIL THIS ARTICLE

BY: MARLENY ARNOLDI
CREAMER MEDIA ONLINE WRITER

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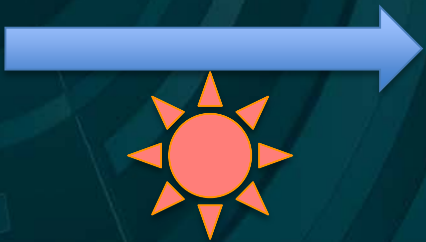
Transnet Freight Rail (TFR) has successfully run a 375-wagon manganese train over a distance of 861 km from Sishen to Saldanha Bay.

https://www.engineeringnews.co.za/article/transnet-tests-worlds-longest-manganese-production-train-soon-to-operationalise-2018-10-11/

How do you proof a concept?

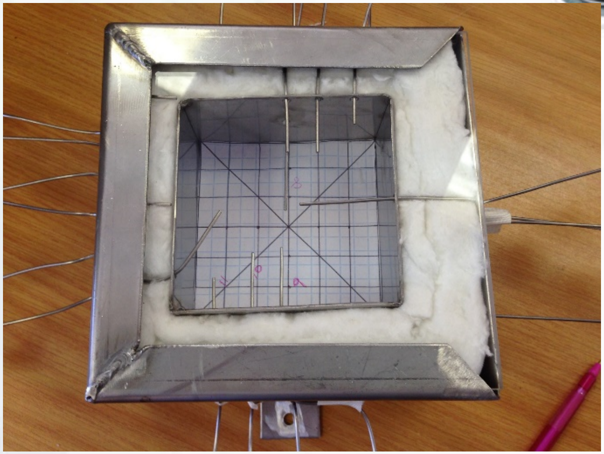
- Demonstration of technical feasibility
- Understanding of the fundamental physics involved
- Relating the value of the concept to its practical application



< 6 mm ore fines

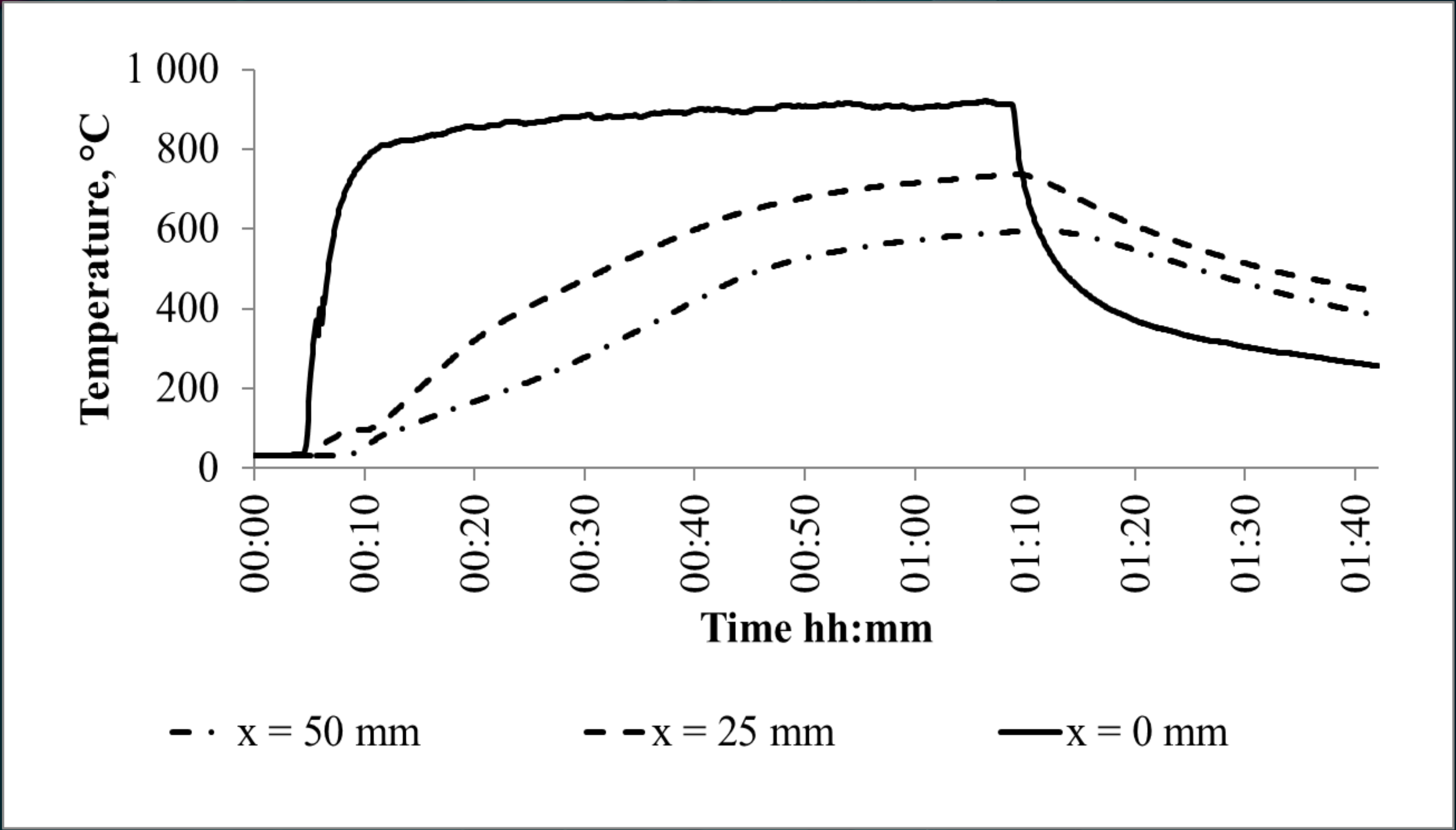
manganese ore sinter

Experiments – Round 1



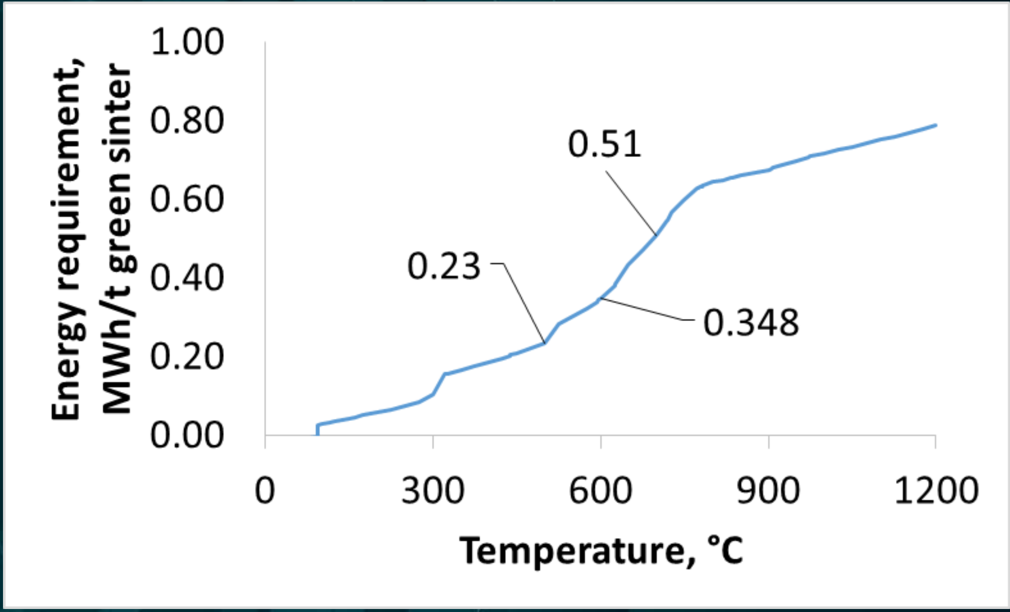
STERG solar concentrator

Results – Round 1

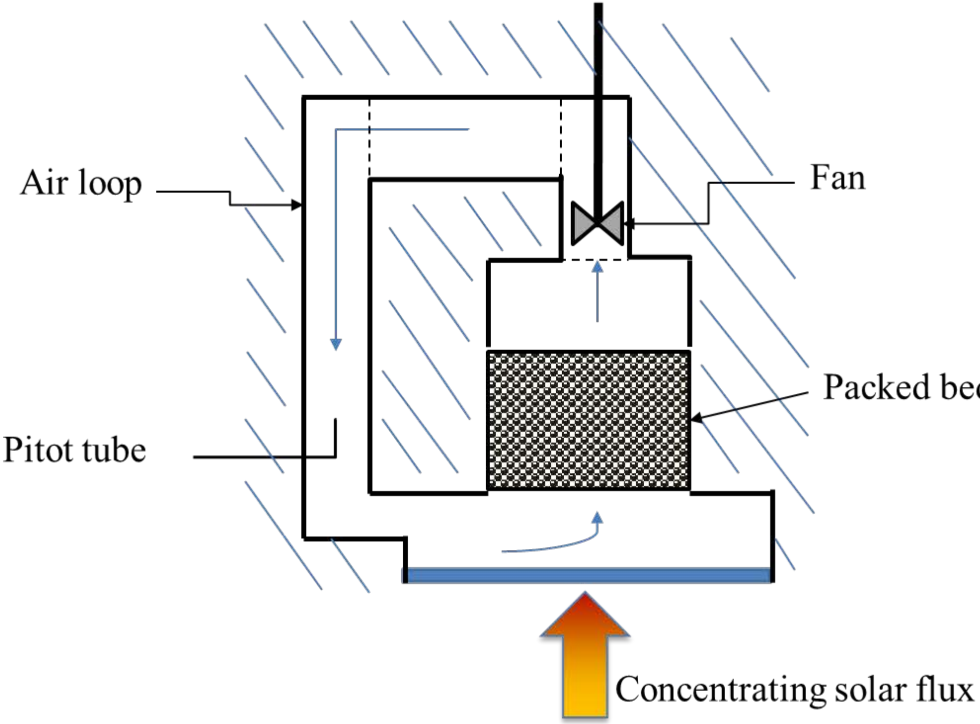


Results – Round 1

- **Heating and thermal decomposition of manganese ores has been demonstrated**
- **Empirical results when compared to thermodynamic equilibrium models indicate that kinetics factors are limiting decomposition**

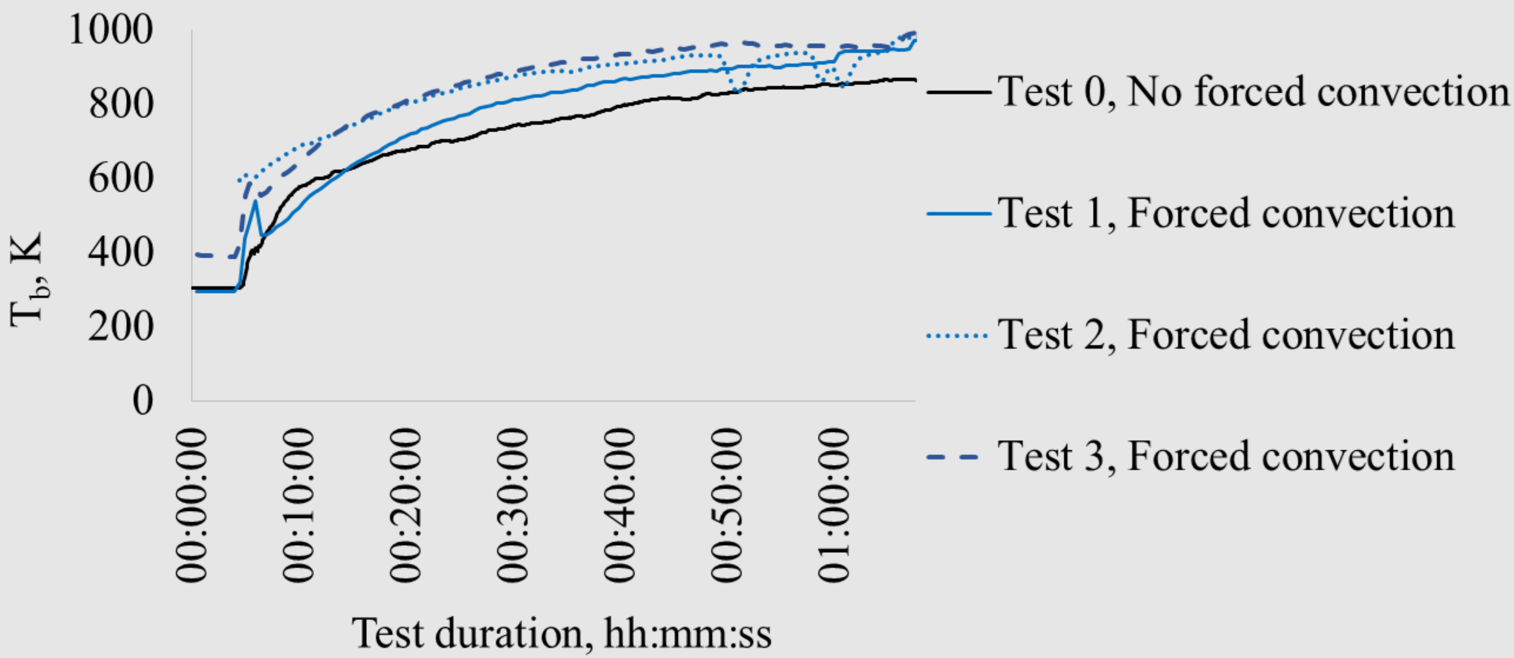


Experiments – Round 2



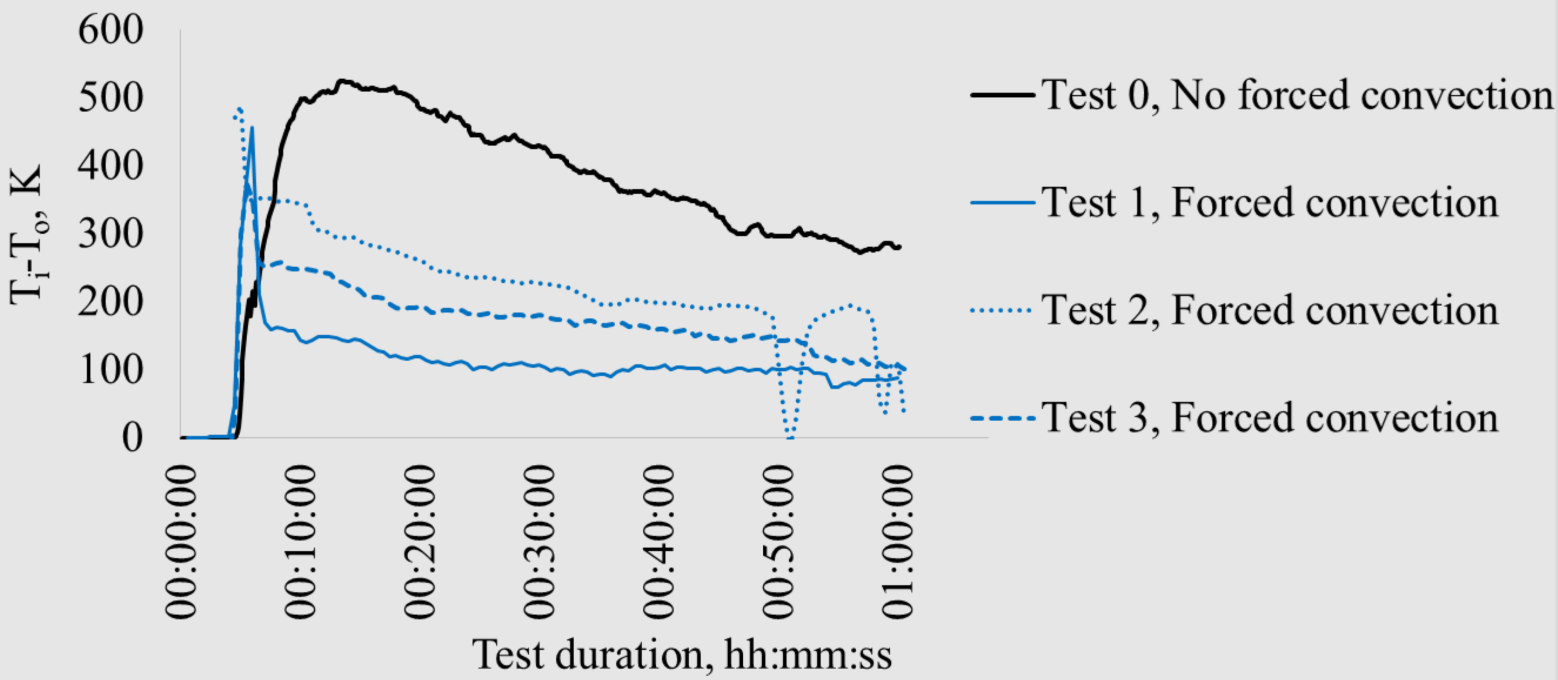
STERG Solar Roof, Stellenbosch, South Africa

Results – Round 2

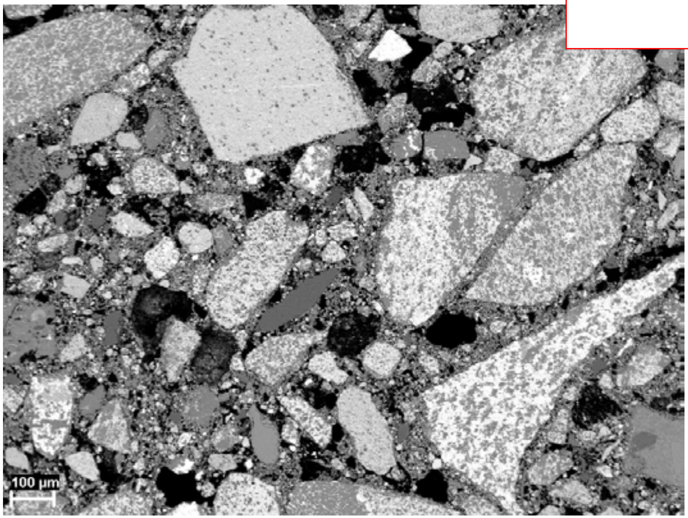


Average packed bed temperature

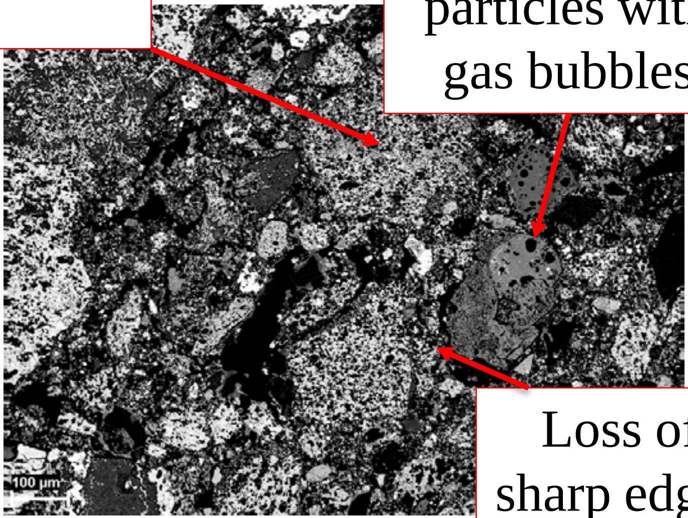
Results – Round 2



Scanning Electron Microscopy (SEM) images

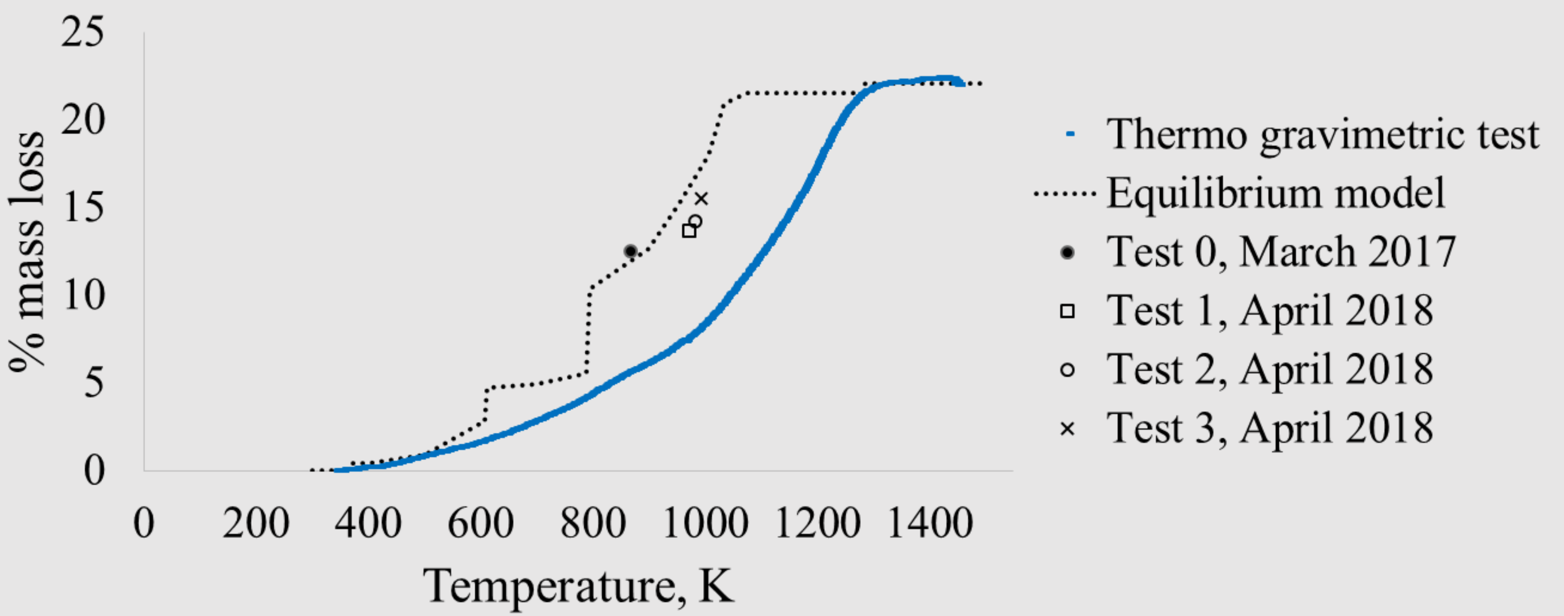


Before solar thermal treatment



After solar thermal treatment

Thermodynamic model



Thermo gravimetric experiments mass loss as compared to FACTSage model. Mass loss for experiments are plotted against the maximum bed temperature, T_b, calculated for each experiment.

Towards a Solar Sinter – Outside help

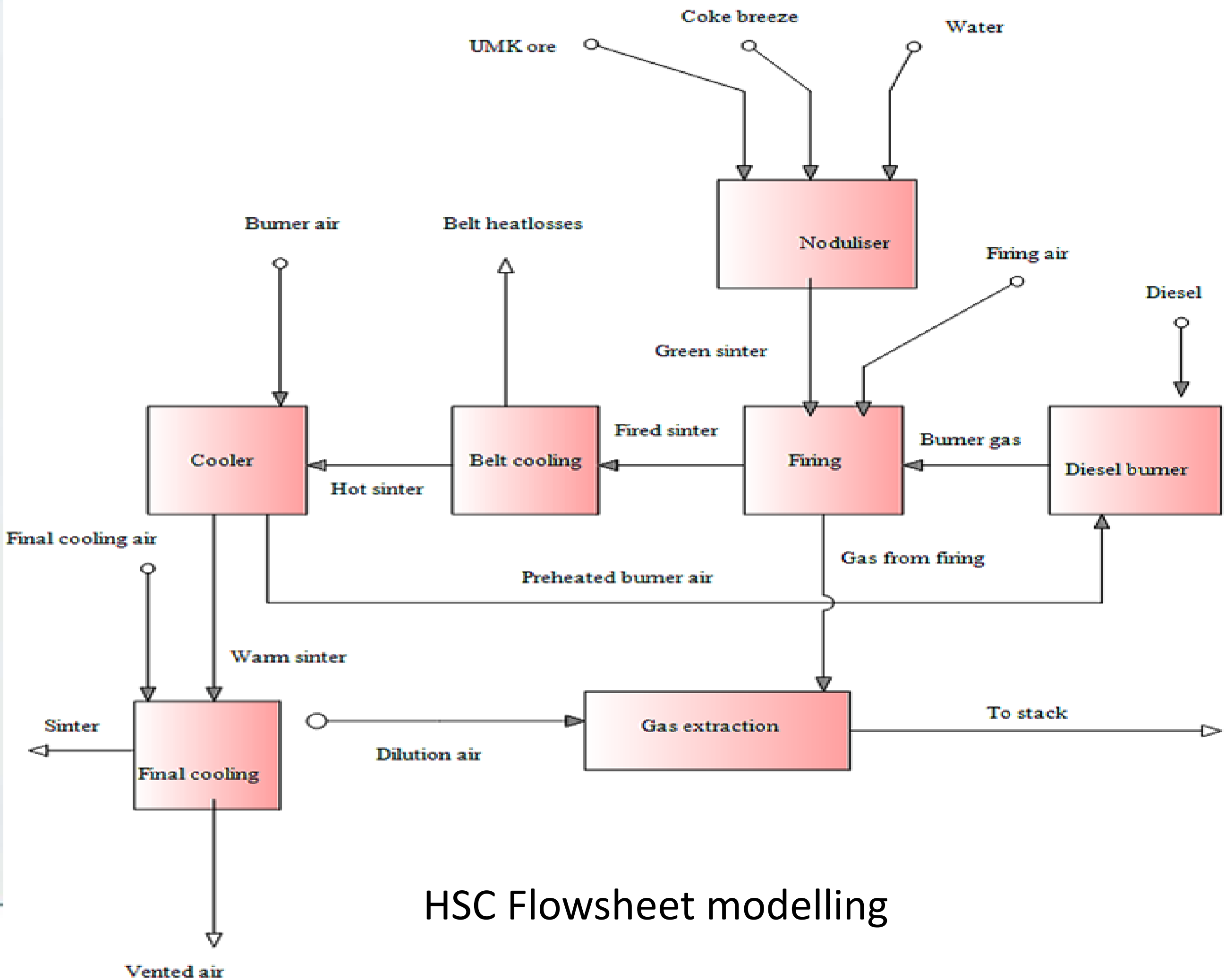
Sintered by concentrating solar flux

Not sintered by concentrating solar flux

10 mm

Thank you to Prof. Flamant from CNRS-PROMES, France

Towards a Solar Sinter – Value of concept



HSC Flowsheet modelling

Reduced fossil fuel consumption is possible

Burner air temperature, °C	Diesel consumption, kg/t ore	Drying and preheating of green sinter, °C*	Coke breeze consumption, % of ore
350 (current practice)	1.65	None (current practice)	9.4
600	1.22	110	9.0
800	0.85	200	8.7
	0!!!	**1200?**	**0?**
***Drying by air at 300 °C produced by concentrating solar thermal plant**			

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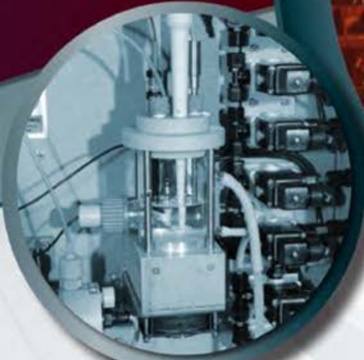
Conclusions

- Currently data processing is still underway
- Flowsheet evaluation and techno-economics is under consideration for the SolarPACES 2019 paper
- Modelling is in progress with the aim to include mass transfer as well as heat transfer into the model

By the way….

- **PREMA** Project

- **SolarPACES** 2019, 1 to 4 October 2019, Daegu, South Korea
- **SASEC** 2019, 25th to the 27th November 2019
- **HiTEMP2**, 6-18 March 2020, Adelaide, Australia
- **Colloquium** on Renewable Energy for Energy Intensive Industry (SAIMM) 21 June 2019, Kathu
- **Mn School** (SAIMM) 23-24 June 2019, Kathu



Thank You

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How to reduce your CO_2 footprint

- Energy efficiency
- Replacement
  - Electrification
  - Other reductants
  - Renewable energy
- CO_2 capture and sequestration

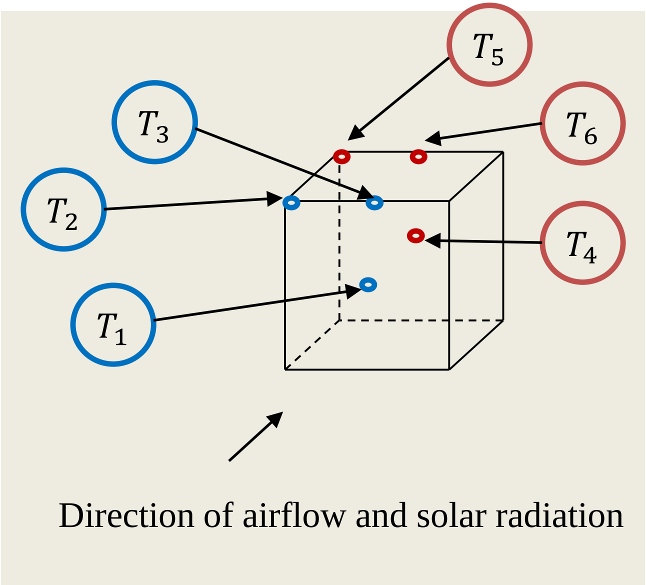
Motivations for solar thermal energy use

- Increasing demand for products with lower carbon dioxide emissions
- Carbon tax implemented in more countries
- Tax incentives for reducing fossil fuel consumption
- Reduced operating costs when replacing diesel/electricity

Chemical reactions during sintering

- Decompose carbonate minerals to release CO_2, e.g.
  $CaCO_3 \rightarrow CaO + CO_2$
- Decompose manganese minerals releasing O_2, e.g.
  $4MnO_2 \rightarrow 2Mn_2O_3 + O_2$
  $3Mn_2O_3 \rightarrow 2Mn_3O_4 + 0.5\ O_2$
  $Mn_3O_4 \rightarrow 3MnO + 0.5\ O_2$
- Agglomerate fine particles into larger particles
- Mn and Fe grades are increased but Mn/Fe ratio not improved.

Temperature measurements and definitions



$$T_i = \frac{T_1}{4} + \frac{T_2}{4} + \frac{T_3}{2} \qquad (1)$$

$$T_o = \frac{T_4}{4} + \frac{T_5}{4} + \frac{T_6}{2} \qquad (2)$$

$$T_b = \frac{T_i + T_o}{2} \qquad (3)$$

A sinter plant