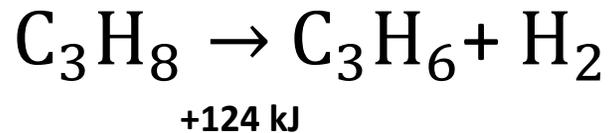


Catalyst Solar Particle Heat Carriers for Paraffin Dehydrogenation

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DOE SETO Project DE-EE0010240

Co-PI's: Thomas Schwartz (U. Maine), David Hibbitts (U. Florida)

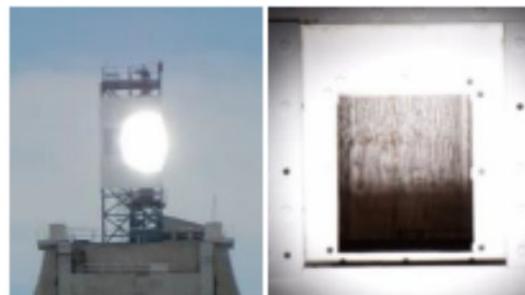


- Paraffins (Propane) to Light Olefins (Propylene)
- \$325B+ Annual Value in Light Olefins Production
- 75 MMt CO₂ emissions
- State-of-the-art
 - Multi-stage, near-isothermal reactors
 - Packed bed of catalyst particles
 - 500-600°C

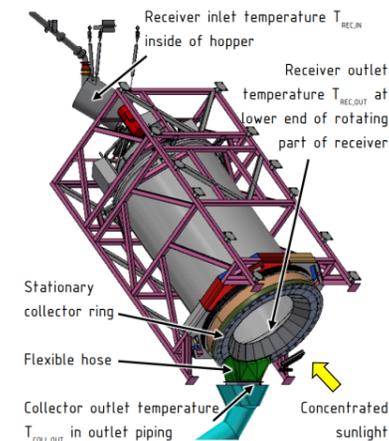


• Solar Particle Receivers

- Outlet temperatures demonstrated up to 965°C [1]
- Solar-to-thermal efficiency >85% [2]
- 300-800 μm particle size



Falling Particle Receiver [3]



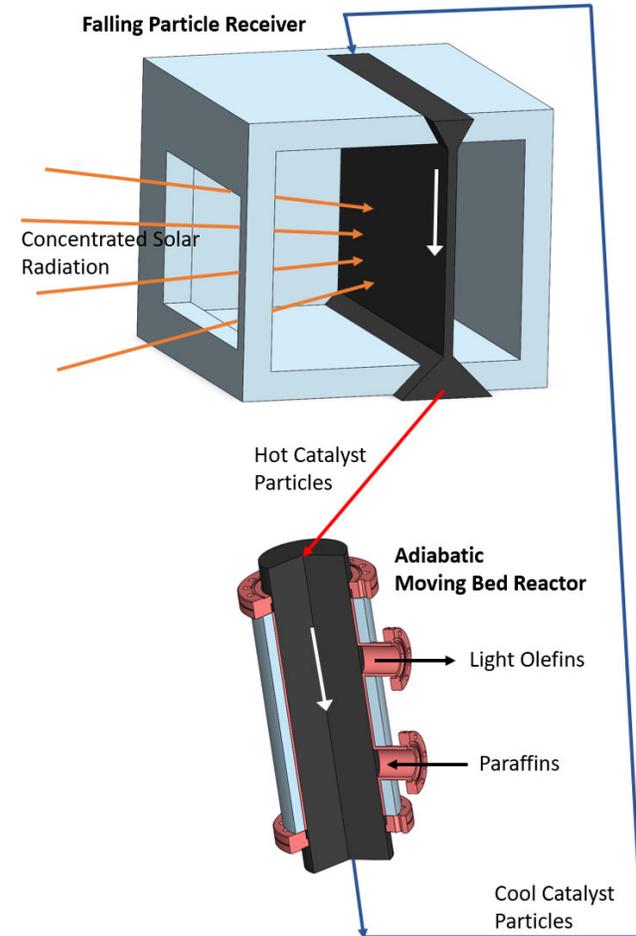
Centrifugal Particle Receiver [1]

[1] Ebert et. al., 2019 AIP Conf. Proc.

[2] Ho et. al., 2022 AIP Conf. Proc.

[3] Ho et al., 2019 J. Sol. Energy Eng.

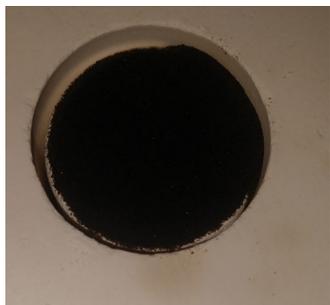
- Technology Concept
 - Catalyst particles as heat carriers
 - Existing particle receiver technology used to heat particles
 - Adiabatic, counterflow reactor for dehydrogenation
- Benefits
 - Solar decarbonization of energy-intensive process
 - Leverages current DOE investment for one step of process
 - High particle heat capacity could reduce reactor stages
- Questions
 - Will particles absorb light?
 - Catalysis performance in non-isothermal range
 - Reactor design for efficiency / conversion
 - Durability / lifecycle / cost of particles



Particle Absorptance



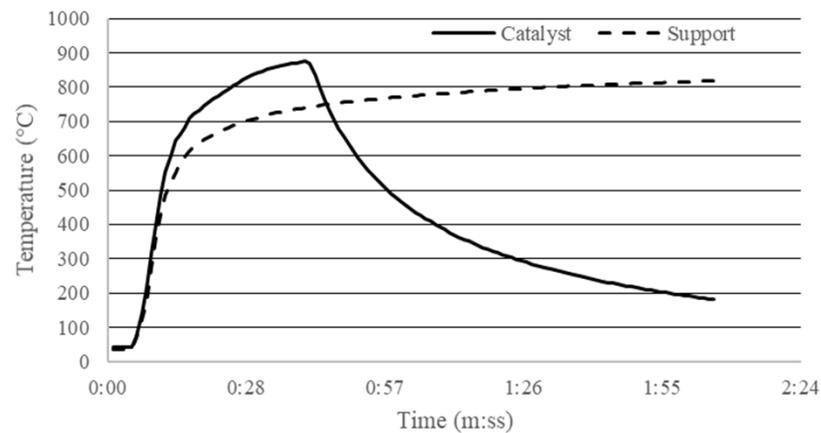
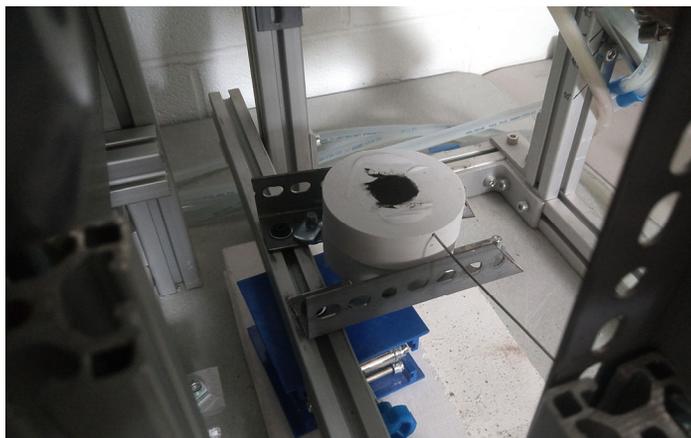
SiO₂



1% Pt 1% Sn on SiO₂

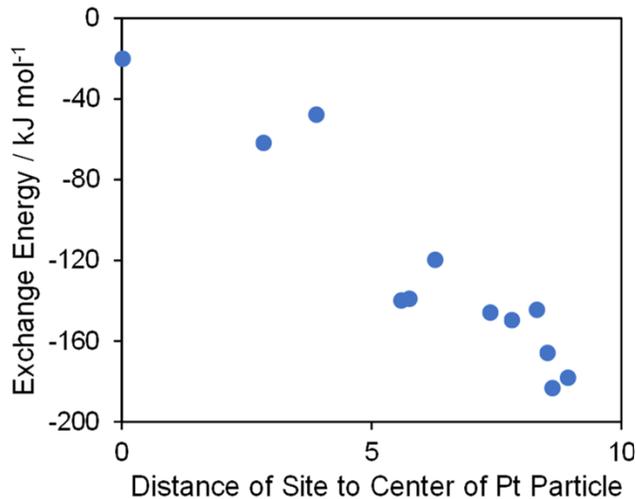
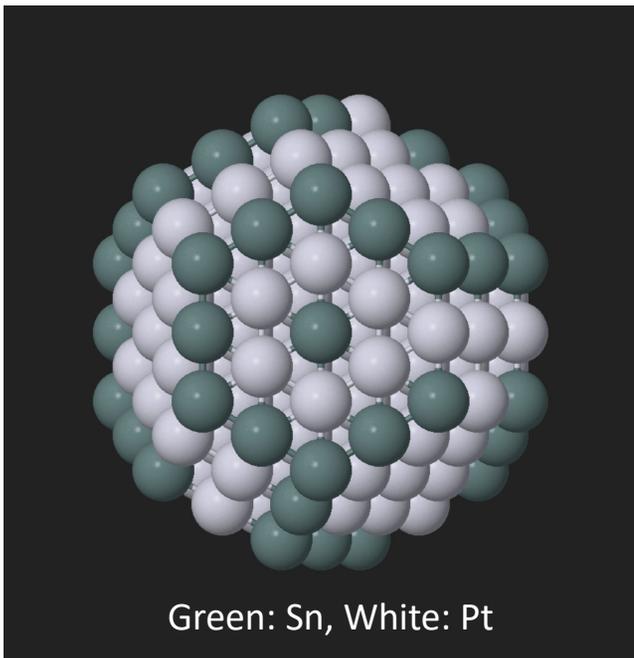


Carbobead CP

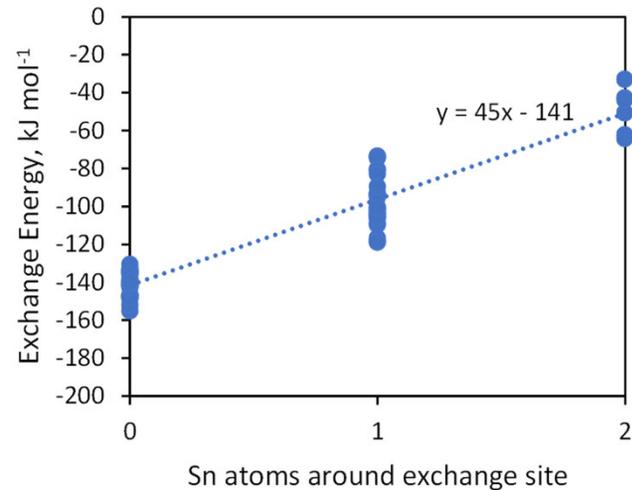


Understanding Highly Non-Isothermal Catalysis

- DFT Calculations can predict how catalyst nanostructures will reconfigure with temperature



Tin prefers to be on outside of nanoparticles



Tin atoms prefer to be well dispersed

Thermodynamic Analysis

