**PCI’S INNOVATIVE APPROACH**

- Combines multi-step multi-vessel energy storage, release and CO₂/CH₄ conversion into a single reactor
- Uses unique sorbothermal catalyst optimized for
  - energy storage and release via CaO + CO₂ → CaCO₃ cycle
  - CO₂ ‘dry-reforming’ with CH₄ to H₂ and CO
- Uses PCI’s Microlith® substrate for enhanced heat and mass transfer via boundary layer disruption

**TWO STEP PROCESS IN A SINGLE REACTOR FOR CONVERSION OF CO₂ AND NATURAL GAS INTO SYNGAS AND CHEMICALS**

- Step 1: 900°C, CaCO₃ → CaO (Endothermic)
- Step 2: 750°C, CaO + CH₄ → CO₂ + H₂ (Exothermic)

**CaO, CO₂ AND CH₄ CONVERSIONS FOR THE SIMULTANEOUS REACTION OF CO₂ WITH GAS-PHASE CH₄ AND SOLID-PHASE CaO**

Based on Gibb-free energy minimization to calculate equilibrium for feed compositions of CO₂:CH₄ of 3:1 and CO₂:CaO of 3:2

**OVERALL PROCESS ECONOMICS FOR GASOLINE PRODUCTION VS. NATURAL GAS AND CSP COSTS**

- Target operating space
- Levelized cost of concentrated solar power (CSP) electricity is currently 0.13 $/kw-hr, DOE target is 0.06. Assumes overall process efficiency of 75%
STABLE REGENERABLE MATERIAL FOR HIGH TEMPERATURE
CARBON DIOXIDE CAPTURE AND UTILIZATION

PCI’S NOVEL STABILIZED MATERIAL

• Developed for high temperature CO₂ processes
• CaO-based with stabilizers
• Tested for CO₂ sorption cycling
• Drop-in replacement for solid sorbents in fluidized beds

RESULTS OF FIXED BED BENCH SCALE TESTING

- Significant Cost Reduction Projected for Calcium Looping based on higher capacity and reduced replacement rates

- Applications include:
  • Fixed bed secondary capture
  • effective at CO₂ conc. < 1 %
  • Fluidized / Spouted / Ebullated Bed Primary Capture
  • effective over wide range of CO₂ conc.
  • based on sulfur-tolerant composition
  • Superior capture and durability will translate to improved processing economics

- Material proven highly effective in SUNSHOT program for Solar Thermal Energy Storage (DE-EE0006535)
  • Performing under subcontract to Southern Research (PI – Santosh Gangwal)

ADVANTAGES OVER LIMESTONE / STABILIZED CaO

• Resists Deactivation (other materials sinter)
• Stable for at least 50 cycles (others - either rapid loss or low capacity)
• Achieves 0.3-0.5 g CO₂ / g sorbent capacity (others < 0.2 g/g)

COMPARISON WITH STABILIZED SORBENTS

- PCI material resists sintering
  • maintains particle size and surface area after 15+ thermal cycles

- Currently progressing to commercial scale production for SUNSHOT application

Precision Combustion, Inc. provides innovative reactors and systems for cleaner and more efficient use of fossil fuels. We develop, manufacture, and market catalytic devices for clean and efficient combustion, emissions control, and chemical manufacturing.

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