Sustainable Conversion of Carbon Dioxide and Shale Gas to Green Acetic Acid via a Thermochemical Cyclic Redox Scheme

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Susteon Inc.

Cost share partner: Praxair Inc.

NC STATE UNIVERSITY

Susteon

Project Overview

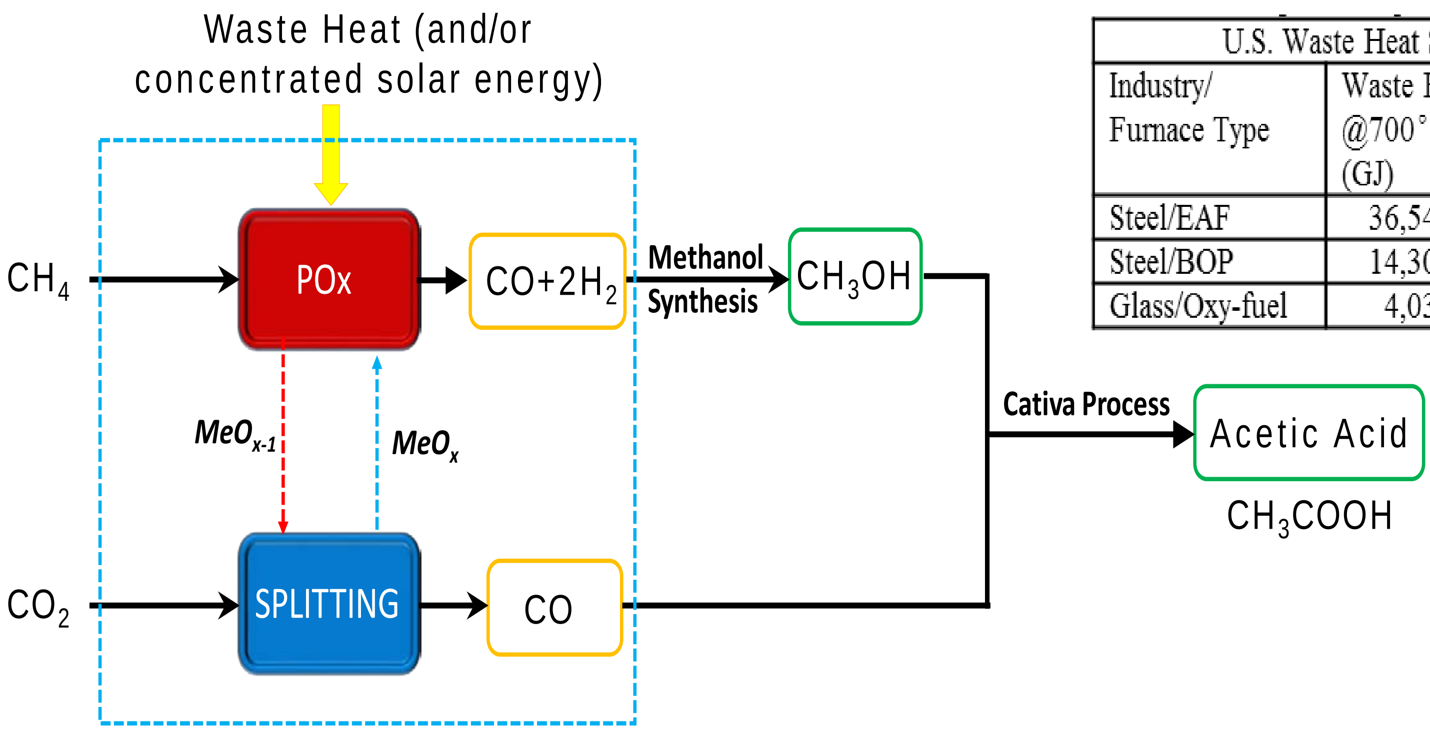
Project Funding: DOE - $797,244; Cost share - $199,606

Performance Period: 02/01/2019 – 01/31/2022

Project Participants: North Carolina State University, Susteon Inc., Praxair Inc. (cost share partner); **Project Manager:** Andy O'Palko

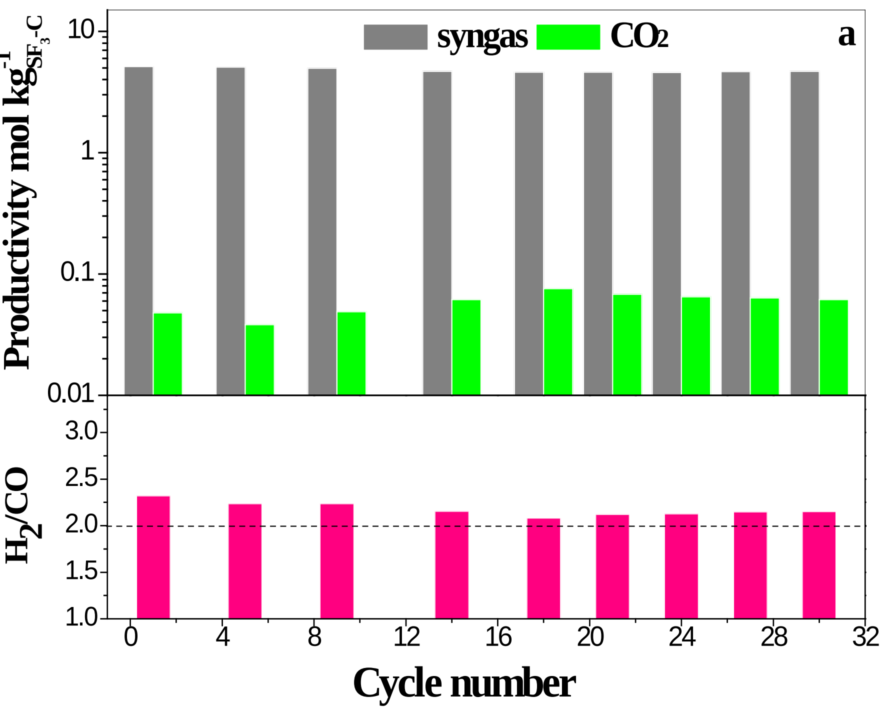
Project Objective: To develop a process for sustainable and cost-effective production of acetic acid from carbon dioxide, domestic shale gas, and waste heat.

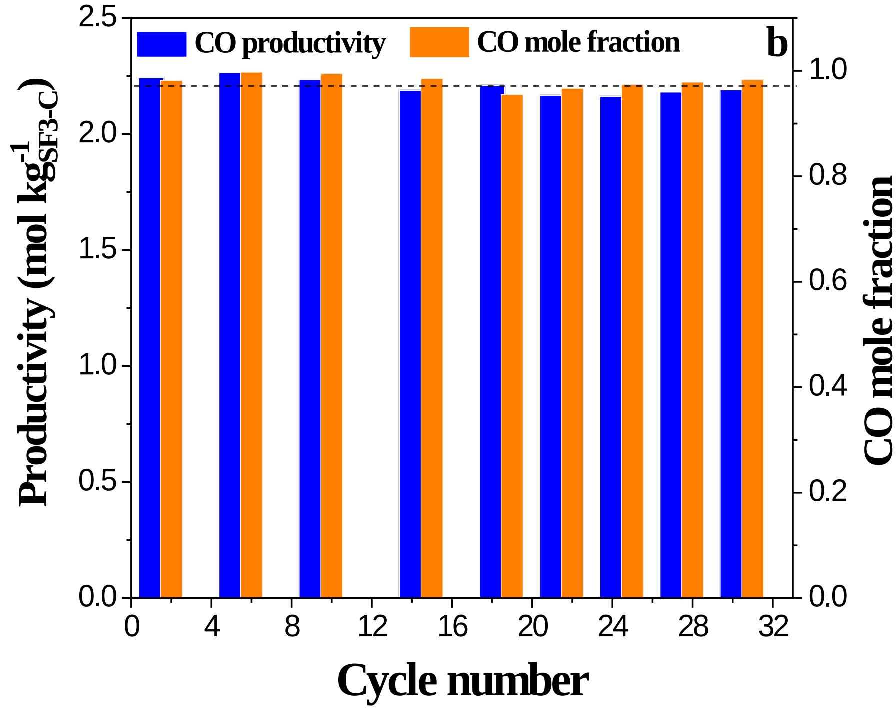
Proposed Strategy: To perform CO_2-splitting and methane partial oxidation (POx) in a synergistic two-step, thermochemical redox scheme via a hybrid redox process (HRP).

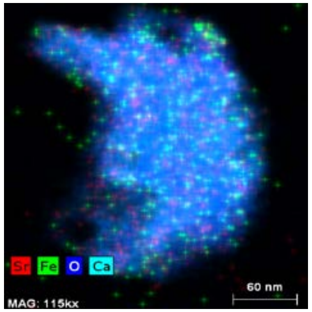


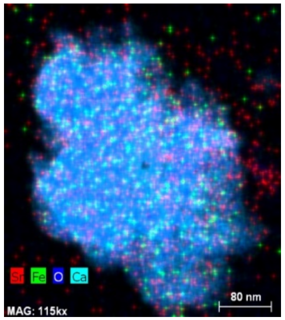
U.S. Waste Heat Sources (Annual)		
Industry/ Furnace Type	Waste Heat @700° C (GJ)	CO_2 Converted (tonne/year)
Steel/EAF	36,547,000	6,180,000
Steel/BOP	14,300,000	2,260,000
Glass/Oxy-fuel	4,033,000	683,000

Preliminary Data – HRP for CO_2 Splitting via $SrFeO_3$-NC





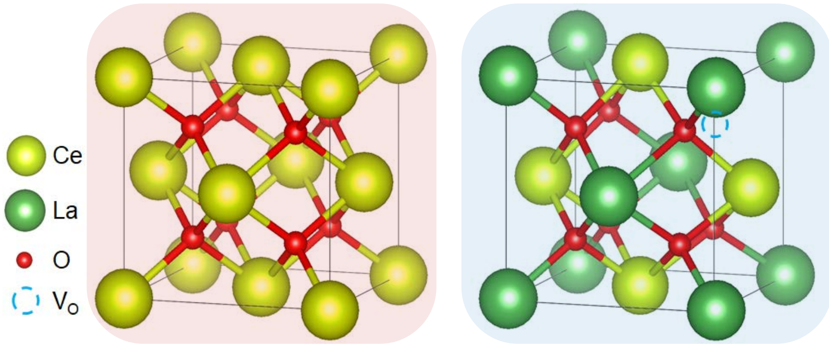


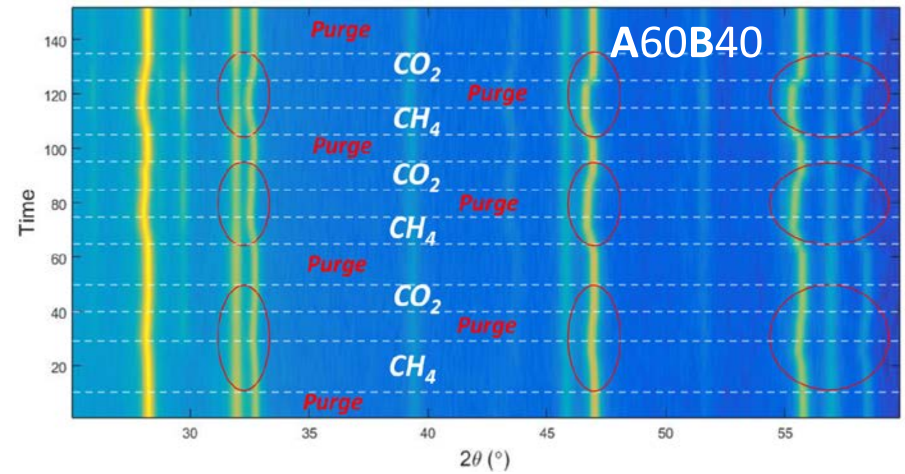


***>98%** CO_2 conversion and >95% syngas selectivity, <u>but requires >930 °C</u>*

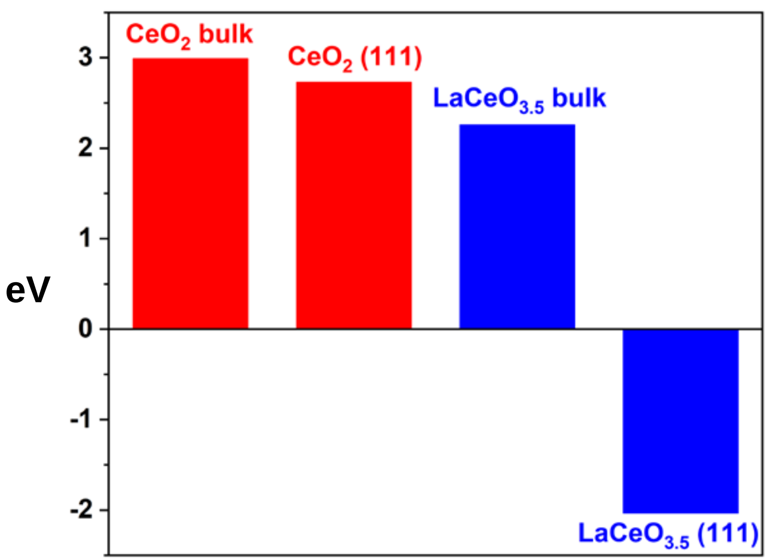
Zhang, Haribal, and Li., Science Advances, 2017 , 3 (8), e1701184

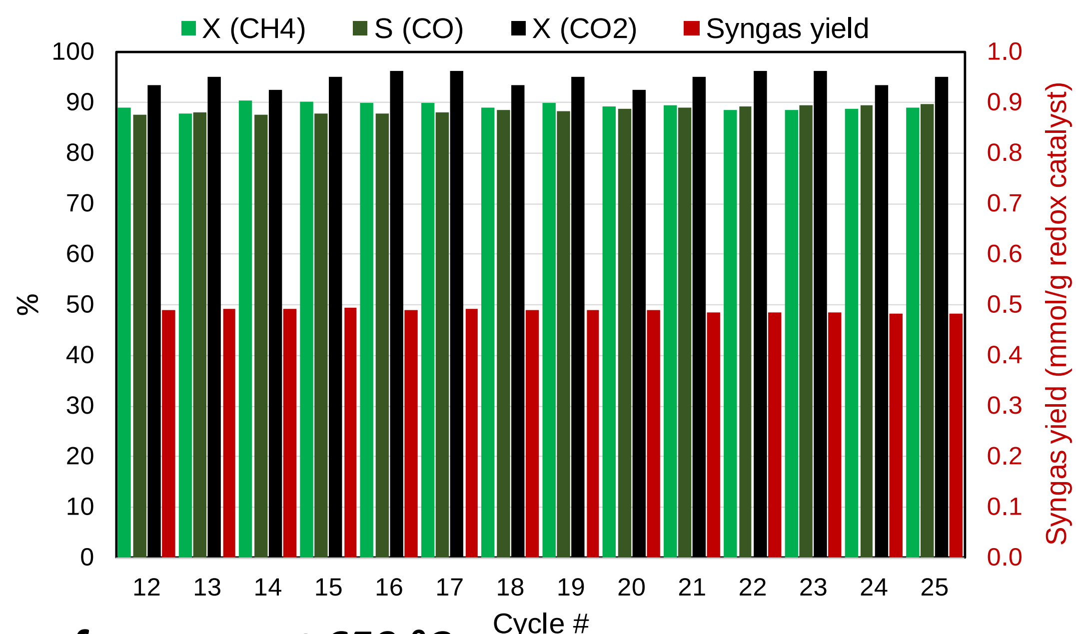
“Low Temperature” HRP Redox Catalyst





Oxygen Vacancy Formation Energy (ΔE_v)





Satisfactory performance at 650 °C

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Project Plan

Research Plan:

Year I. Redox catalyst synthesis, screening and characterization; Preliminary TEA and LCA.

Year II. Stability validation of redox catalysts; Refined TEA and LCA models.

Year III. Redox catalyst demonstration and reactor design; Process scale-up and high fidelity techno-economics.

Key Milestones/Successful Criteria and Timeline:

Q3 **Title: Milestone 2.2: *Redox material down selection*** Select at least 4 redox catalyst with >20% CO_2/PO_x kinetics improvements and/or >40% per cycle CO yield increase vs the $CaO\text{-}SrFeO_3$ reference material.

Q4 **Title: Milestone 3.2 *Redox performance & stability (decision point)*:** Show CO_2 and methane conversions of >85% at temperatures ≤700 °C after 50 cycles.

Q8 **Title: Milestone 5.2 *Large lab-scale performance verification (decision point)*:** Show methane and CO_2 conversions of >85% at temperatures ≤700 °C after 500 cycles in a .75” I.D. packed bed.

Q10 **Title: Milestone 7.1 *Optimized reactor Sizing:*** Report modified reactor sizing based upon TEA optimized catalyst.

Q12 **Title: Milestone 7.2 *Scalable up material validation:*** Report CO_2 and methane conversions of >85% at process optimized temperature and cycle timing for redox material over 500 Cycles for a one pot synthesize catalyst.

Thank you