Field-Scale Testing of the Thermocatalytic Ethylene Production Process Using Ethane and Actual Coal-Fired Flue Gas CO_2

DE-FE0031713

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SOUTHERN RESEARCH

- Founded in 1941
- Private 501(c)(3) non-profit CRO
- Team ~ 400 Divisions - 4
- Discovered 7 FDA approved Cancer drugs
- Sustainable Chemistry and Catalysis – New Processes and catalysts for production of chemicals/fuels

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U.S. Department of Energy

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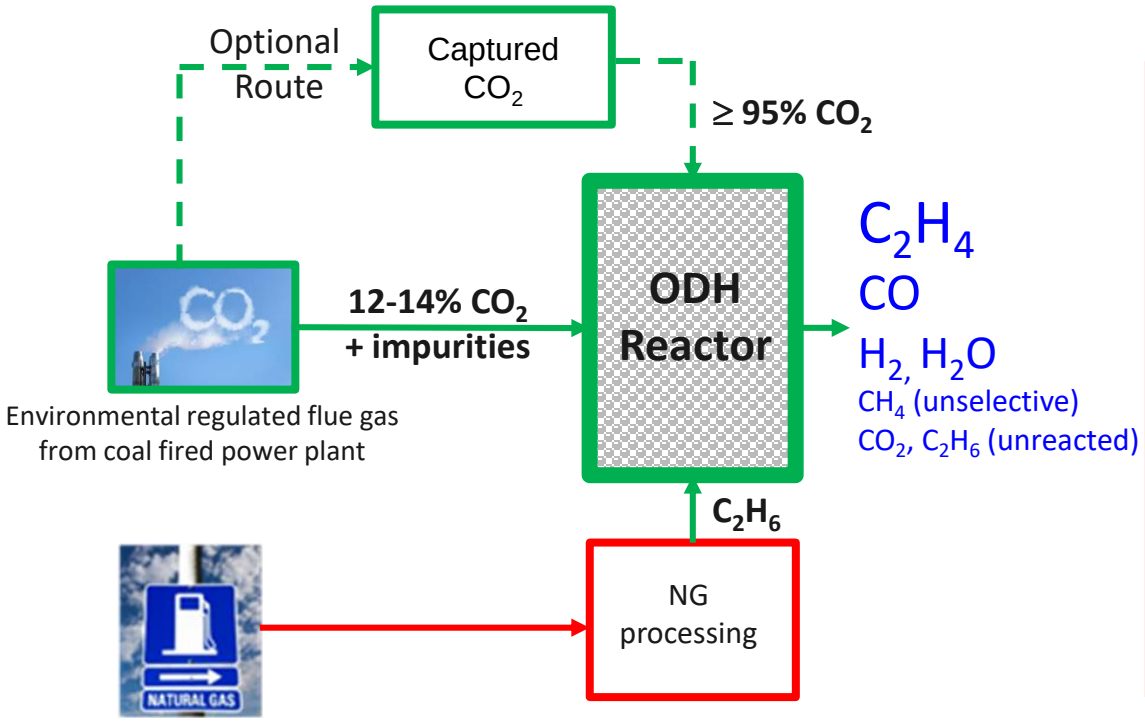
Technology

Thermo-catalytic ethylene production using ethane and CO_2 *(CO_2 ODH)*

Overall reaction: $C_2H_6 + CO_2 = C_2H_4 + CO + H_2O$



Technology originally developed for integration with coal fired utility plant using relevant dilute as well as concentrated CO_2 streams with impurities

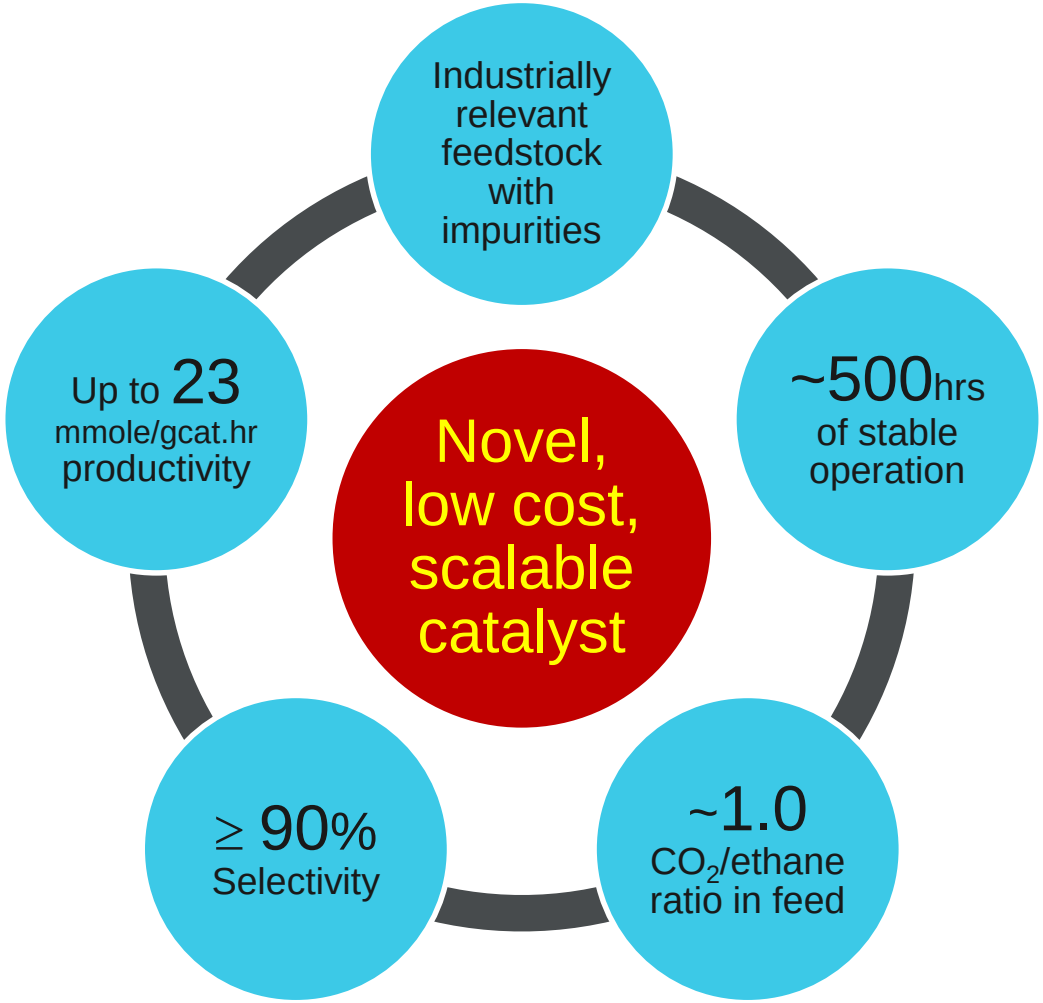
Advantages over *commercial steam cracking*-

- ✓ At least **150°C** lower operating temperature
- ✓ **50%** or more overall GHG emission reduction via direct CO_2 conversion
- ✓ Reduced process footprint due to high reaction selectivity
- ✓ Co-production of CO-rich syngas

Project History

	DE-FE0031713	DE-FE0029570
Status	Ongoing	Completed
Duration	02/2019-01/2021	03/2017-06/2019
Scale	Bench (~100x of Lab scale)	Laboratory
Goals	Long term testing with actual CO_2 streams	Catalyst development & Impurity effect study

Innovation



Catalyst addresses key commercialization issues

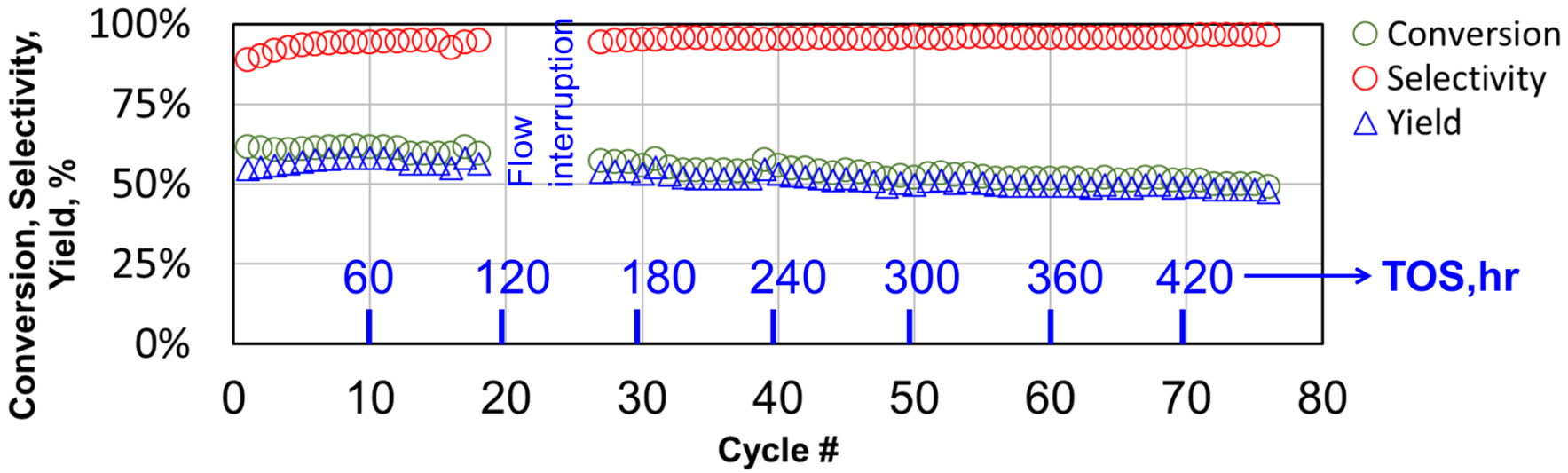
Validation Using Two Relevant CO_2 Concentrations:

FG: Environmentally Regulated Flue Gas (**12-14% CO_2, balance N_2 + impurities**)

CAP: Captured CO_2 **(>95% CO_2, balance N_2)**

Laboratory Scale Results (Contd.)

Long Term Stability



- **Cycle** = 5-7hr continuous run followed by 1hr air regeneration
- **Feed:** CO_2:ethane ~1.5, 80ppm SO_2, 80ppm NO (**FG** case)
- Stable performance during 76-cycle (~500hr) testing.

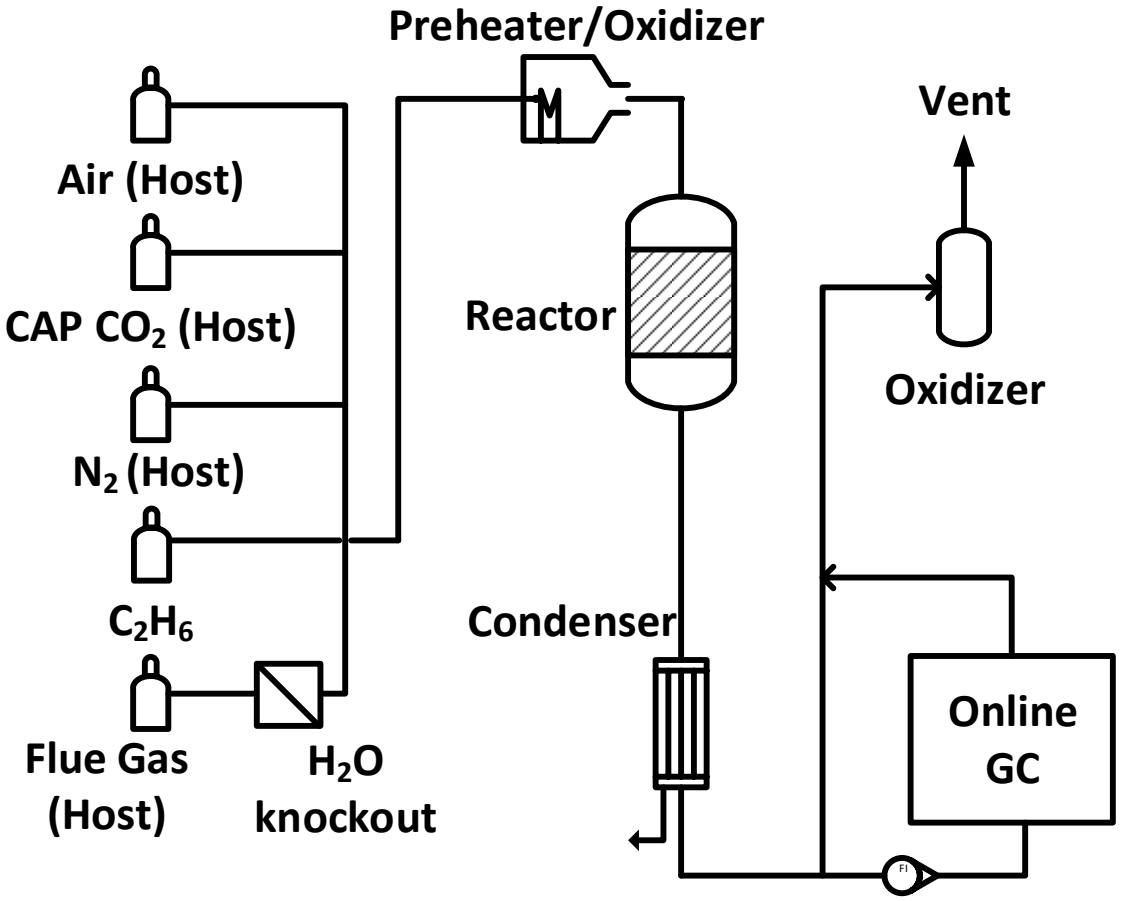
Field Scale Study

Objectives/Test Plan

- National Carbon Capture Center (NCCC), Wilsonville, AL (*Host site)*
- ~100x catalyst scale up from laboratory scale
- Total 2000-hr of total testing using **two actual** CO_2 streams (**FG & CAP**)
- Process simulation to determine post reaction separation and estimation of capital cost
- Skid equipped with O_2 and H_2O knockout

	Actual Composition (vol%)
FG	14% CO_2, 4.5% O_2, N_2+Ar 68.5%, H_2O 13%, SO_2 2.5ppm, NO < 10ppm
CAP	> 99.5% CO_2, balance N_2

Field Scale Study (Contd.)



Process Schematic with H_2O and O_2 knockout

52” x 76” skid enclosure to maintain Class I, Division 2 and NCCC code standards

Acknowledgement

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Disclaimer

Thank you!

Questions/Comments?