

Analysis of Mixed Oxide Based Catalysts under Low Temperature Diesel Combustion Exhaust

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ACEC Tech Team
Low Temperature Test Protocol
For Aftertreatment R&D

Introduction



In response to the 150°C challenge, the Advanced Combustion and Emissions Control (ACEC) Technical Team has developed a standardized method for evaluating powder catalysts in simulated exhaust streams. This method subjects potential catalysts to strenuous hydrothermal conditions and complex exhaust mixtures which can severely affect the performance of even the most promising catalyst.

Here we report on the performance of three mixed-oxide catalysts that have been strictly subjected to the ACEC Low Temperature Diesel Combustion (LTC-D) protocol. These catalysts were chosen based on exceptional low-temperature oxidation activity, relatively high thermal stability (>600°C), and other unique properties. After their activity was determined on their own, small amounts of precious metal was deposited on these catalysts to determine their use as supports.

Protocol Streams

Degreening

[O₂] = 10%
[H₂O] = 5%
[CO₂] = 5%

Pretreatment

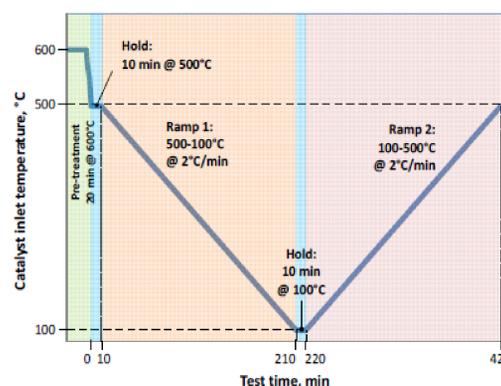
[O₂] = 10%
[H₂O] = 5%
[CO₂] = 5%

Evaluation

[O₂] = 10%
[H₂O] = 5%
[CO₂] = 5%

[H₂] = 400 ppm
[NO] = 100 ppm
[CO] = 2000 ppm

[C₂H₄] = 833 ppm
[C₃H₆] = 333 ppm
[C₃H₈] = 111 ppm



Catalyst was degreened at 700°C for 4 hours prior to evaluation.

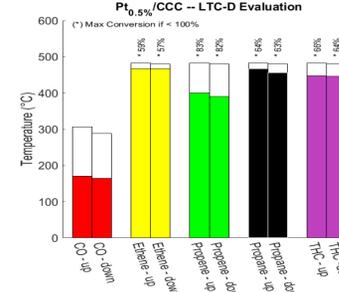
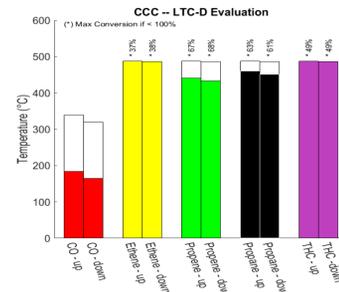
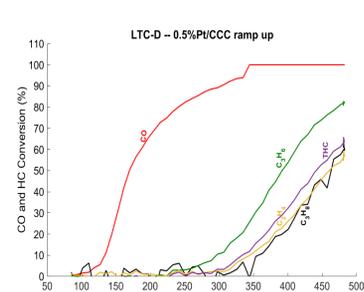
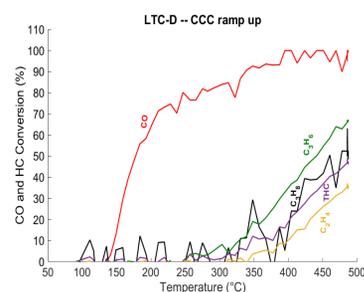
Experiment Details

- 100 mg catalyst
- 200 L g⁻¹hr⁻¹ (333 sccm) flow
- H₂O added via bubbler
- Gas stream mixed via mass flow controller bank.

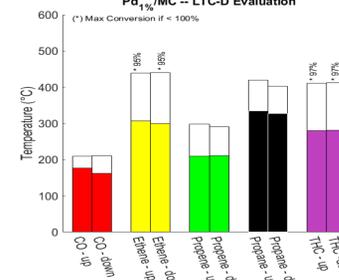
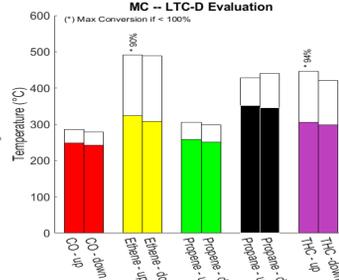
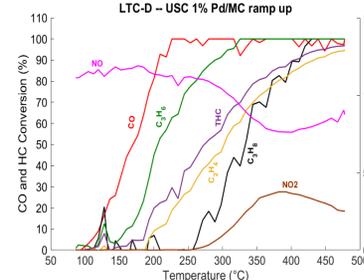
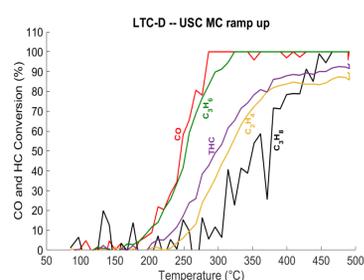
Analyzers

- Gas Chromatograph
- Mass Spectrometer
- NO_x Chemiluminescence Analyzer

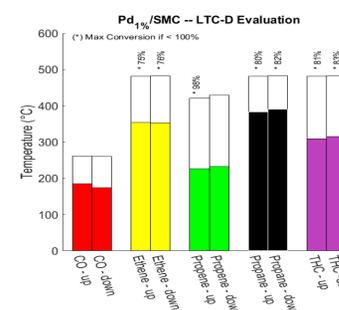
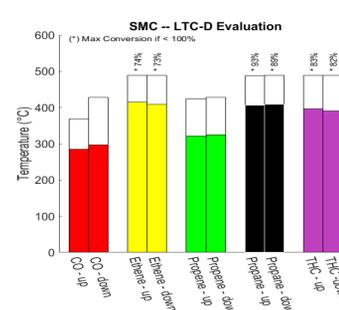
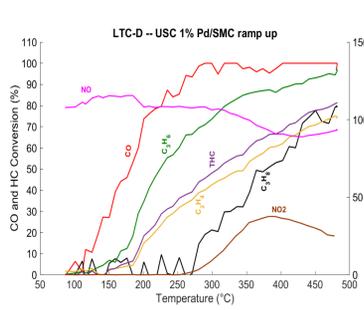
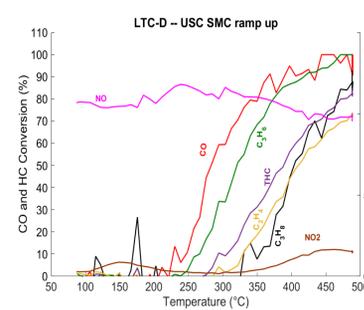
- 29 **Cu**
Copper
63.546
- Mixed-phase CuO, Co₃O₄, CeO₂ (1)
 - 1:5:5 atomic ratio (Cu:Co:Ce)
 - Aqueous co-precipitation synthesis
- 27 **Co**
Cobalt
58.933
- 58 **Ce**
Cerium
140.115
- Resistant to hydrocarbon inhibition w.r.t. CO oxidation
 - Pt deposited by wet impregnation



- 25 **Mn**
Manganese
54.938
- Single phase MnO_x-CeO₂ (2)
 - 1:1 atomic ratio (Mn:Ce)
 - Aqueous co-precipitation synthesis
- 58 **Ce**
Cerium
140.115
- High sulfur tolerance PGM support
 - Pd deposited by impregnation



- 50 **Sn**
Tin
118.71
- Mixed phase SnO₂ and MnO_x-CeO₂ (2)
 - 1:4:5 atomic ratio (Sn:Mn:Ce)
 - Aqueous co-precipitation synthesis
- 25 **Mn**
Manganese
54.938
- 58 **Ce**
Cerium
140.115
- Room temperature CO oxidation activity
 - High sulfur tolerance PGM support
 - Pd deposited by impregnation



Acknowledgements and References

This work was supported by:

- U.S. Department of Energy (DOE): Office of Energy Efficiency and Renewable Energy – Vehicle Technology Program – Program Managers: Gupreet Singh, Ken Howden, Leo Breton
- The South Carolina SmartState Center of Economic Excellence for Strategic Approaches to the Generation of Electricity
- SPARC graduate research grant from University of South Carolina.

(1) A.J. Binder et al. / Angew.Chem. 127 (2015) 13461 –13465
(2) C. Wang et al. / Catalysis Today 258 (2015) 481–486



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