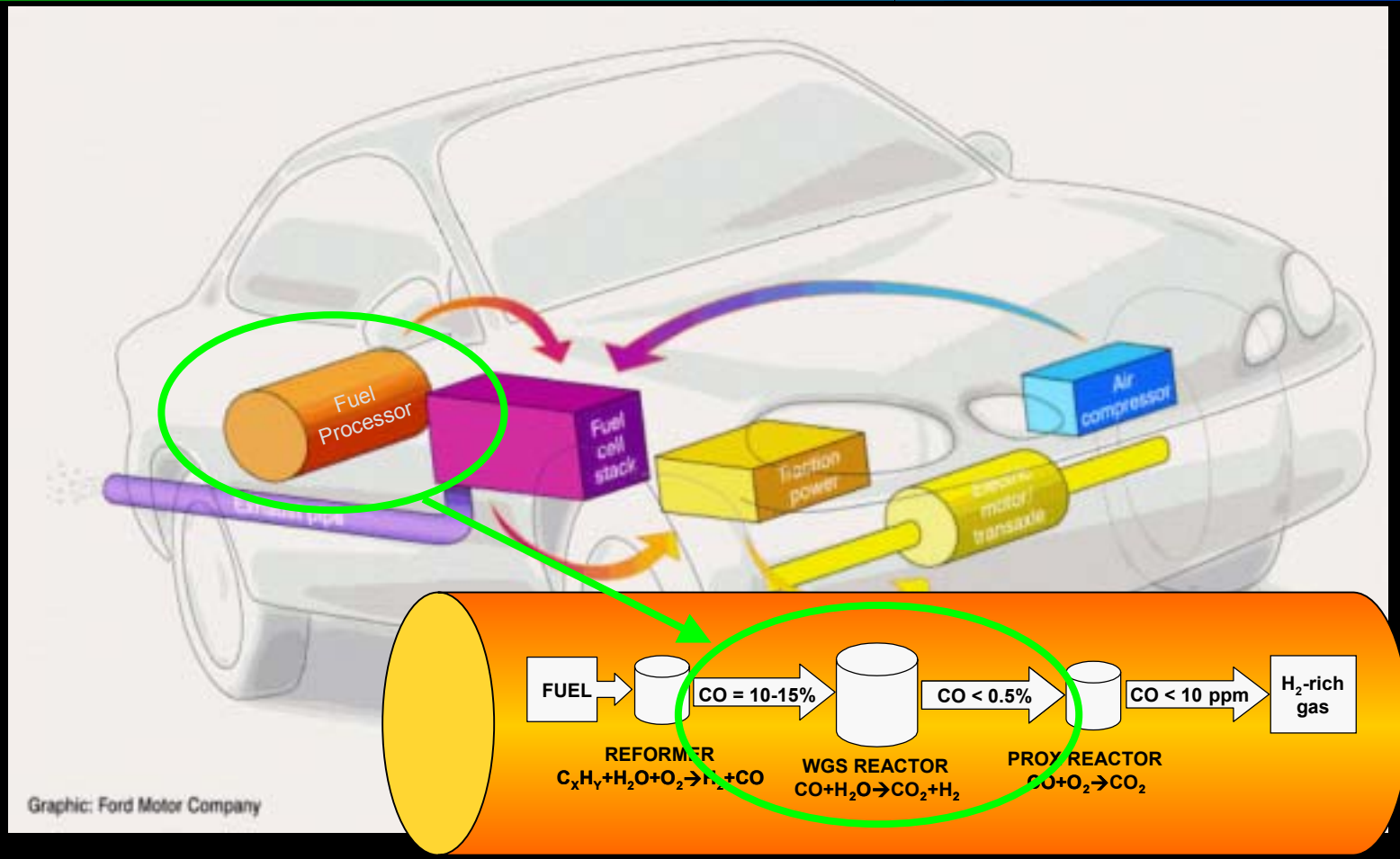
Water Gas Shift Catalysts



Donna Lee Ho

Targets

Water Gas Shift (WGS) Catalysts

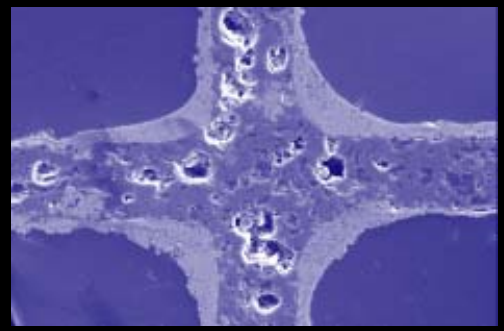
WGS catalysts for reforming Tier II gasoline containing 30 ppm sulfur.

Characteristics	Units	Target	Status
GHSV	Per hour	30,000	20,000-30,000
Exit CO Content	%	<0.5	0.5-1.0
Conversion	%	>90	>90
Hydrogen Selectivity	%	>99	>99
Volume	L/kW_e	<0.10	0.10 - 0.15
Weight	kg/kW_e	<0.10	0.10 - 0.14
Durability	Hours	5,000	200 - TBD
Cost	$\$/kW_e$	<1.00	0.90 – 3.00

Water Gas Shift Catalysts Challenges & Objectives

CHALLENGES

- Thermal Mass
- Sulfur Tolerance
- Cost
- Durability



OBJECTIVES

- Reduce size/weight of reactor while maintaining CO conversion capability
- Develop low-cost, sulfur-tolerant catalysts
- Extend lifetime of catalysts

WGS Catalyst Projects

LABS / UNIVERSITIES

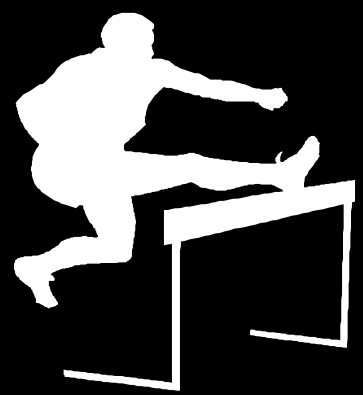
- Argonne National Lab: Alternative WGS Catalyst Development
- University of Michigan (with Catalyte, Union Miniere, Inc., Süd-Chemie, MesoSystems, Ricardo) :
  - Transition Metal Carbide WGS Catalysts
  - Microsystem-Based Fuel Processors for PEM Fuel Cells

INDUSTRY

- NexTech Materials, Ltd. (with Univ of Penn, Süd-Chemie, Catalyte, UTC Fuel Cells): Nanoscale WGS Catalysts
- Nuvera Fuel Cells, Inc. (with Corning, Süd-Chemie,NexTech, STC Catalysts): Advanced Fuel Processor Development for Transportation Fuel Cell Power Systems
- McDermott Technology, Inc. (with NexTech, Catalytica): Multi-Fuel Processor for Fuel Cell Vehicle Applications
- Catalytica Energy Systems, Inc.: Plate-Based Fuel Processing System

Industry Interactions / Technology Transfer

- ANL catalysts are being evaluated by
  - Süd-Chemie
  - HydrogenSource
  - H_2Gen Innovations, Inc.
  - H-Power Enterprises
- ANL catalyst has been used in the prototype of a commercial 5 kW_e natural gas fuel processor
- NexTech catalysts being evaluated by Süd-Chemie, Hydrogen Source, and seven others.
- Univ. of Michigan catalysts are being evaluated by Süd-Chemie, and two others.



Discussion Points

- Base metals (which are lower cost) tend to have lower sulfur tolerance, less stability in air (pyrophoric)
- Some base metals are non-pyrophoric and have higher activity, but long-term stability must be improved.
- Precious metals are non-pyrophoric and may become viable options (if cost can be kept low).
- Transition metal carbides provide high activity and sulfur tolerance.
- Trade-offs between size/weight/cost of WGS and PROX reactors.
- Total “system” perspective is required.