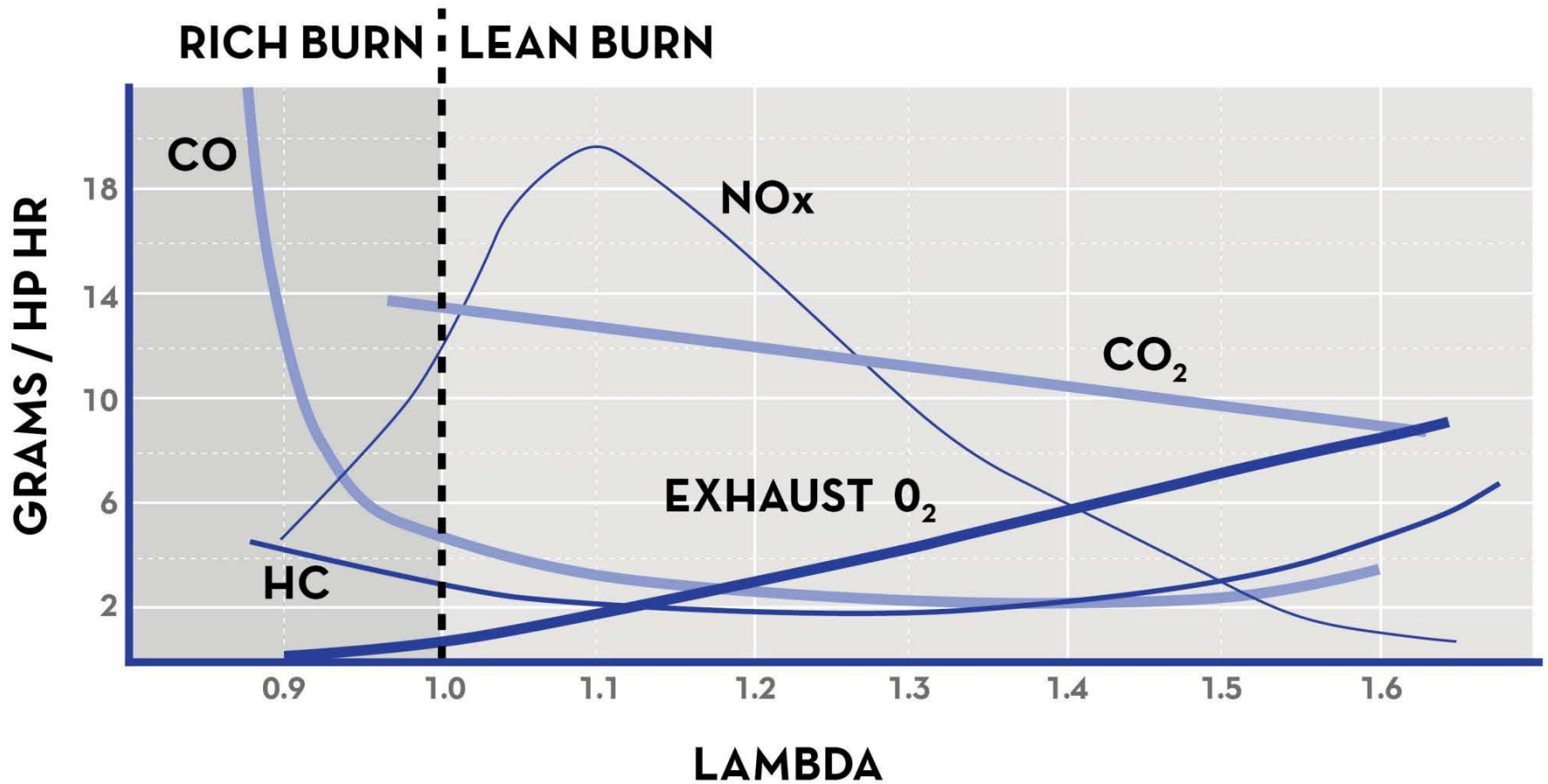


Catalyst Solutions for the MSAPR, NO_x, CO, CH₄,
and VOC's from Natural Gas Engine Exhaust

Dynamic Catalyst Systems



GAS ENGINE EMISSIONS



*Data from Caterpillar Gas engine application and installation guide



Augie DeCapite

SAIT Grad, Chemical Engineering
Power Engineer, Alberta 3rd Class

Over 40 years of catalyst experience in numerous process operations
Sour Gas Processing, Compression, Electrical Generation, Sulfur Plants, Boilers
Petroleum Refining, LPG's, Gasoline, Kerosene, and Diesel
Petrochemicals – PETPAC, Pharmaceuticals – Tylenol, Sunscreen,
Chemicals industry - Ammonia – Nitric Acid

- Supplier of quality catalysts to the oil and gas industry
- Operational Experience of Fluid Catalytic Cracking, Hydro Processing
Catalytic Reforming, Alkylation, Nitric Acid production



Our Manufacturing Partner

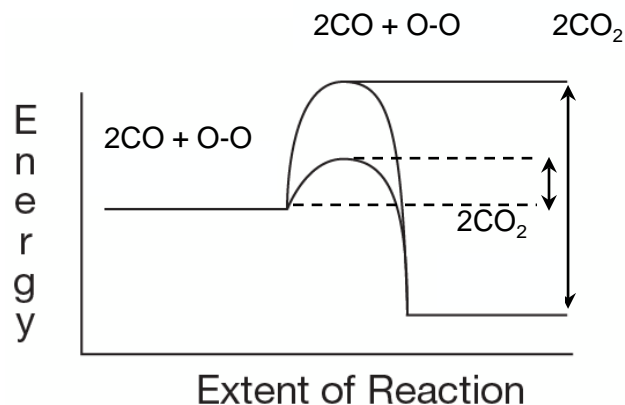


- 40+ years of experience in power plant pollution control
- Superior products at competitive pricing
- ISO 9001: 2008 Certified Manufacture
- Rapid response to customer product needs and technical support
- Employee owned, founded by Larry Campbell, PhD Chemical Engineer
One of the Engelhard R&D team that invented the automotive catalytic converter
- Over 100 man years of leading edge catalyst research and manufacture
- 34 US patents for precious metals catalysis
- Professional and Honest



What is a Catalyst ?

A substance that lowers the activation energy required for a chemical reaction without being consumed by the reaction.



Activation Energy without, 70 Kcal/mole @ 606C

Pt/Al₂O₃ Catalyst, 20 Kcal/mole @ 350C

Requires 1/3 of the activation energy

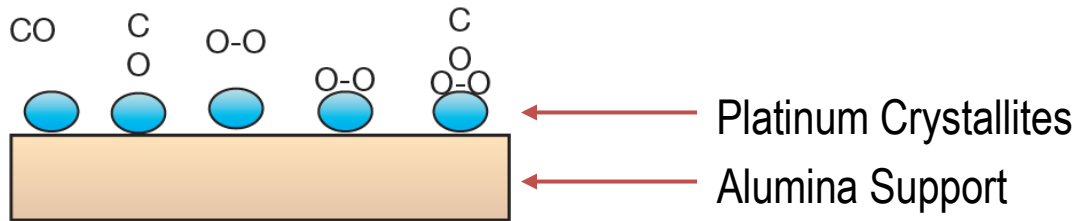


Our Catalyst Components

- Platinum (Pt) – for CO, CH₄, Hydrocarbon oxidation
- Rhodium (Rh) – for Reforming of NO_x back to elemental N₂
- Aluminum Oxide (Al₂O₃) – the surface coat for catalytic metals
- Cerium Oxide (CeO₂) – for oxygen storage
- Zirconium Oxide (ZrO₂) – surface area stabilizer and oxygen storage



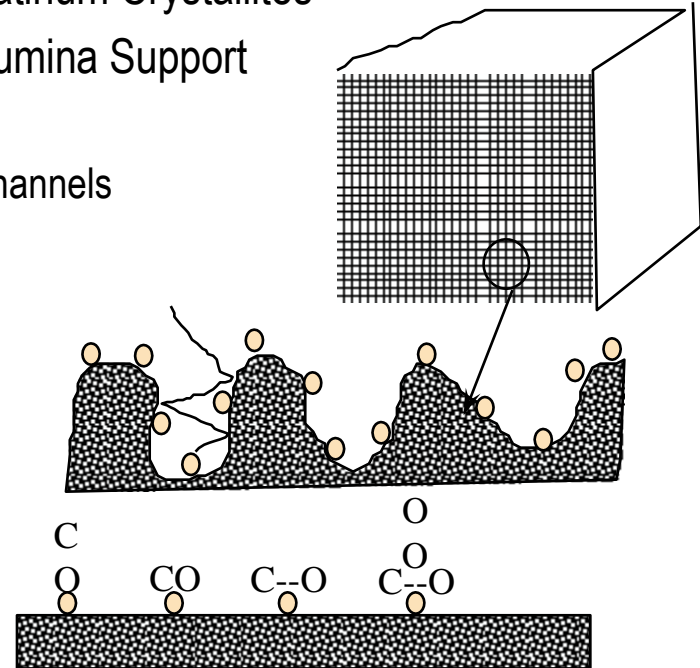
Catalyst Chemistry



1. Gases flow into the honeycomb channels

2. Gases diffuse into porous catalyst sites

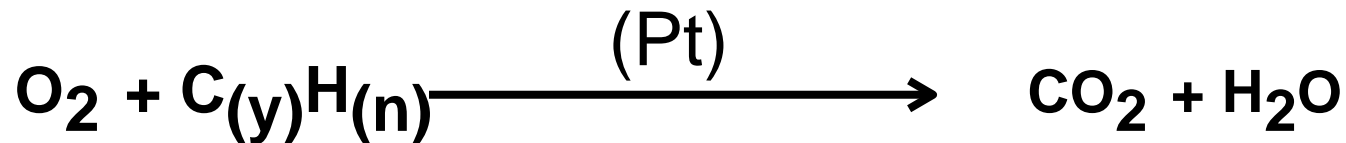
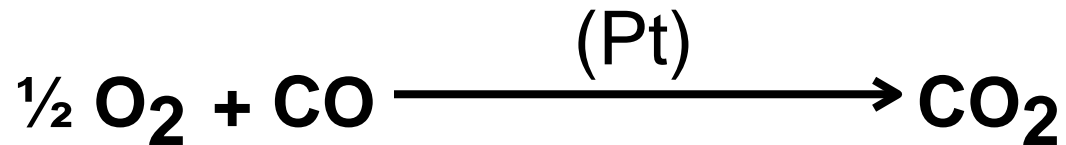
3. Activation involving chemisorption, reaction, de-adsorption of gas molecules



Catalyst Chemistry

First Phase - Oxidation

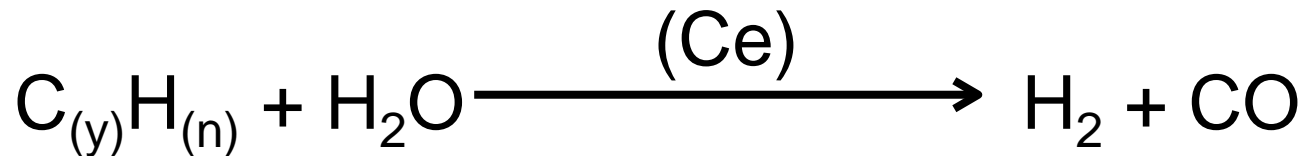
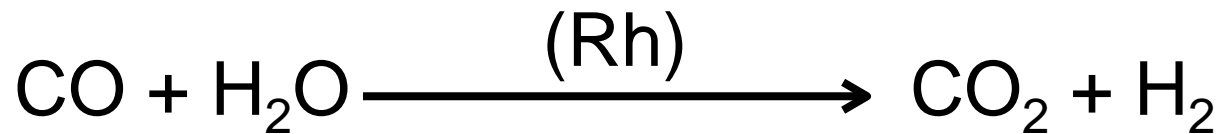
- CO and Hydrocarbons, like CH₄, C₂H₆, C₃H₈.....
- Utilizes the Platinum in the catalyst (Pt) and oxygen (O₂) in the exhaust
- Produces carbon dioxide (CO₂) and water



Catalyst Chemistry

Second Phase – Reforming

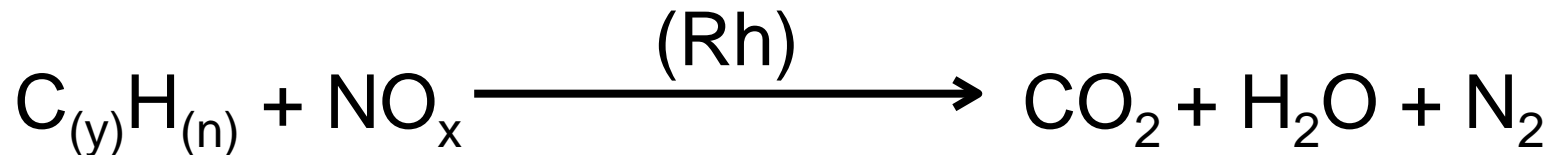
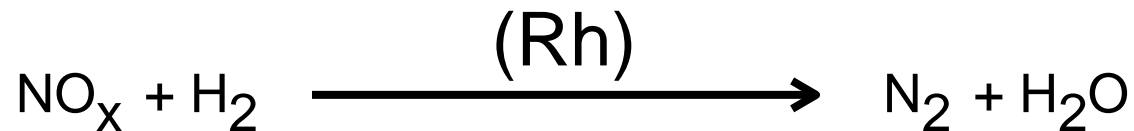
- Utilizes Rhodium (Rh) and Cerium (Ce) catalyst
- Produces Elemental Hydrogen (H₂) and Carbon Dioxide (CO₂)



Catalyst Chemistry

Third Phase – Reduction

- Converts 95% to 99% NO_x back to elemental nitrogen and water
- Utilizes the Rhodium (Rh) in the catalyst
- Consumes Hydrogen Produced in the previous Reforming Reaction



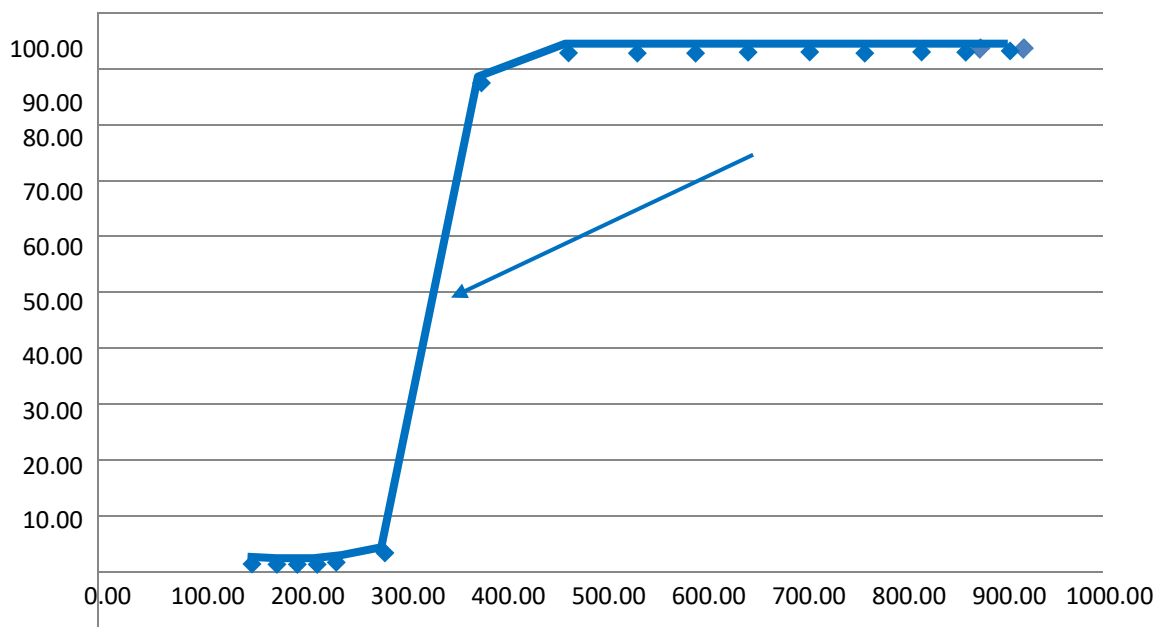
Catalytic System Design

- 1) Temperature
- 2) Flow Rate
- 3) Allowable Pressure Drop = Cells per Square Inch
- 4) Duct Diameter, Dimensions (Area)
- 5) Destruction Efficiency Requirements for NO_x, CO, VOC
- 6) Geometry, round, rectangular, hexagonal



Catalyst Chemistry

Performance Curve For
% CO Conversion vs Temperature Degree C



Light off temperature
(Typically 350C = 662F)



Catalyst Limitations

- Temperature
 - Greater than $677^{\circ}\text{C} = 1250\text{-}1300\text{F}$
 - Sintering of Al_2O_3 , encapsulates the active sites and decreases catalysts life
 - Lower than $315^{\circ}\text{C} = 600\text{F}$
 - Activation energy is too low, reduced efficiency
 - Pore diffusion and kinetics become limited
- Poisoning agents
 - P, Hg, Pb, As, S, Oil and Glycol carry over
 - High amounts of particulate matter, dust, dirt, soot



Applications, Emission Control For:

Exhaust Gas from Stationary Engines



Exhaust from Gas Turbines Plants



Quality Assurance

- Implement internal control and monitoring to assure process consistency and provide data for process improvement.
- Technical and engineering expertise to assist clients in improving product performance.
- We deliver a product which meets or exceeds our customer's specifications and expectations in a timely manner.



Quality Assurance

- Highly Trained Personnel
- Strictly defined production procedures
- 100% inspection of all components at each step
- All production steps and Materials are defined on Production Traveler
- Every element is engraved with the production record, gasket wrapped on the circumference to prevent bypassing, has an acorn nut welded on for ease of installation.



Client Services

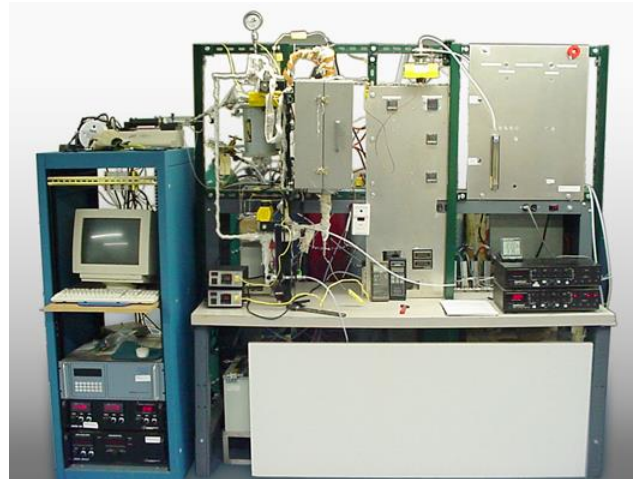
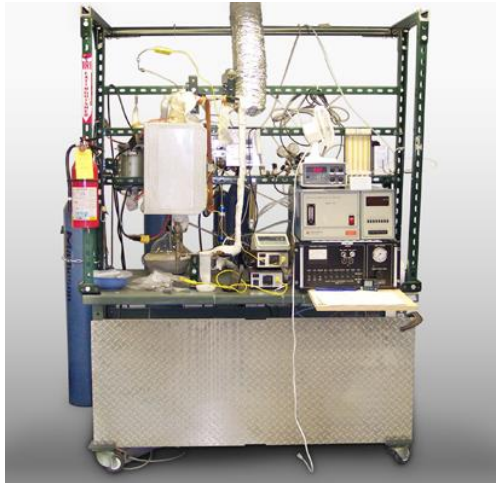
- Diagnostic and post-mortem analysis of used catalyst
- Chemical and physical characterization of deactivation mechanisms
- Regeneration procedures and catalyst protection alternatives
- **Precious metals reclamation \$ from spent catalysts**



Diagnostic Analysis

Computer interfaced gas phase catalyst testing reactors.

With NO_x, hydrocarbon, CO, O₂, H₂, SO₂, H₂S, and CO₂ detectors



Diagnostic Analysis

- Gas Chromatography
- FTIR Analysis (EPA standard)
- GC Mass Spectrometry
- High Pressure Liquid Chromatography



Diagnostic Analysis

Thermal gravimetric analyzer for sorption studies



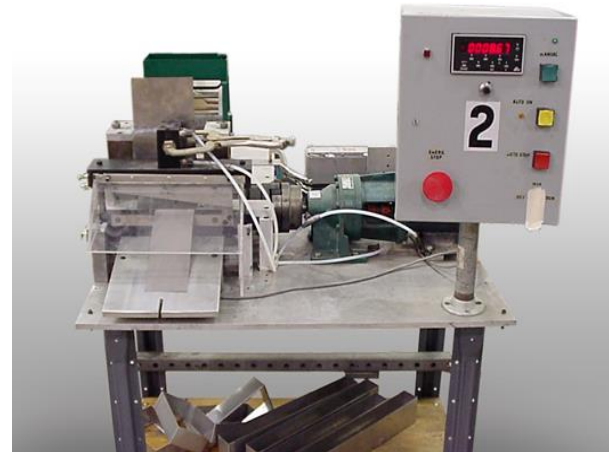
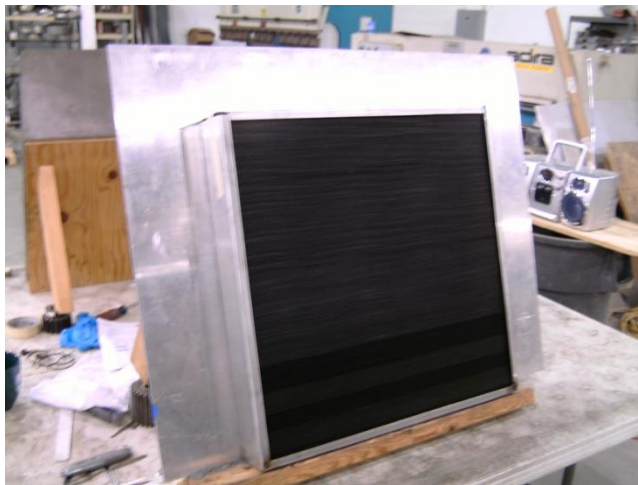
Auto sorb analyzer for surface area, pore size distribution and chemisorption



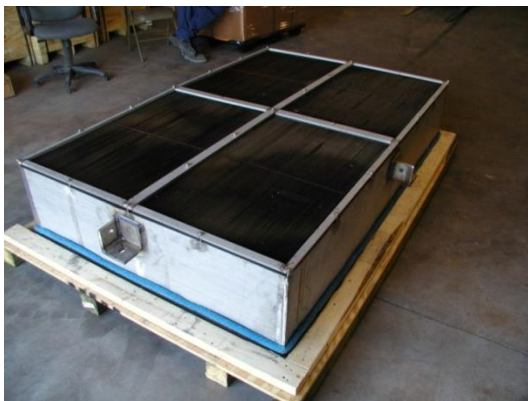
Product Manufacturing

Metal honeycomb substrates are fabricated using automated precision corrugating equipment:

- From $\frac{3}{4}$ " up to 6" deep
- Cell densities ranging from 16 cpsi up to 700 cpsi.



We can fabricate our catalyst in any shape and size

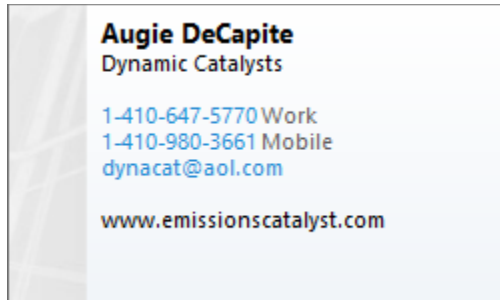


Clients, Canada and USA

Tourmaline-Comp Tech FSJ
Compass Compression FSJ
Cenovus – Vortex AB
Keyera-Vortex AB
ARC Resources-CJC AB
DCP Midstream Services
Devon Gas Services
MidCon Compression
Compressor Systems, Inc.
Energy Transfer
Kinder Morgan

West Texas Gas
Targa Resources
Mark West
XTO Energy
Pioneer Natural Resources
Xterran
Anadarko Petroleum
Highmount Exploration
Hoover Energy
EOG Resources
TC Energy – Vortex AB

For more information or a quote,
please contact



Dynamic Catalysts Inc.