REINHOLD ENVIRONMENTAL ®

2022 Reinhold/PCUG Round Table Presentation

Hosted by Duke Energy in the Charlotte Sheraton/Le Meridien Hotel, Charlotte, NC on June 27-28, 2022

CORMETECH
RELIABILITY. DELIVERED.

Gas Turbine Operation Improvement with Multi-Emission Catalyst

Reinhold

June 2022

Multi-Emission Catalyst

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Capable of NOx, CO and VOC Reduction in 1 Layer

Multi-Emission Catalyst

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Can Multi-Emission Catalyst be used?

Vertical

Add Oxidation

Fit in the Reactor

Lower Pressure Loss

Horizontal

Multi-Emission Catalyst

CORMETECH
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Can Multi-Emission Catalyst be used?

Vertical

Add Oxidation

Fit in the Reactor

Lower Pressure Loss

Yes…

Horizontal

Agenda

- Gas Turbine Concerns
- Multi-Emission Catalyst
- Evaluating System
- Case Study A
  - Reducing Backend Fouling
- Case Study B
  - Lower Partial Load
- Case Study C
  - Startup Emissions
- New Technology

Gas Turbine Concerns

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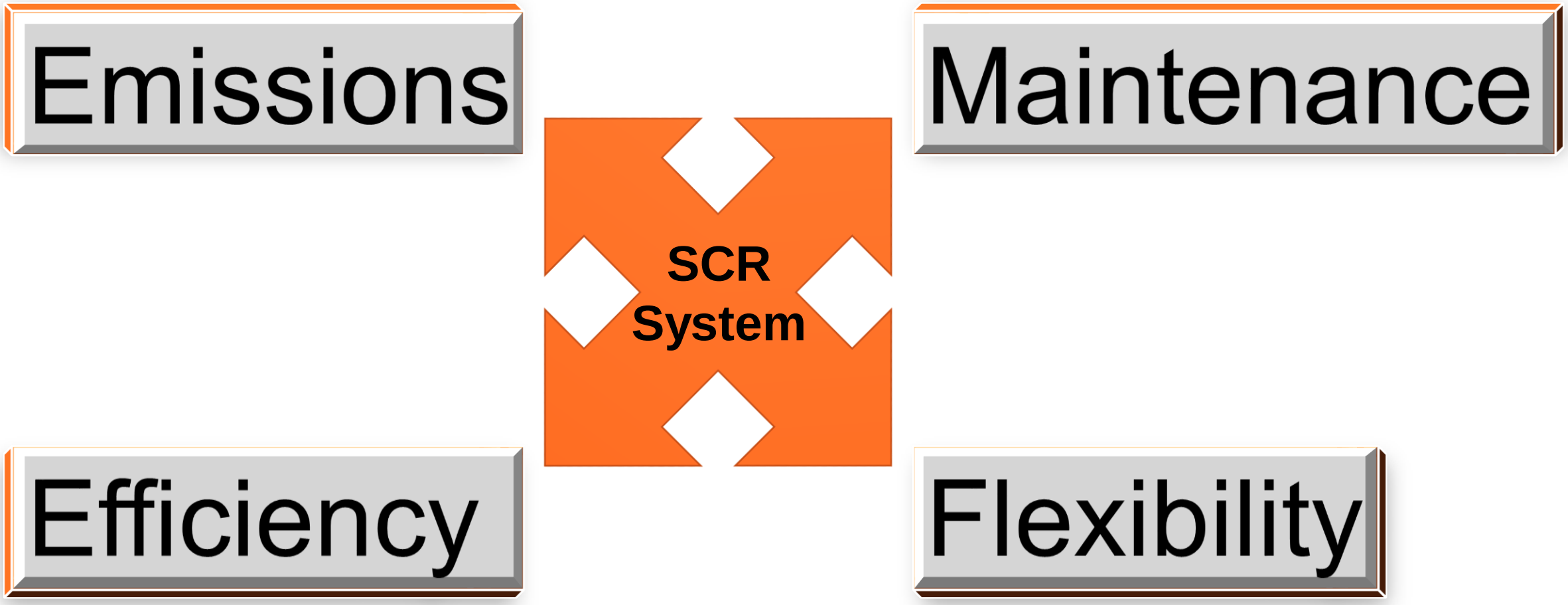

Gas Turbine Concerns

- NOx Reduction
  - Alternate Fuels (Hydrogen / Ammonia)
  - Alternate Operating Scenarios (H_2O Inject)
  - Reagent Vaporization Sizing and Grid Design
- Reagent Slip
  - Unreacted Reagent at Stack
- CO Reduction
  - Oxidation Catalyst
- VOC Reduction
  - Oxidation Catalyst
- Other Concerns
  - Yellow Plume (NO2)
  - Particulate

Gas Turbine Concerns

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- Turbine Back Pressure
- Assumes Historical Price of $3/mmBTU
  - 25mmH2O (1inH2O) ≈ $50,000 per year
- Current $6-9/mmBTU June 2022 alone
  - 25mmH2O (1inH2O) ≈ >$100,000 per year

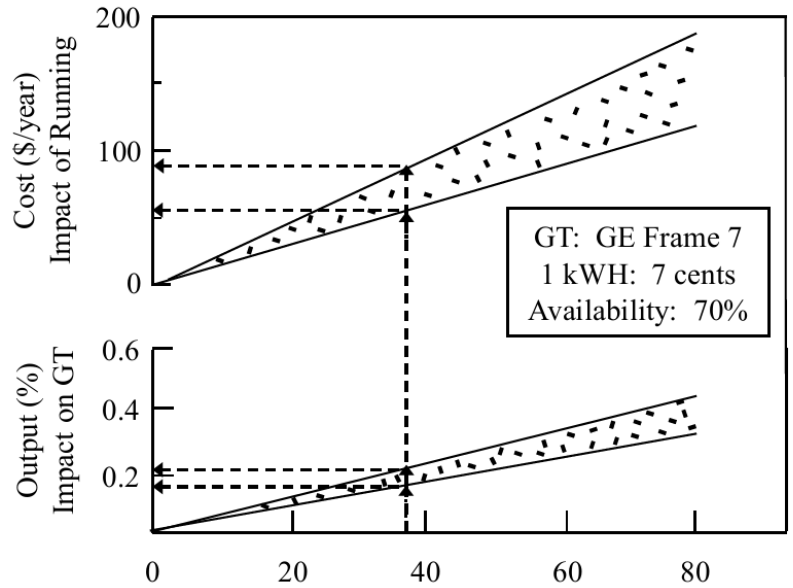

Chart By Environex, Inc.

Efficiency

Gas Turbine Concerns

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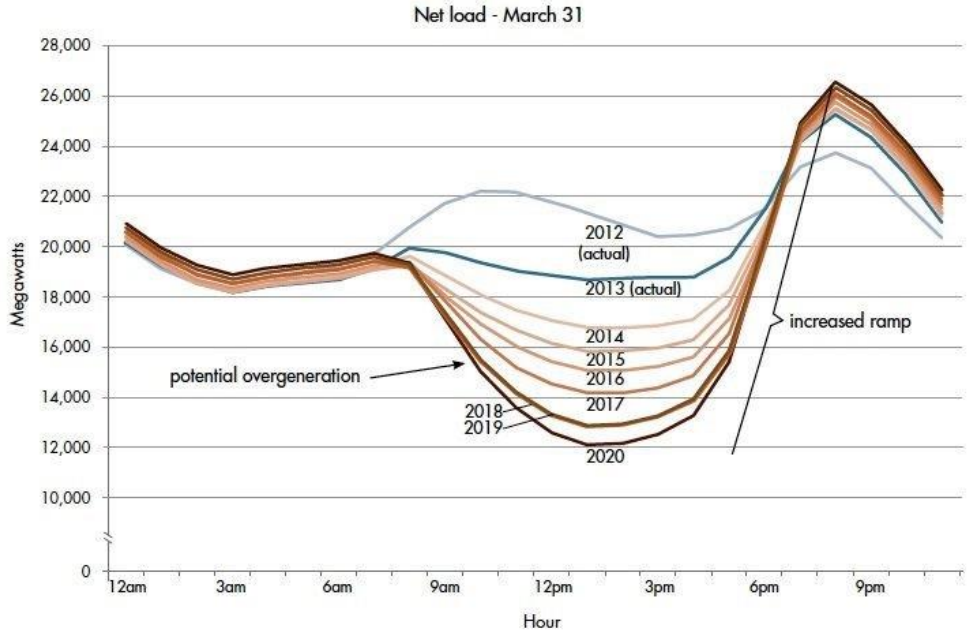
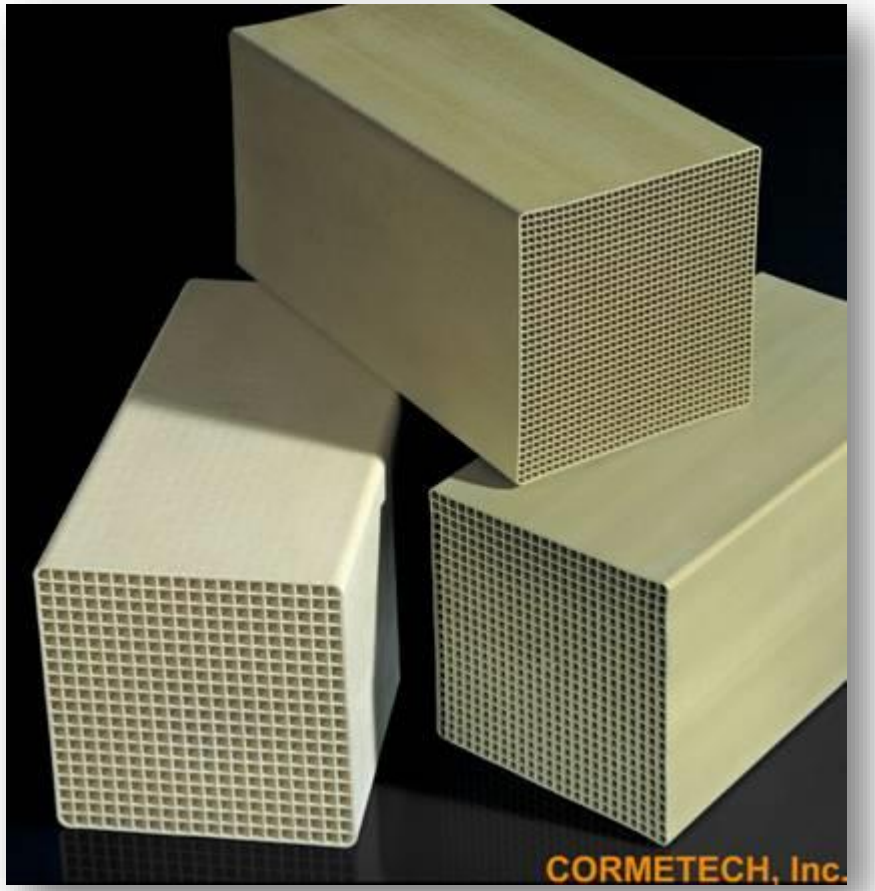
- Catalyst Maintenance
  - Cleaning
  - Testing
  - Repair
- System Maintenance
  - Injection Grid Cleaning
  - Vaporizer Cleaning
  - Fan Maintenance
- HRSG Maintenance
  - Finned Tube Cleaning
  - Downstream Fouling

Gas Turbine Concerns

- Low Load Operation
  - Higher CO Emissions
  - Higher VOC Emissions
  - Higher NO2 Emissions
- Frequent Startup Operation
  - Higher CO Emissions
  - Higher VOC Emissions
- Hydrogen / Ammonia Firing
  - Higher NOx Emissions (potentially)

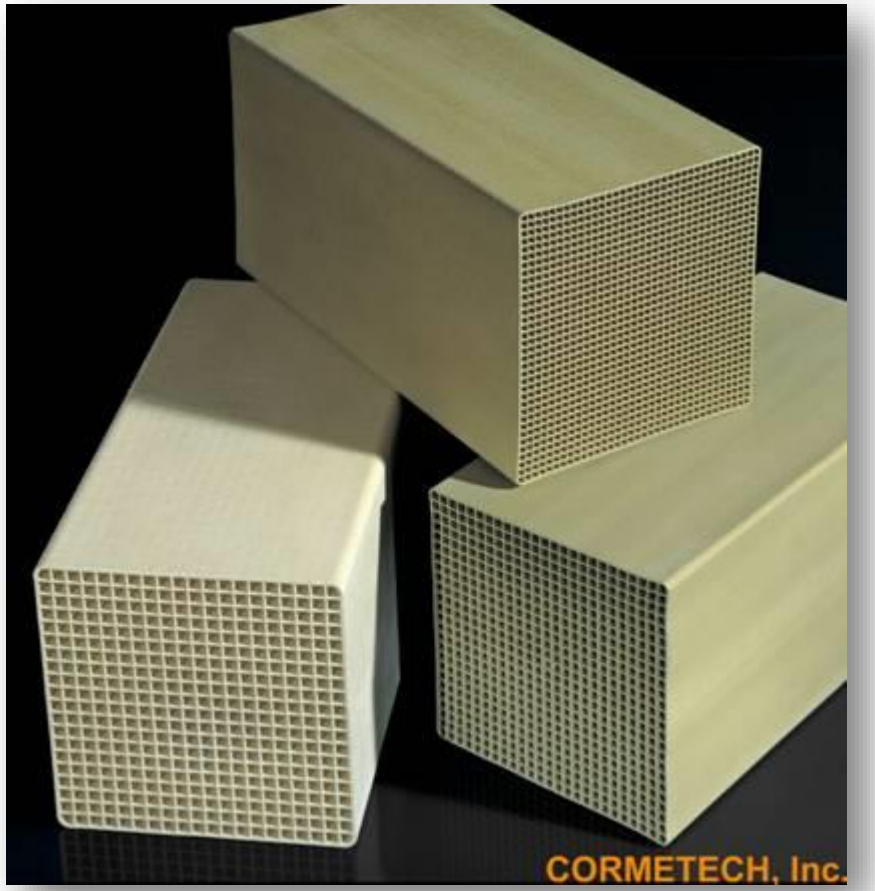


Multi-Emission Catalyst



- **Traditional SCR Catalyst**
  - Titania Substrate
  - Catalytic Metals
    - Vanadium
    - Tungsten
- **Traditional CO Catalyst**
  - Titania or Alumina Substrate
  - Catalytic Metals
    - Platinum
    - Palladium

Multi-Emission Catalyst



CORMETECH METEOR™

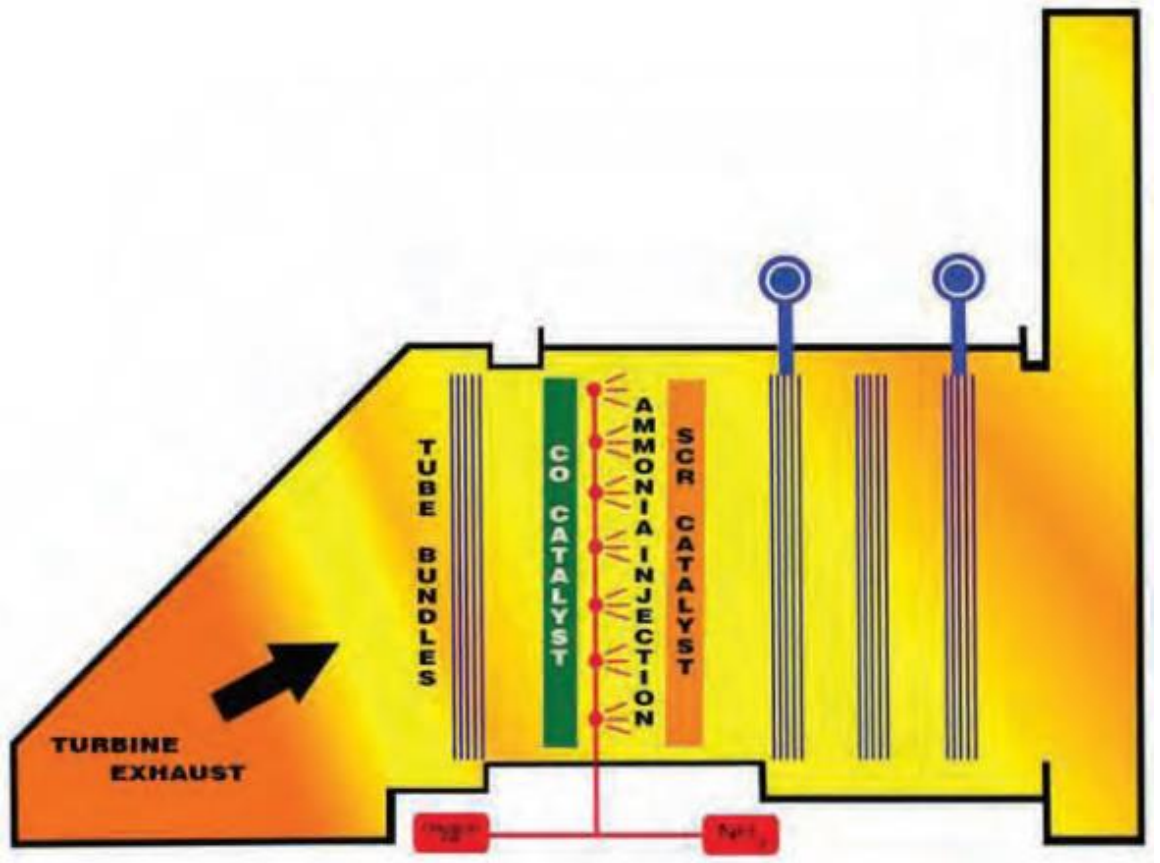
- **Titania Substrate**
- **Catalytic Metals**
  - Vanadium
  - Tungsten
  - Palladium
  - Platinum

Multi-Emission Catalyst

CORMETECH METEOR™

Layout Benefits

- Smaller Footprint
- One Catalyst to Manage
- Reduce Back Pressure



Multi-Emission Catalyst

CORMETECH METEOR™

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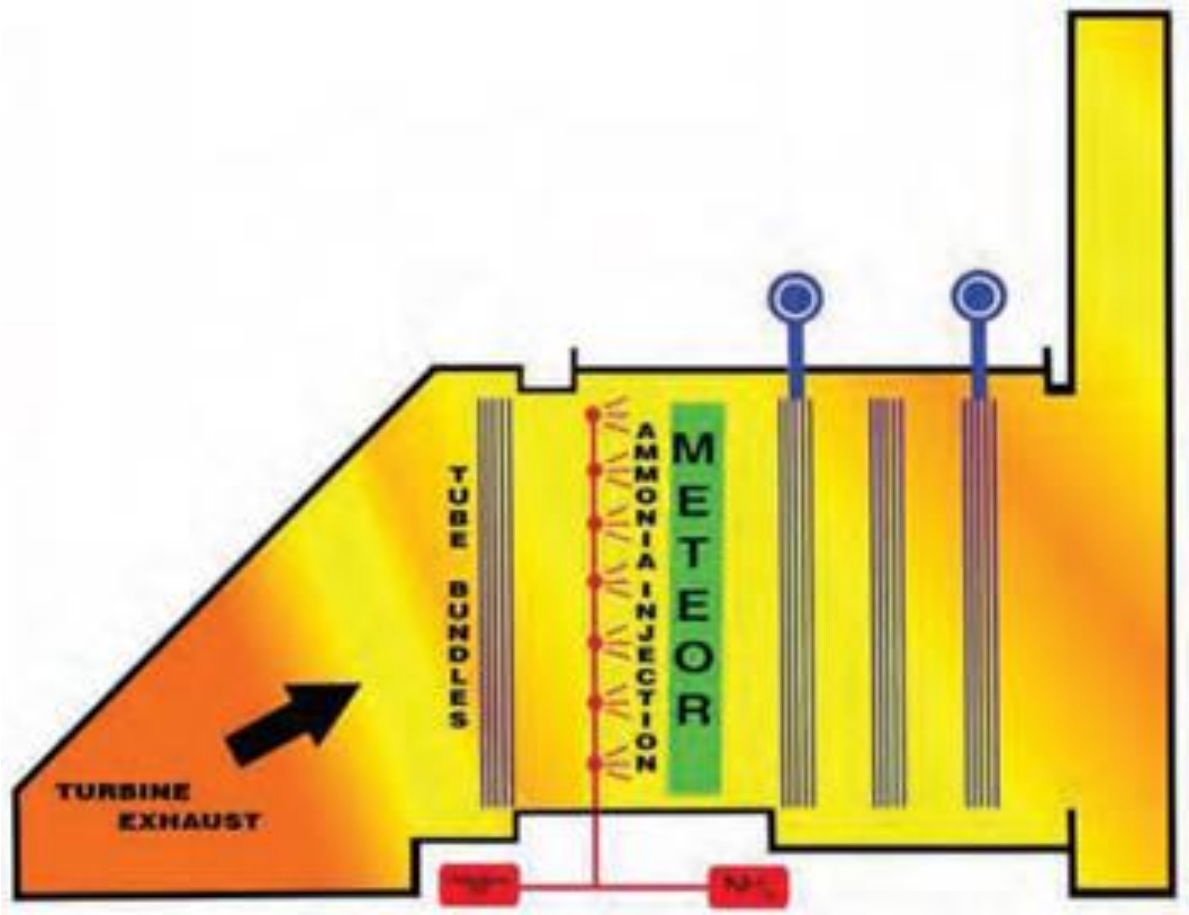

Multi-Emission Catalyst

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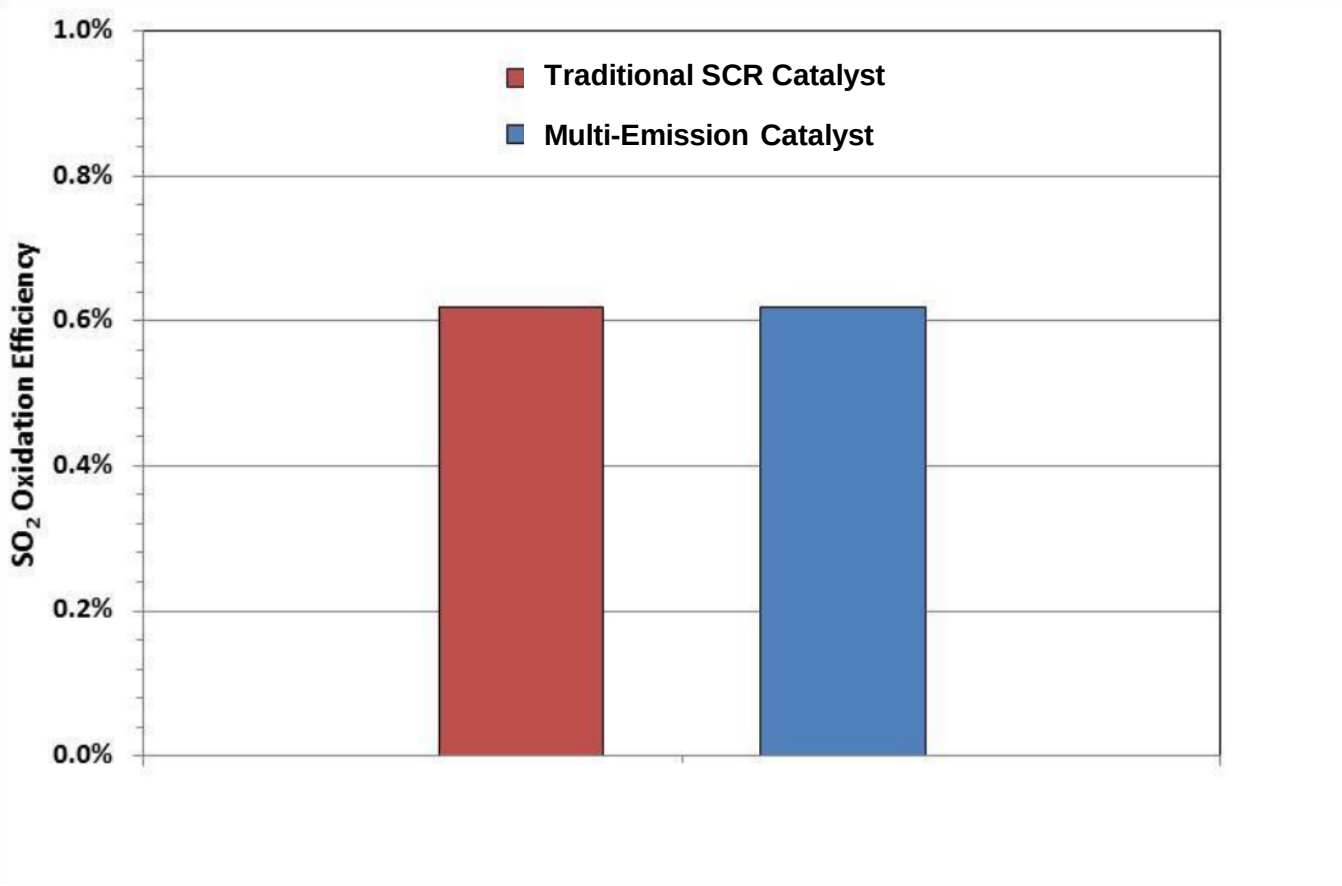
CORMETECH METEOR™

Sulfur Resistant

Low SO2 Oxidation

Eliminate NO Oxidation



Evaluating System

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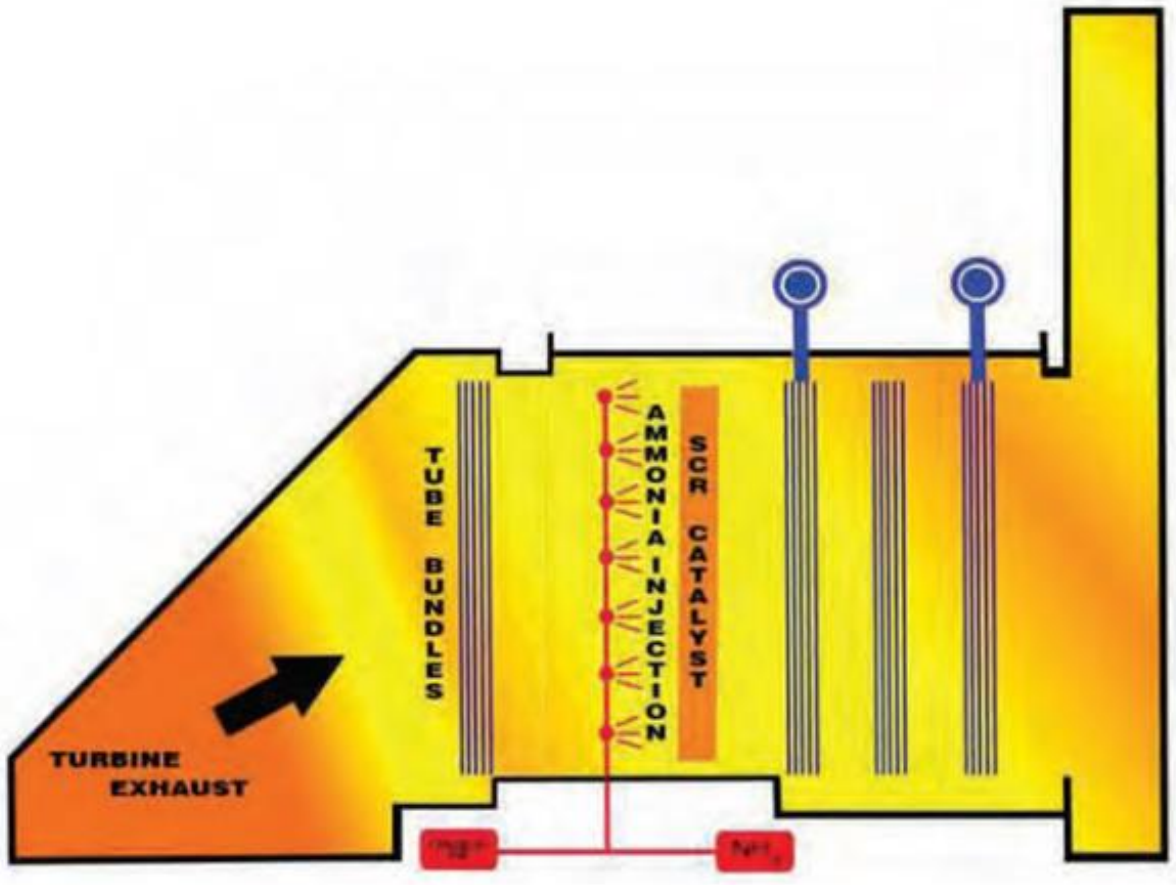
Question:

Do we have to modify our system?



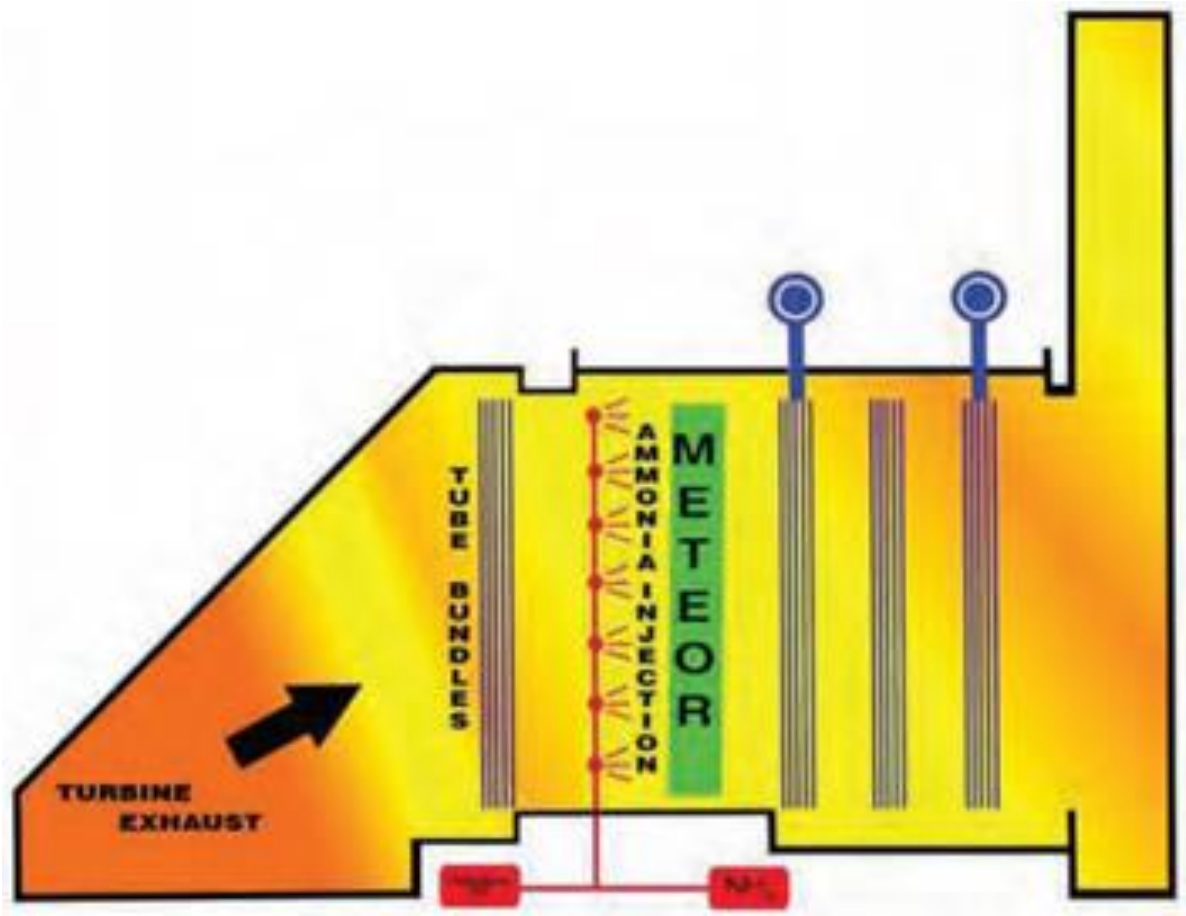
Evaluating System

Question:

Do we have to modify our system?

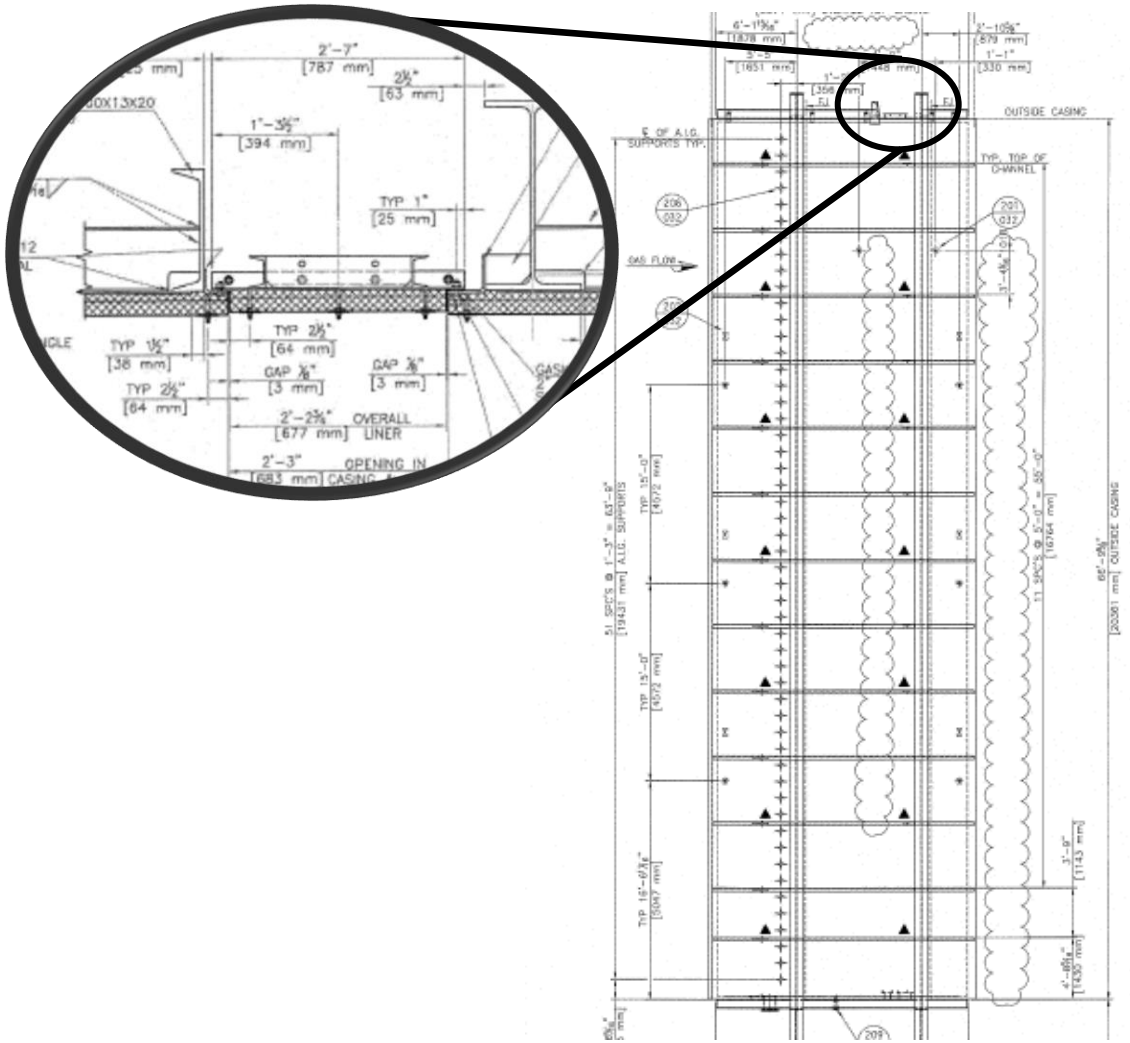
No..

Multi-Emission Catalyst Replaces SCR Catalyst



Evaluating System

- Commonly No CO Catalyst
- CO Cavity Without Frame
- Multi-Emission Catalyst Fits in SCR Catalyst Frame
- Review SCR Frame
- Loading Hatch is Critical



Evaluating System

CORMETECH ELITE™

- Modern Catalyst Design
- Highly Flexible Module Size
- Minimizes Pressure Loss
- Increased Surface Area

Evaluating System

CORMETECH ELITE™

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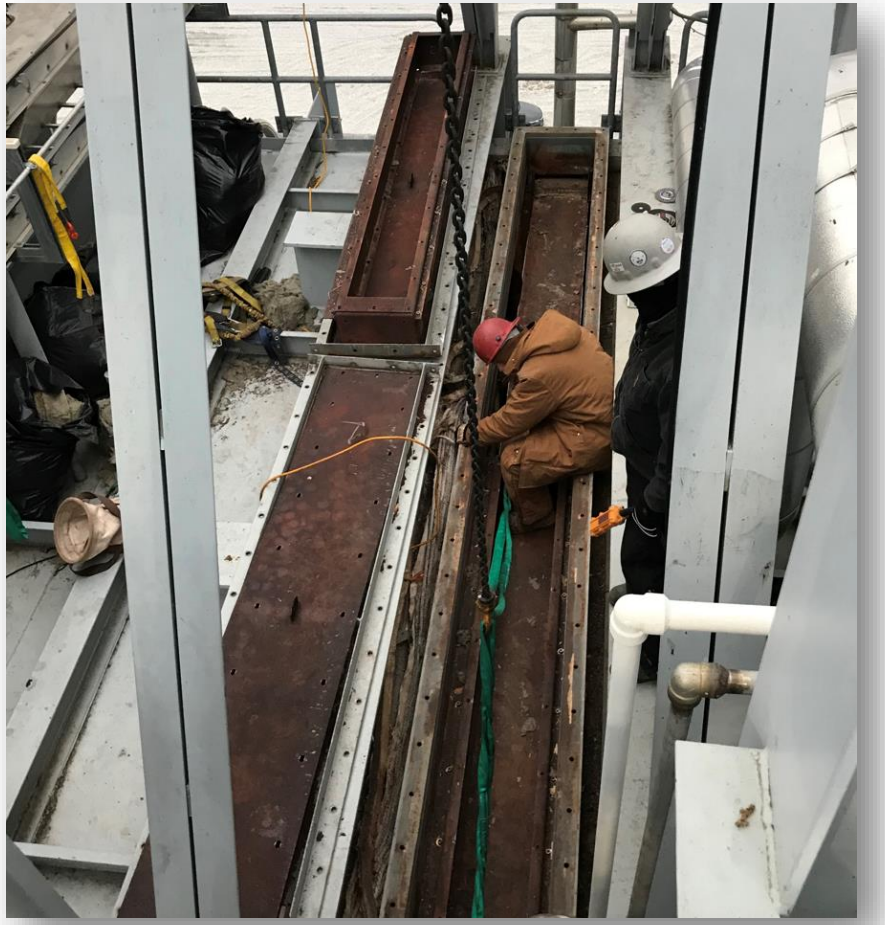
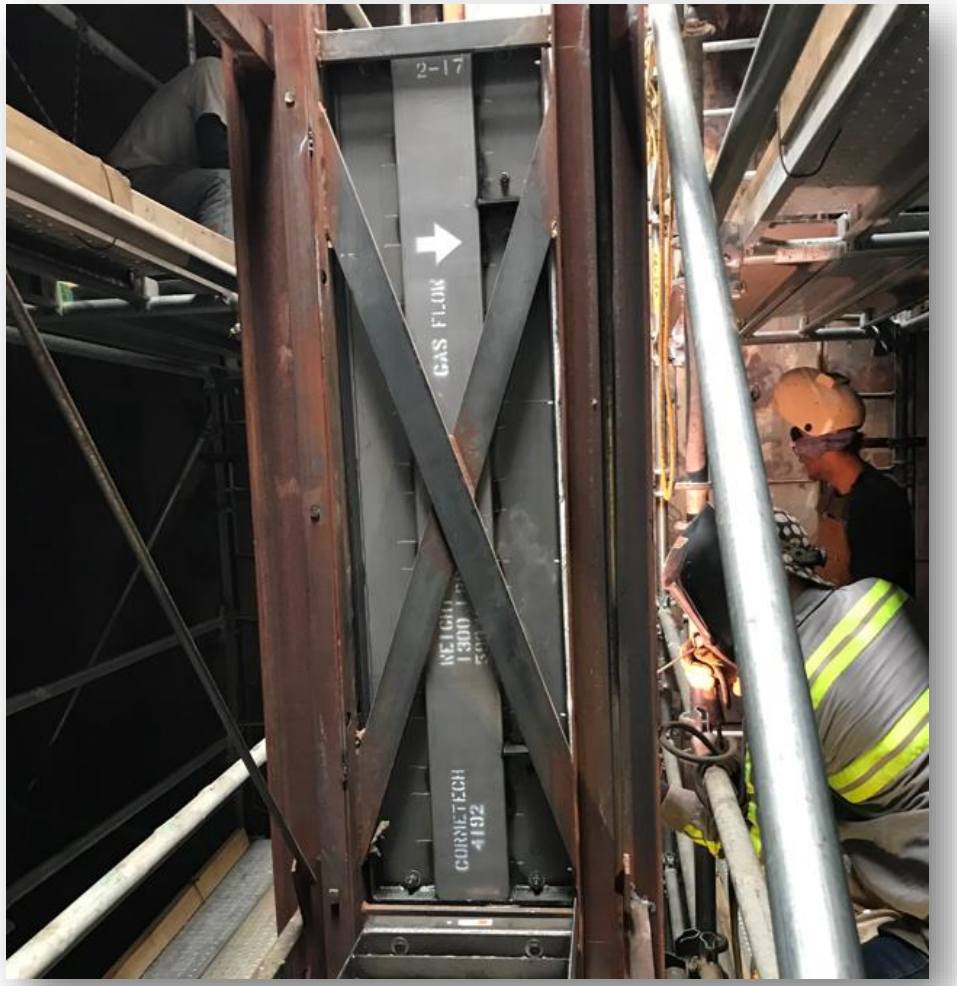


Evaluating System

CORMETECH ELITE™

- 16in Module Depth
- 0.5inH2O Pressure Loss



Evaluating System

CORMETECH
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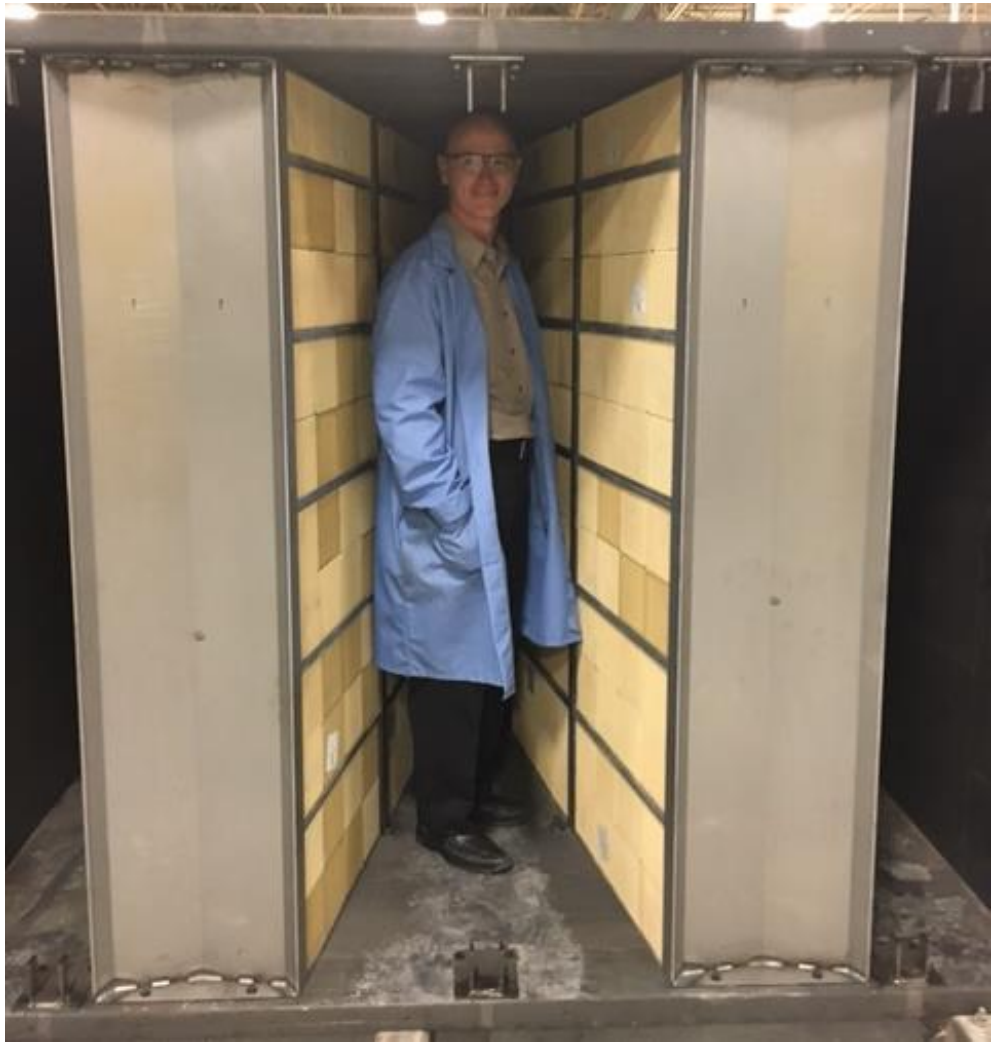
CORMETECH ELITE™

Did I Mention Highly Flexible Module Size?

- 80in Module Depth
- 6.7inH2O Pressure Loss
  - More than 60% lower dP than conv module



Evaluating System

CORMETECH
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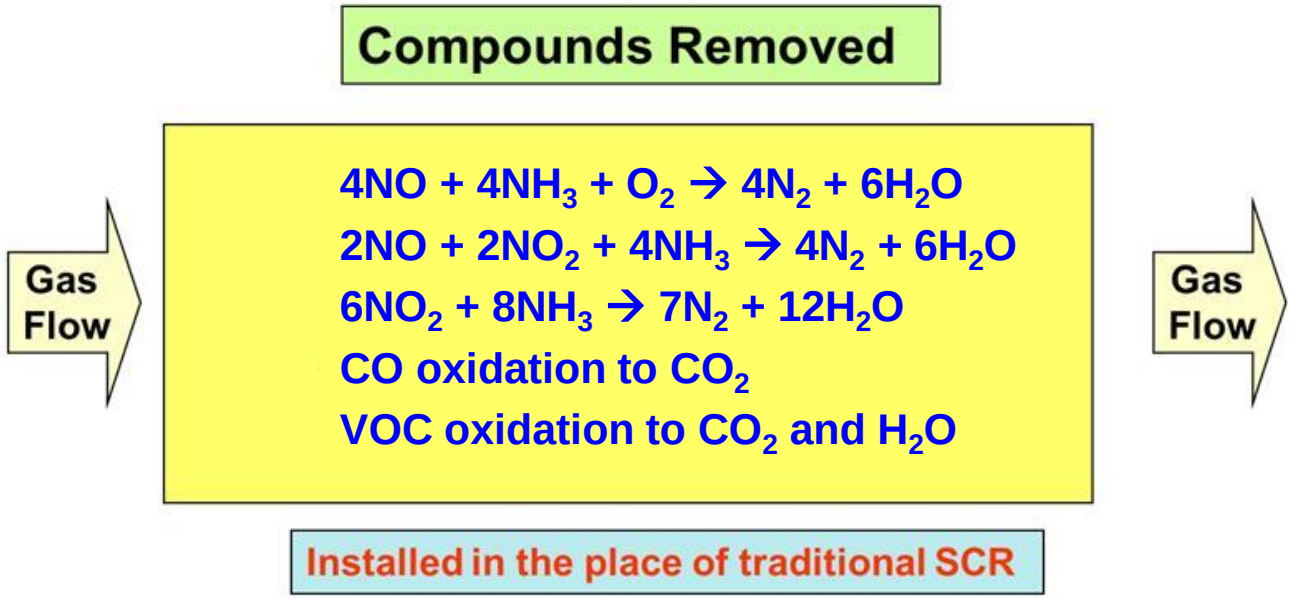
Question:

What Performance Can Be Expected?



Evaluating System

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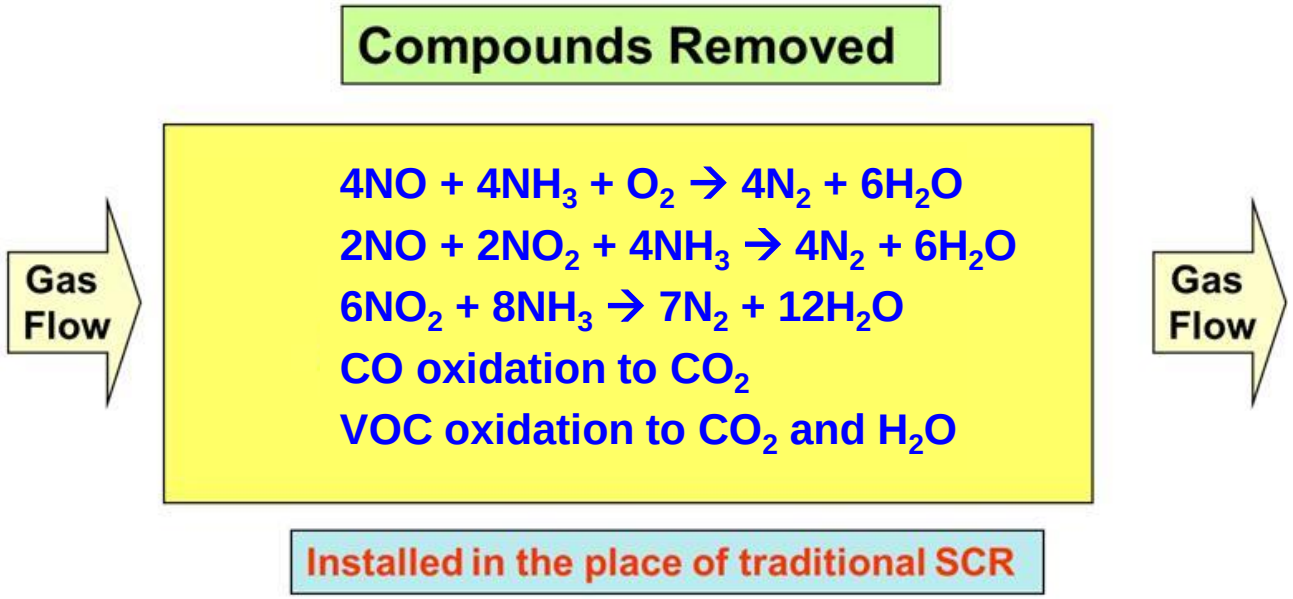
Question:

What Performance Can Be Expected?

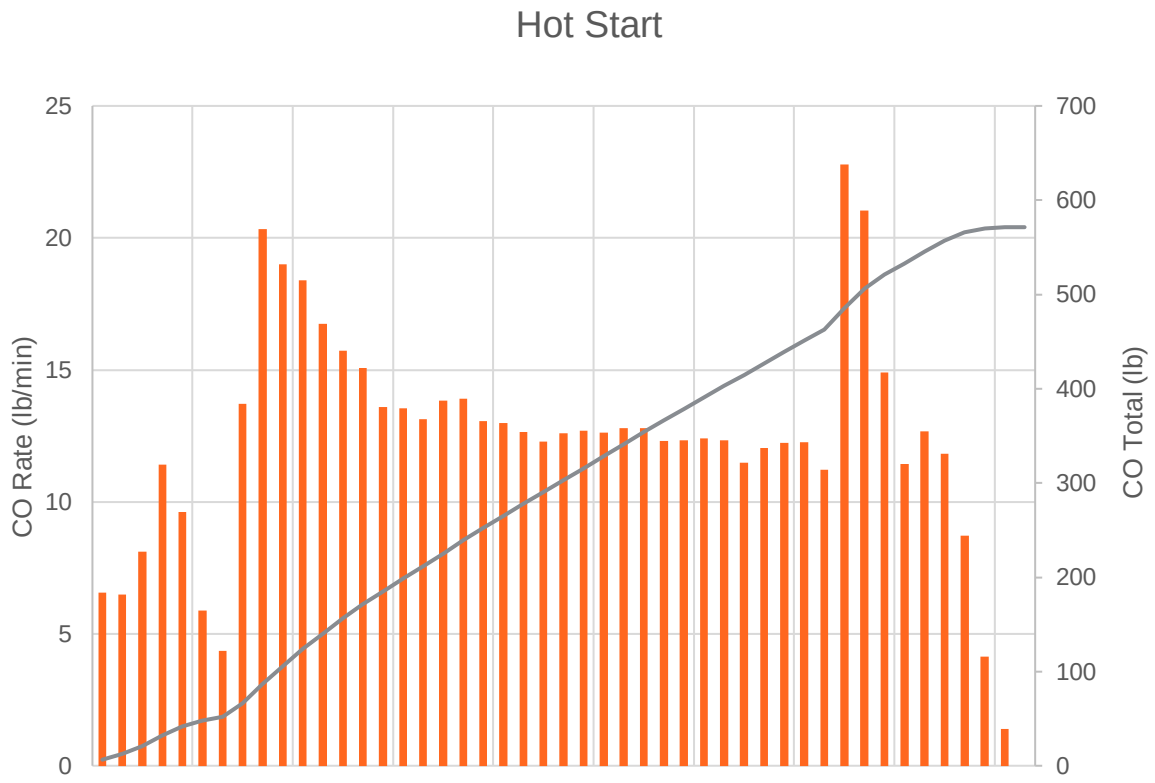
It depends…

High DeNOx and High CO/VOC Oxidation Possible



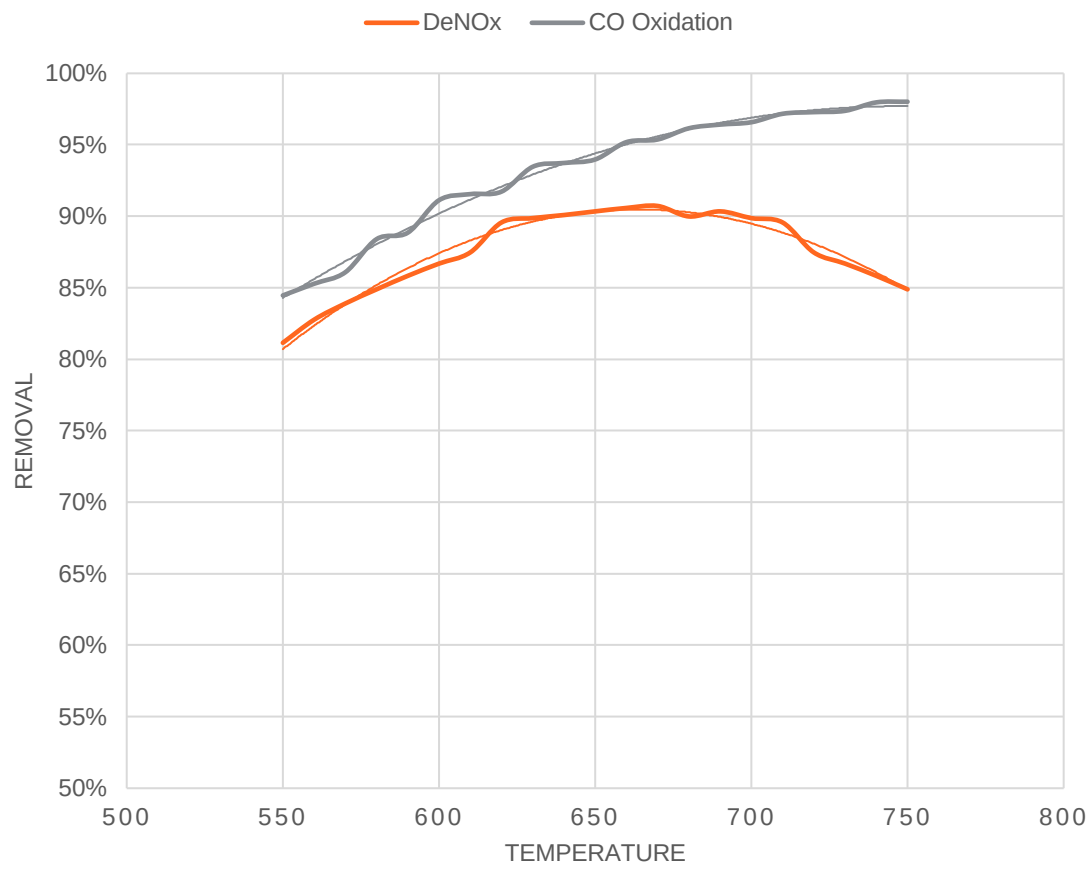
Evaluating System

- **Flue Gas Concentrations**
  - O2, H2O, CO2, Ar, N2
- **Inlet NOx**
- **Inlet CO**
- **Inlet VOC**
- **VOC Speciation Critical**
- **Reagent Slip**
- **Temperature at Catalyst Critical**
- **Full Load, Part Load, Startup**



Evaluating System

- Increasing Temperatures
- NOx Activity Varies
- CO/VOC Activity Increases



Case Study A

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<u>Reduce Backend Fouling</u>

F-Class Turbine

SCR System

- **CO Catalyst**
- **NOx Catalyst**
- **Reagent System**

Case Study A

Reduce Backend Fouling

CO Catalyst

- Traditional Panel Style
- 90% CO Oxidation
- 1inH2O Pressure Loss
- 40% SO2 Oxidation
- 10% NO Oxidation

NOx Catalyst

- Traditional Module
- 80% DeNOx
- 2.5inH2O Pressure Loss
- 1% SO2 Oxidation

Case Study A

CORMETECH
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Reduce Backend Fouling

F-Class Turbine

Finned Tube Fouling

- **Product of NH3+SO3 Downstream of SCR**
- **AS/ABS Plugs/Masks Fins**
- **Regular Cleaning Needed**

Case Study A

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Reduce Backend Fouling

Multi-Emission Catalyst

CORMETECH ELITE™

CORMETECH METEOR™

- 90% CO Oxidation
- 80% DeNOx
- 1inH2O Pressure Loss
- 1% SO2 Oxidation

Case Study A

CORMETECH
RELIABILITY. DELIVERED.

Reduce Backend Fouling

Multi-Emission Catalyst

CORMETECH ELITE™

CORMETECH METEOR™

- 90% CO Oxidation
- 80% DeNOx
- 1inH2O Pressure Loss
- 1% SO2 Oxidation

- ~80% Reduction in Downstream SO3
- ~50% Reduction in Downstream NO2
- 2.5inH2O Pressure Loss Reduction (~$250,000/year)

Case Study B

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Lower Partial Load

G-Machine

SCR System

- **NOx Catalyst**
- **Reagent System**

Case Study B

CORMETECH
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Lower Partial Load

NOx Catalyst

- Traditional Module
- 90% DeNOx
- 4inH2O Pressure Loss

- **No CO Catalyst**

Case Study B

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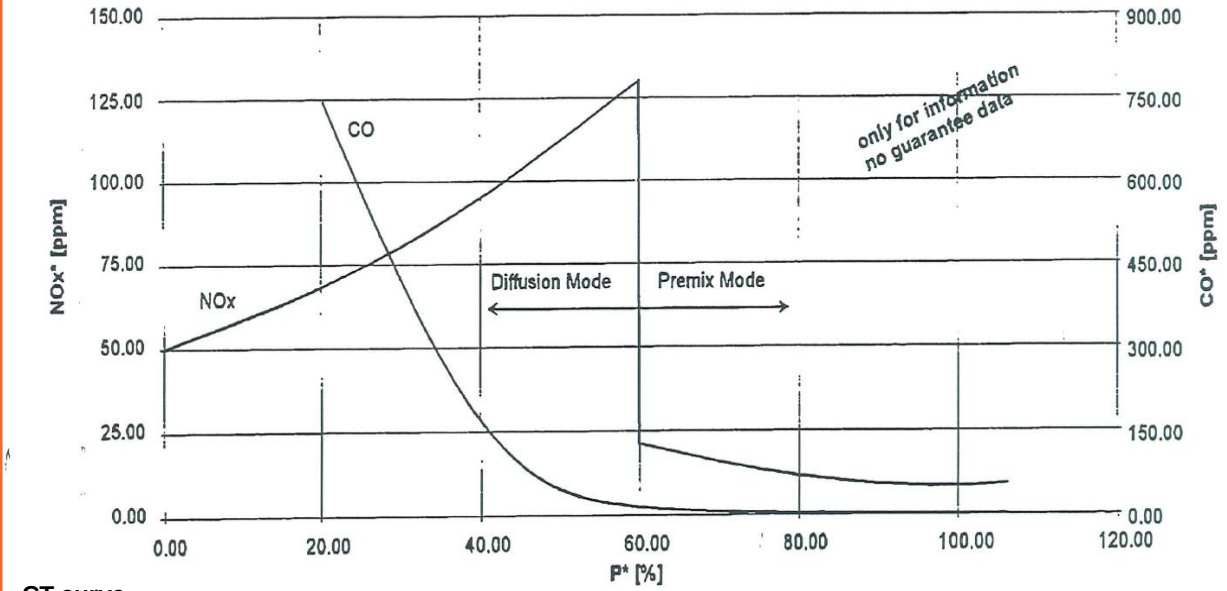
Lower Partial Load

G-Machine

CO Limited Partial Load

- Increased CO At Partial Load
- Desire to Operate Lower
- CO Permit Limit Restrictive



CT curve - Typical

Case Study B

Lower Partial Load

Multi-Emission Catalyst

CORMETECH ELITE™

CORMETECH METEOR™

- 90% CO Oxidation
- 90% DeNOx
- 2inH2O Pressure Loss

Case Study B

CORMETECH
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Lower Partial Load

Multi-Emission Catalyst

CORMETECH ELITE™

- 90% CO Oxidation
- 90% DeNOx
- 2inH2O Pressure Loss

CORMETECH METEOR™

- Add CO Functionality
- 2inH2O Pressure Loss Reduction (~$200,000/year)

Case Study B

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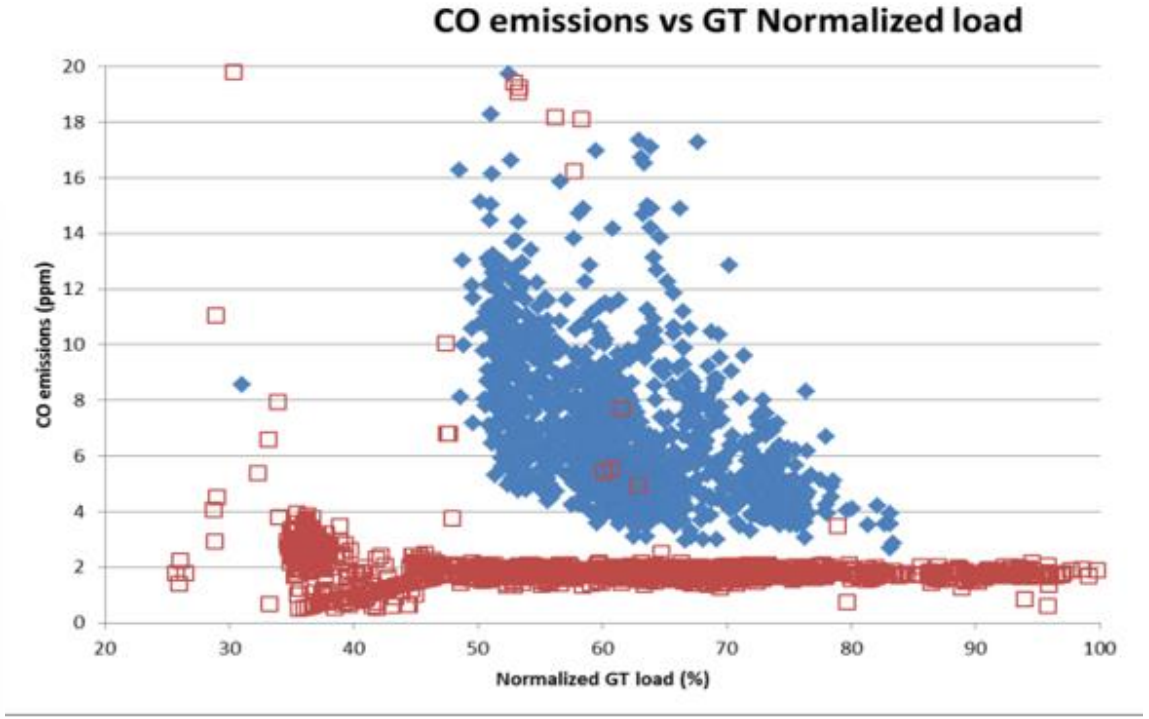
Lower Partial Load

Multi-Emission Catalyst

CORMETECH ELITE™



- **Reduce Partial Load to ~35%**

CORMETECH METEOR™

Case Study C

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Startup Emissions

F-Class Turbine

SCR System

- NOx Catalyst
- Reagent System
- No CO Catalyst

Case Study C

CORMETECH
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Startup Emissions

NOx Catalyst

- Traditional Module
- 90% DeNOx
- 4inH2O Pressure Loss

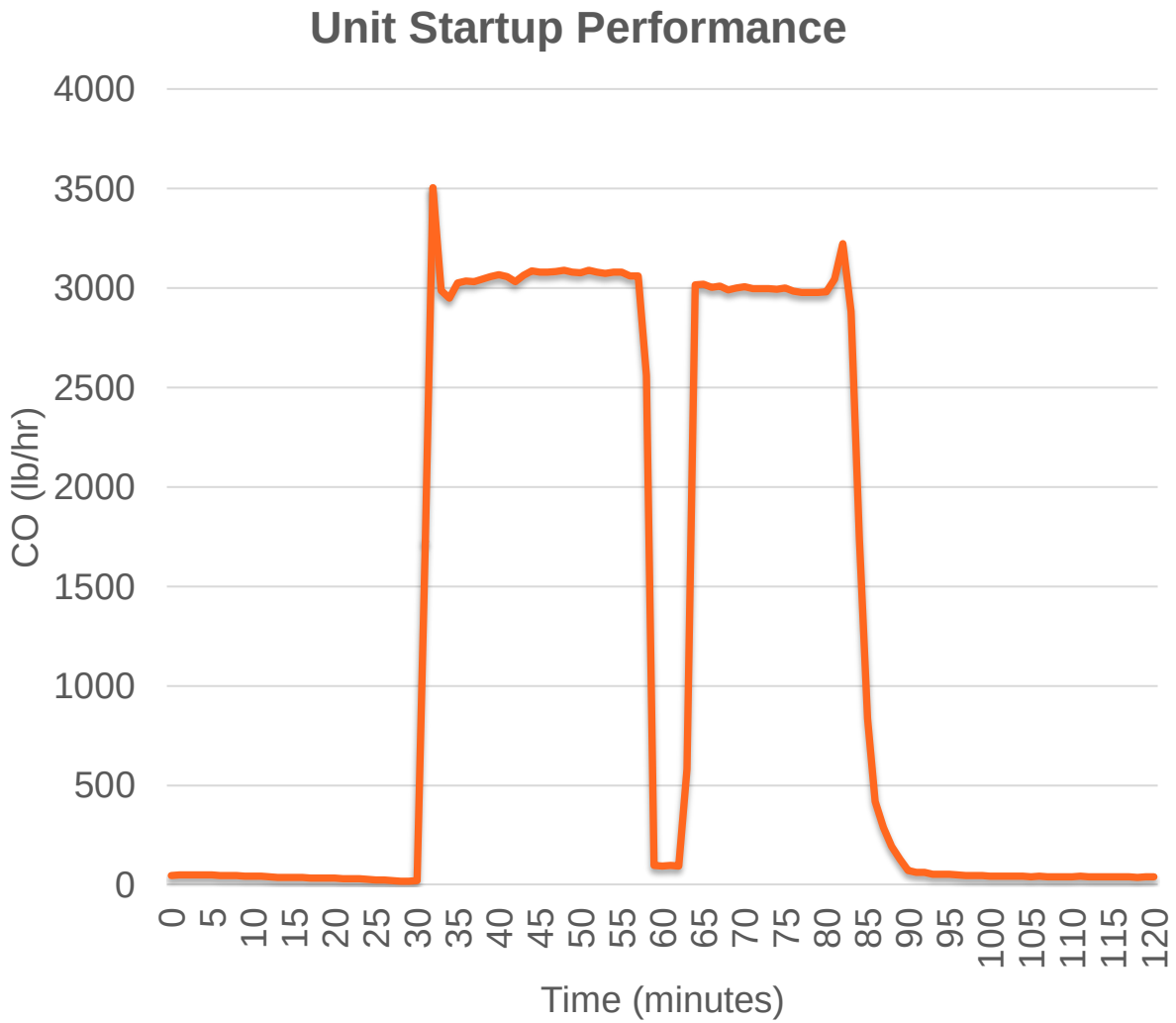
Case Study C

Startup Emissions

F-Class Turbine

CO Limited Partial Load

- Increased CO Through Start
- Desire to Start/Stop More
- CO Permit Limit Restrictive
  - Impacting 12-month limits



Case Study C

Startup Emissions

Multi-Emission Catalyst

CORMETECH ELITE™

CORMETECH METEOR™

- 90% CO Oxidation on Start
- 90% DeNOx
- 2inH2O Pressure Loss

Case Study C

CORMETECH
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Startup Emissions

Multi-Emission Catalyst

CORMETECH ELITE™

CORMETECH METEOR™

- 90% CO Oxidation on Start
- 90% DeNOx
- 2inH2O Pressure Loss

- Add CO Functionality
- 2inH2O Pressure Loss Reduction (~$200,000/year)

Case Study C

CORMETECH
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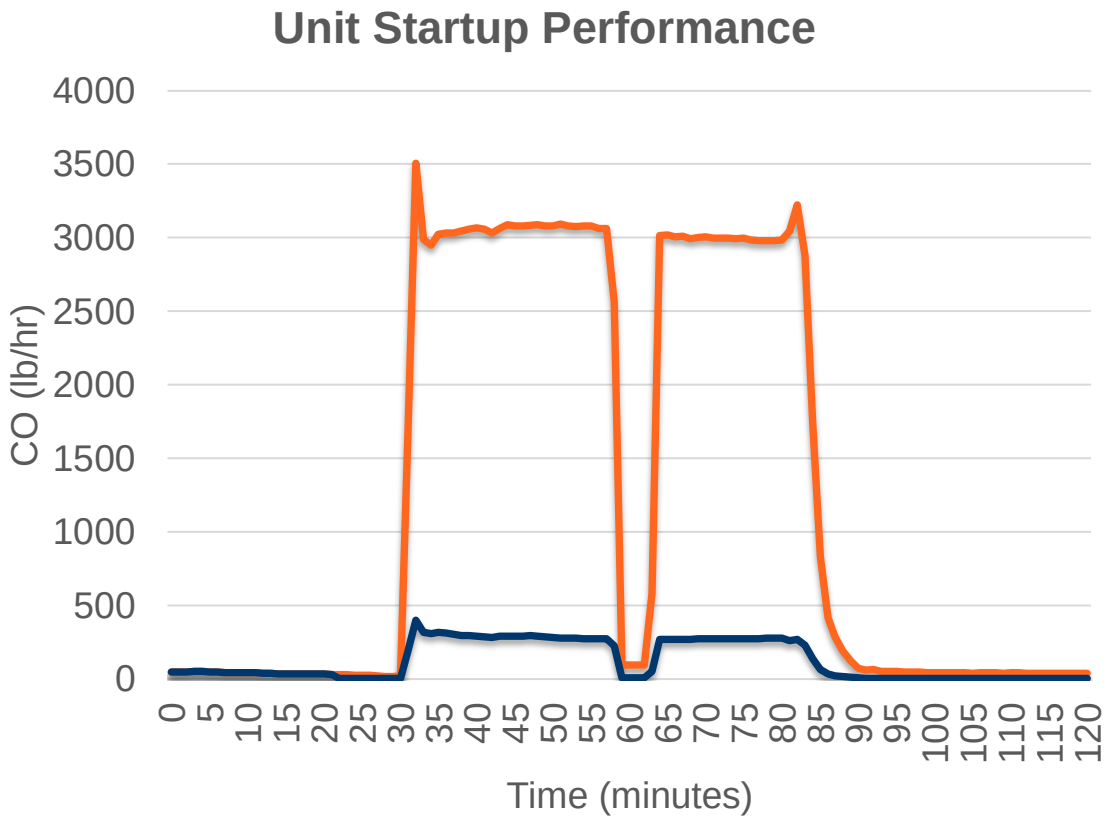
Startup Emissions

Multi-Emission Catalyst

CORMETECH ELITE™

CORMETECH METEOR™



- **Eliminate Startup Restriction**

Summary

- **Multi-Emission Catalyst Installed in place of SCR**
- **Adding Oxidation Functionality and Lowering Pressure Loss**
- **High Performance**
- **Custom** *(Targeted Performance)*

Carbon Capture - CO2 Absorbers Technology Development

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June 15, 2021 – CORMETECH received DOE Award to maximize Direct Air Capture CO2 Adsorbers

- **Increase the amount of CO2 captured in DAC operations** – Cormetech, Inc. (Charlotte, NC) plans to develop a DAC contactor, the process and material through which air and CO2 is moved and captured, that will maximize the amount of CO2 captured from the atmosphere, while reducing the amount of energy needed to operate. **(Award amount: $1,500,000)**

October 6, 2021 – CORMETECH received DOE Award to maximize Point Source Capture CO2 Adsorbers – Award based on reducing cost of current systems by 20%

- **CORMETECH, Inc.** (Charlotte, NC) will further develop, optimize and test a new, lower cost technology to capture CO2 from NGCC plant flue gas, which will enhance scalability to large NGCC plants. Award amount: $2,500,000.

Contact Info

CORMETECH
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