Catalysts for Gas Appliances: A New Take on a Proven Technology

Scott Plageman
Applied Ceramics

The use of catalysts in gas appliances has long been a debated topic in the industry. A review of catalyst technology followed by the benefits of using catalysts to improve not only the emissions, but the visual appeal of the fire within the appliance will be discussed.

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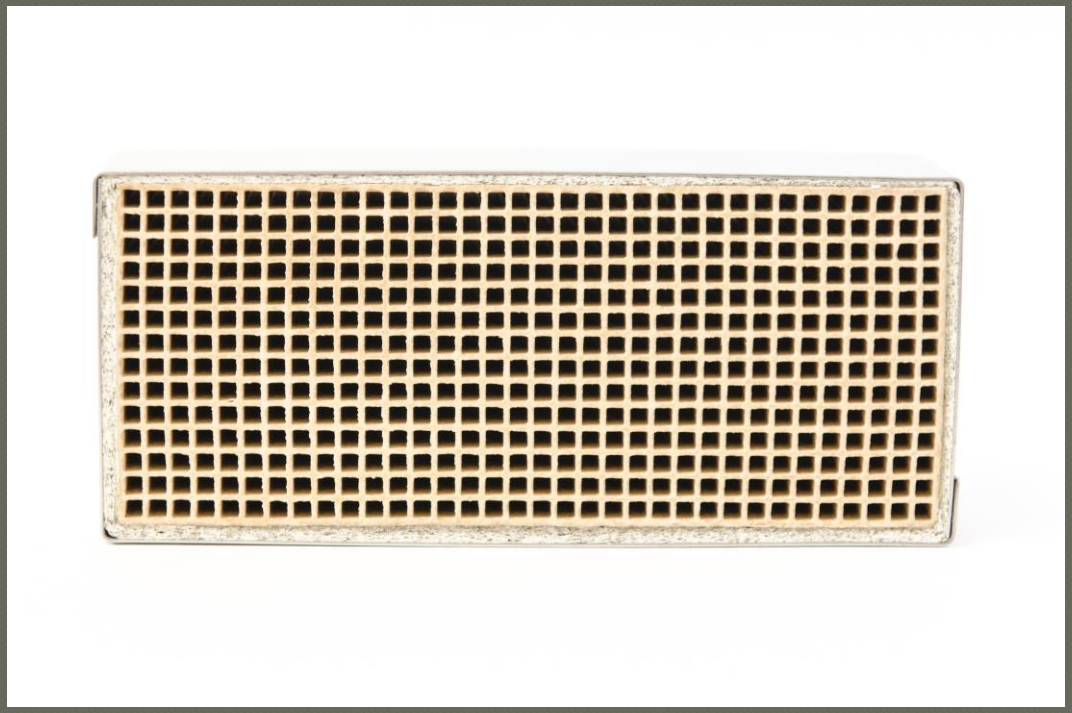
Catalytic Converters for use in Gas Stoves



Presenter Profile: Scott Plageman

- Sales Director at Applied Ceramics of Atlanta, GA
  - Serving the Hearth Products industry since 1977
  - Executive Committee member of the Catalytic Hearth Coalition (CHC)
  - Catalytic Combustor Manufacturer
    - Usage in Wood-burning appliances since 1977
    - Usage in Gas-burning appliances since 1987

The Catalytic Hearth Coalition Was Formed

- Mission Statement:
  - ***To work with <u>all</u> manufacturers, dealers, and service technicians of catalytic products to continually refine and improve these products for the environment.***
  - ***To educate the public about the benefits of catalytic technology*.**

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Applied Ceramics, Inc.

- We are a unique union of inorganic materials manufacturing expertise including ceramics and catalysts
- This allows us to very efficiently and effectively work with our customers to meet their needs
- We have a strong product development track record for taking products from the lab setting to commercialization

Agenda

- Catalyst 101
  - Definition / Fundamentals / Materials
  - Temperatures of Operation & Why
- Two Most Common Gas Stove Types
- Benefits from adding a Catalytic Converter
- System Back Pressure
- What Can go wrong / Things to Avoid
- Closing Thoughts & Questions

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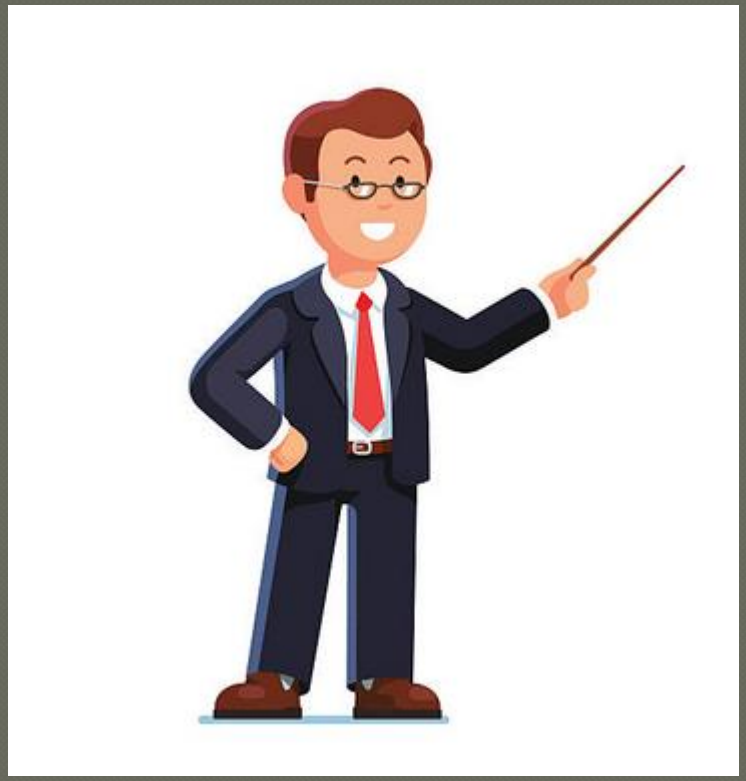
Catalyst 101



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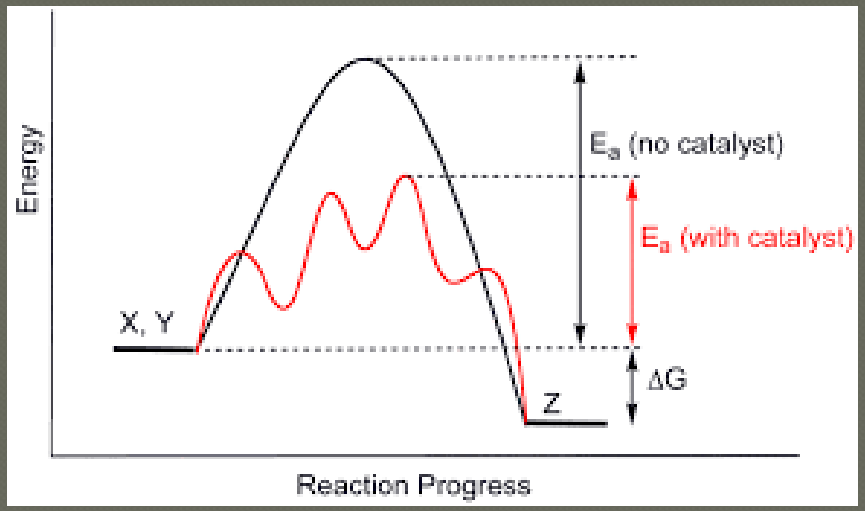
What is a Catalyst?

- Definition: A catalyst is a substance which lowers the activation energy for a given reaction, without being consumed by the reaction.



- Carbon in any compound Combines with Oxygen to form Carbon Dioxide and Water
  - Catalysts create a Combustion Reaction
    - (Also Referred to As "Oxidation "Reaction)
  - In the Case of VOC/CO Oxidation – "HEAT" is the Activation Energy
  - With a catalyst you can "Oxidize / Combust / Destroy" at a lower Temperature

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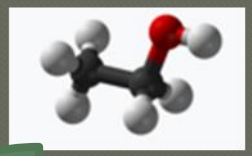
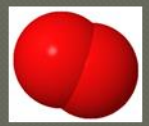
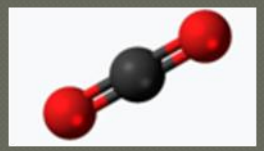
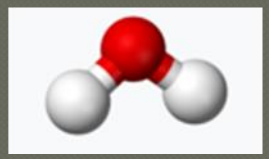
Example

AHHHHH … I love the smell of freshly baked bread !

Ethanol C2H6O + Oxygen (3) O2 → Thermally @ 1500°F / Catalytically @ 500-600°F → Carbon Dioxide (2) CO2 + Water (3) H2O

Smells great, but ethanol is a smog precursor …..

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Catalytic Technology is Everywhere

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Prevalent in the Hearth Industry

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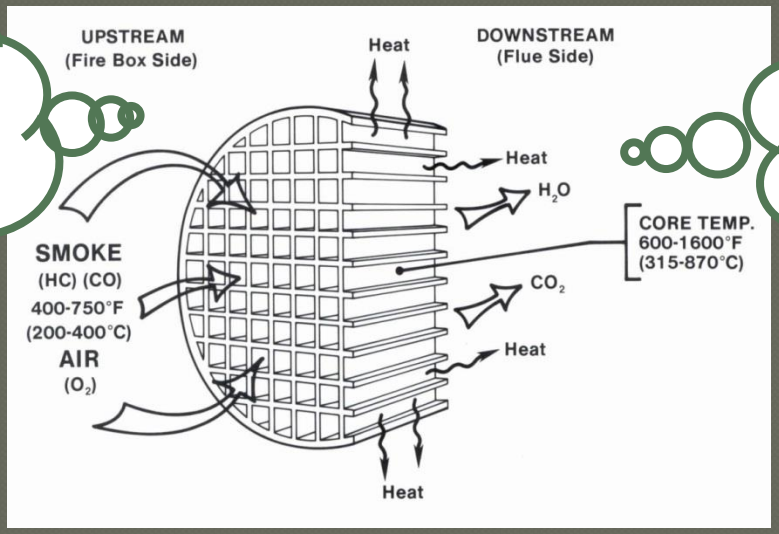
How Does a Catalyst Work?

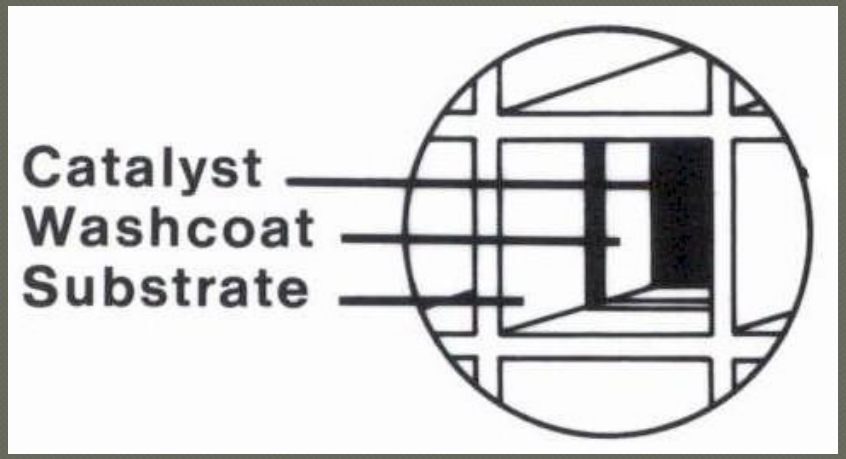
Carbon Monoxide, Smoke & VOC's



Water Vapor & Carbon Dioxide & Heat

Catalytic Combustor Components

- *Carrier* - physical supports for active metal catalyst
- *Catalyst Coatings* – Precious (noble) metals or base metal elements which are "active in the combustion reaction". Some catalyst manufactures also use a pre-coating, also known as a wash coat.



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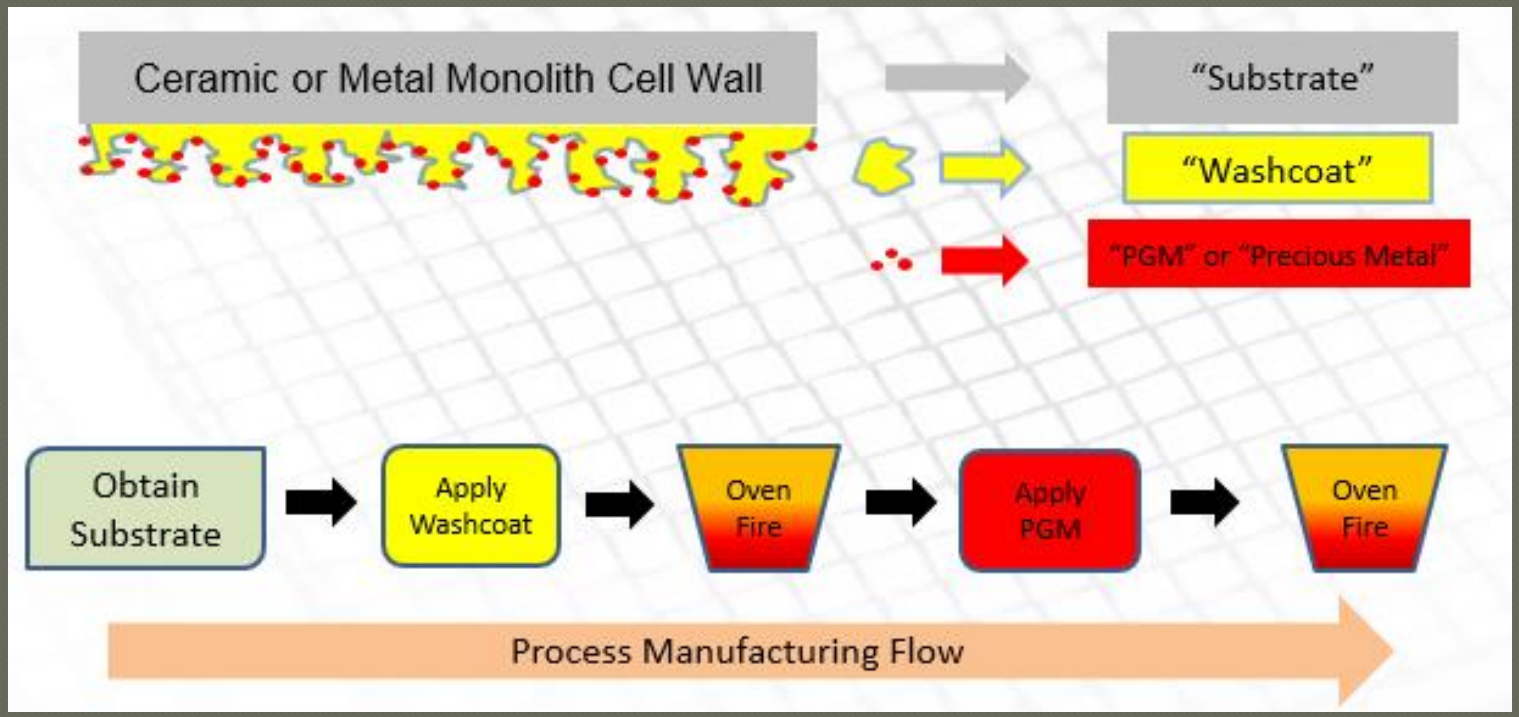
How Do you Make a Catalyst?



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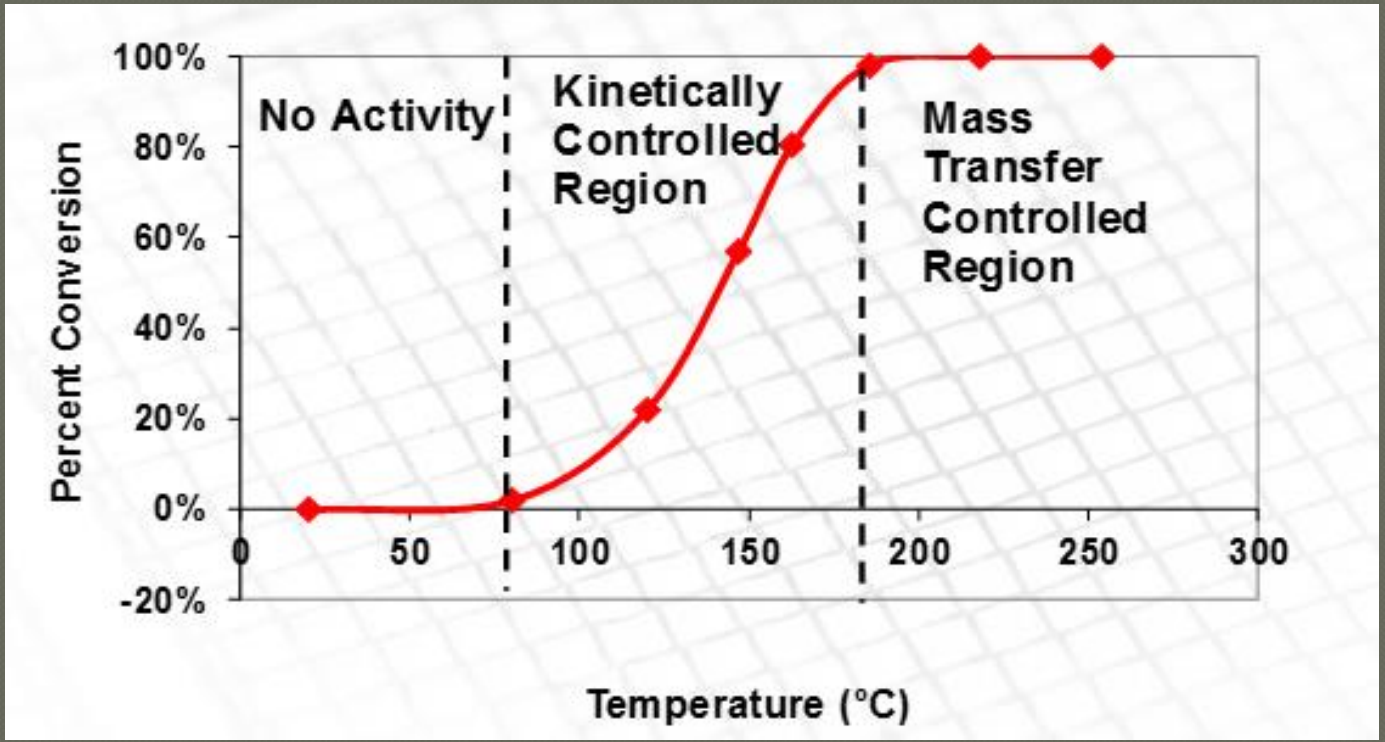
How Does Temperature Impact a Catalyst?



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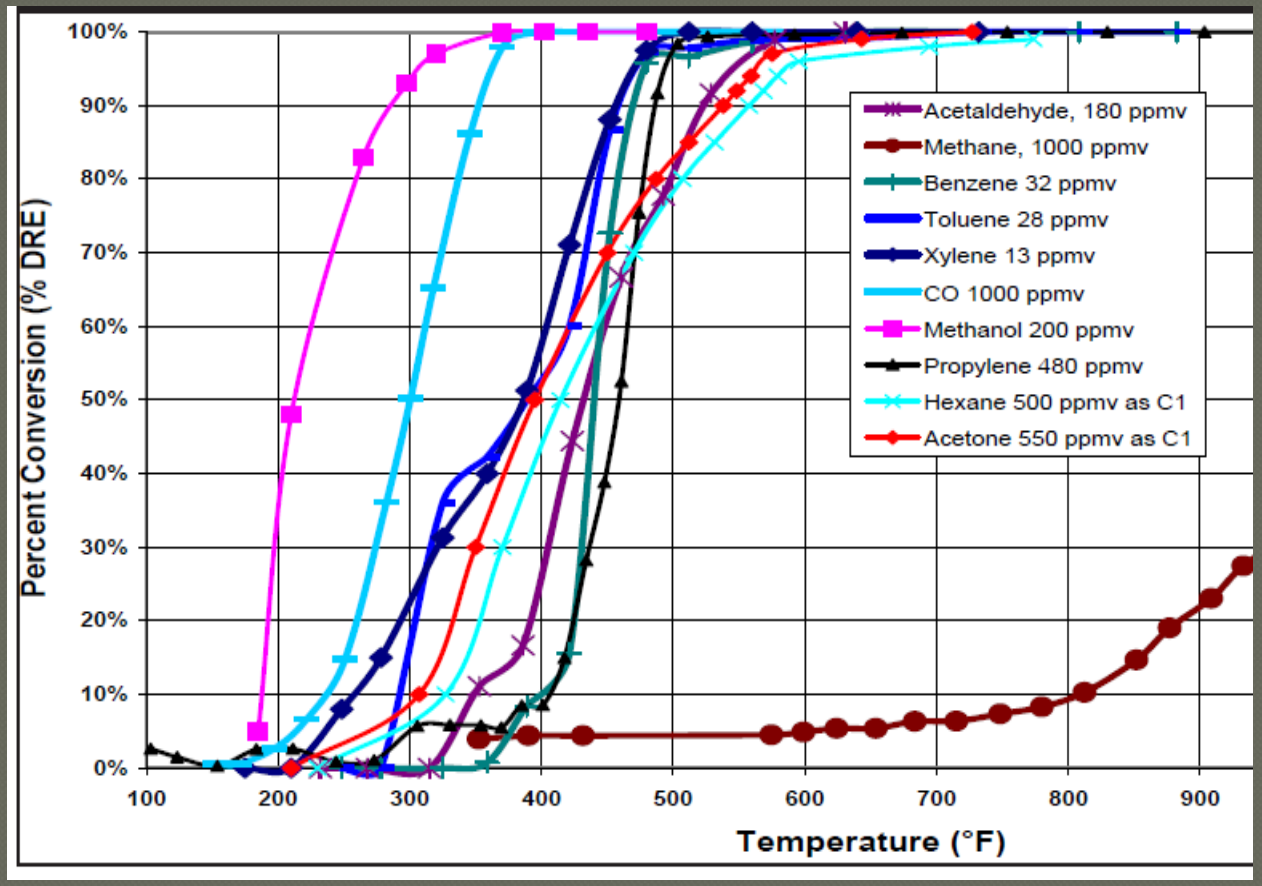
VOC/CO Destruction



VOC – Volatile Organic Compounds

Temperature to Oxidize depends on compound – CO and Methanol are easy for example, methane needs much more temperature

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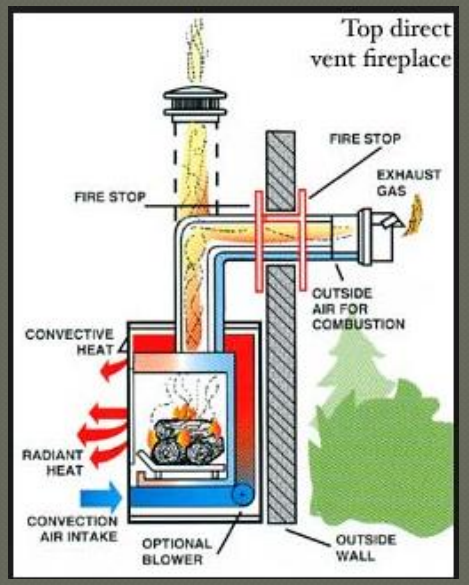
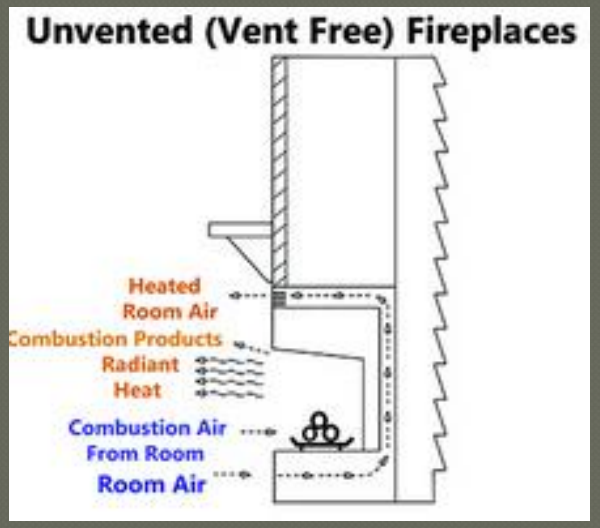
2 Main Types of Gas Appliances





Direct Vent or B-Vent
Products of combustion are Exhausted to outside

Vent-Free or Ventless
Products of combustion are Exhausted *into* Room

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Key Benefits of Catalyst in a Gas- burning Appliance

- Near-Zero Emissions of Carbon Monoxide
- Combustion = Exotherm = Heat in House
- Increased Appliance Efficiency - minimal heat/energy wasted as exhaust
- Back Pressured System
- Run Richer fuel supply
- More realistic flame color & appearance
- More Flow Control
- Long Life – Clean Application vs Wood

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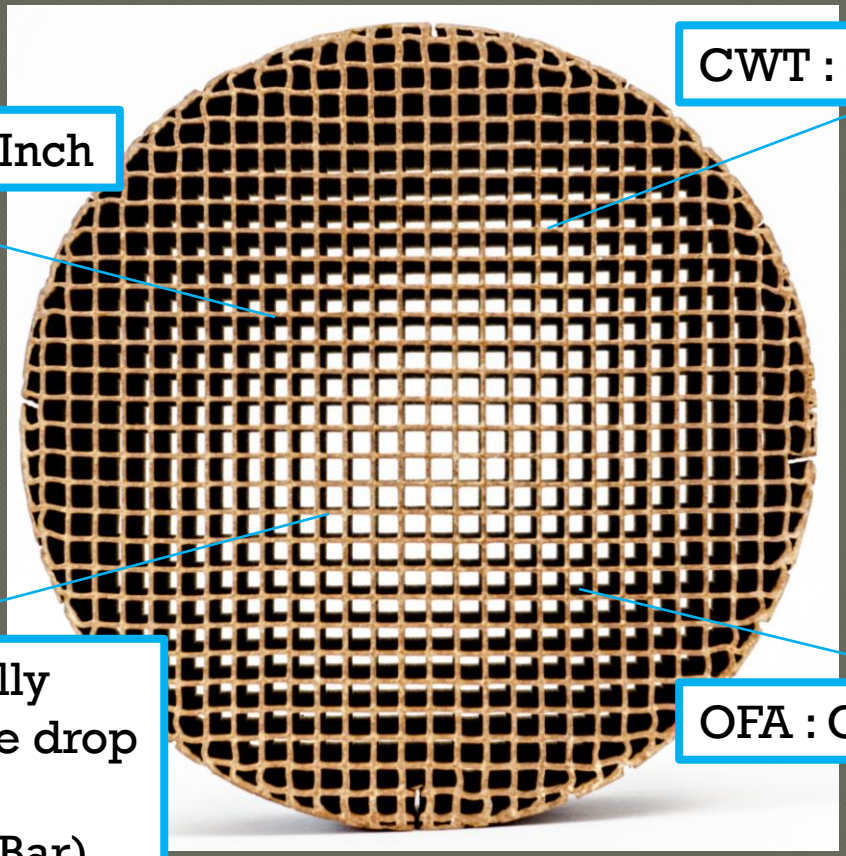
Back Pressure from the Catalytic Converter



CPSI : Cells Per Square Inch

CWT : Cell Wall Thickness

Back Pressure typically
Measured as Pressure drop
Across the catalyst
(i.e. inches of WC or Bar)

OFA : Open Frontal Area

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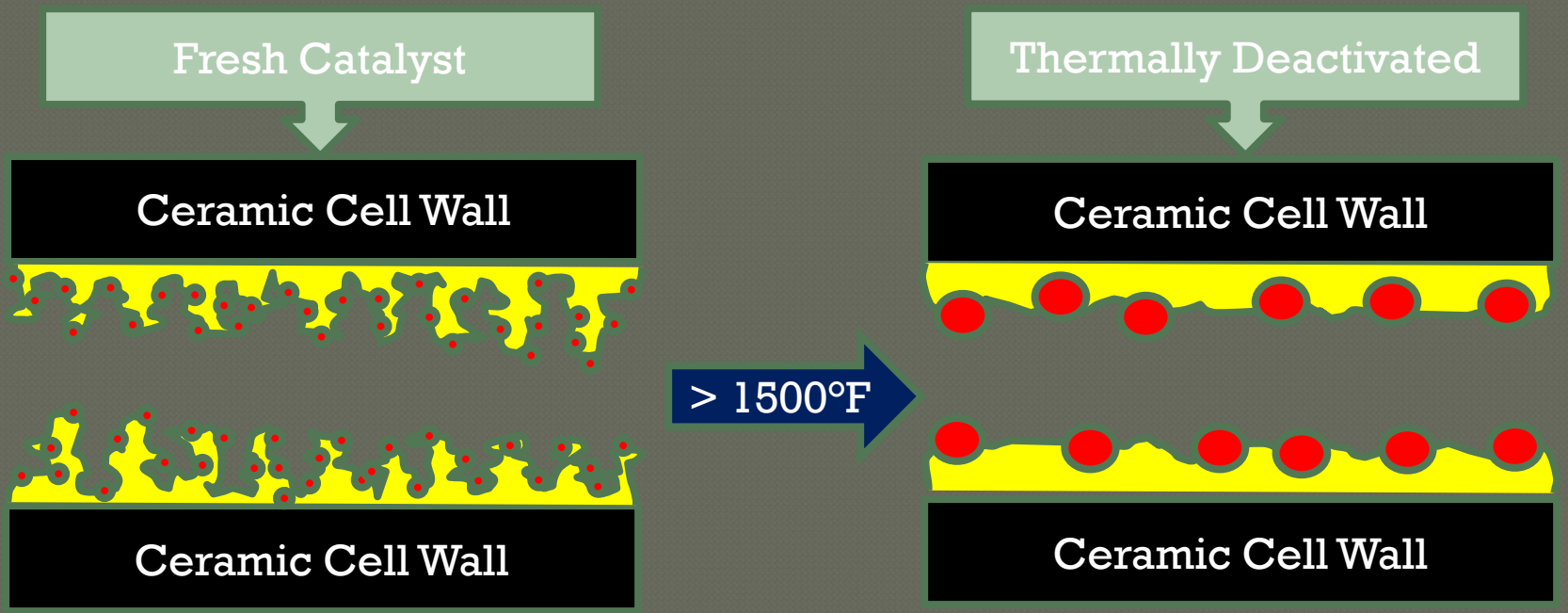
Effects of Extreme Temperature on Catalyst Surface



- **Finely dispersed**, Palladium / Platinum Particle
- **High** Surface Area, Alumina Based Washcoat
- **Thermally Sintered**, Less Active, Palladium / Platinum Particle
- Collapsed **Low** Surface Area, Alumina Based Washcoat

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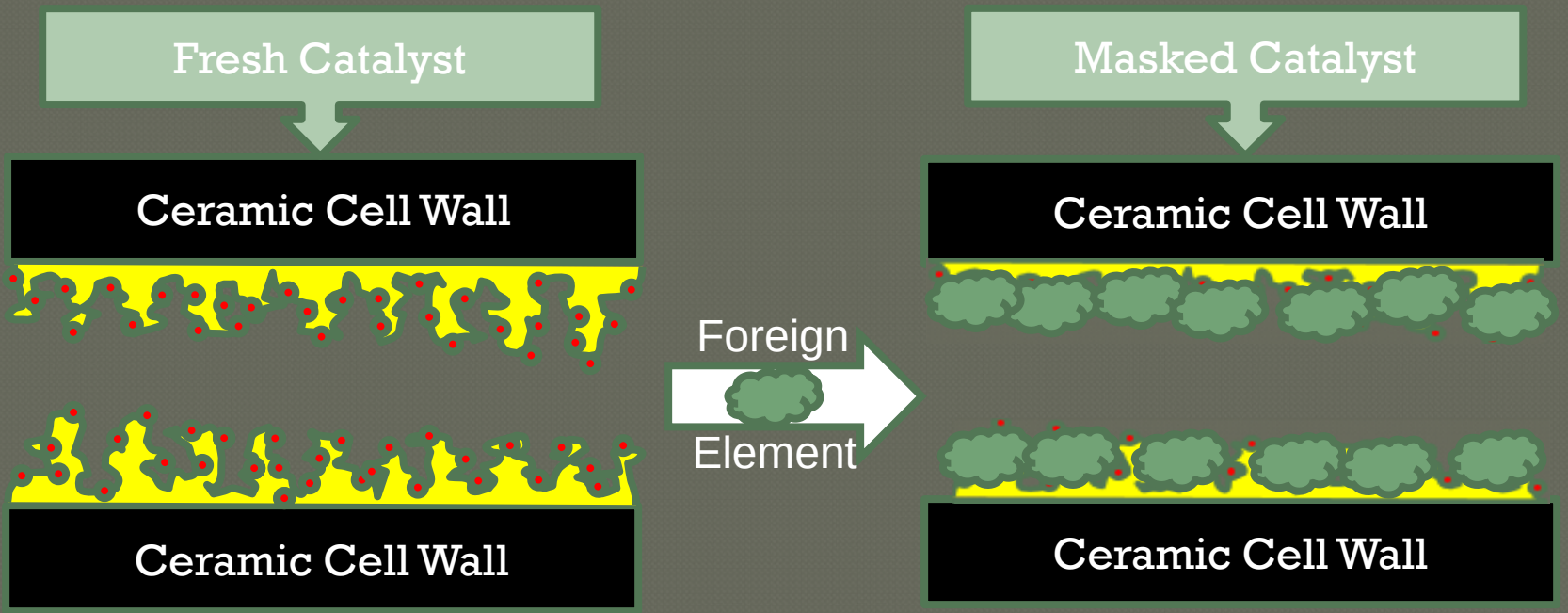
Effects of Foreign Matter on Catalyst Surface



- **Finely dispersed**, Palladium / Platinum Particle
- **High** Surface Area, Alumina Based Washcoat
- Particles of PGM are blocked, no access for reaction to occur
- Washcoat can attract Silicone and Phosphorus Compounds

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What does “Foreign Matter” mean in the real World?

- Paint / Spray Paint contains Pigments
- Pigments are “inorganic” elements
- Inorganic elements mask catalysts
- When paint is dried and cured, the inorganic pigment will not “release”
- Problem? – “Touching up” with Spray paint after installing catalyst – pigment will mask catalyst
- Solution? – don’t Spray Paint after install of catalyst

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What does “Foreign Matter” mean in the real World?

Problem? – Lubricants that contain Silicone. Silicone is #1 Catalyst contaminate

Solution? – Lubricants that contain 100% hydrocarbon – not a problem for catalyst

Note: You can find “Silicone Free” WD-40 and other lubricants – consult MSDS

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What does “Foreign Matter” mean in the real World?

Problem? – Cleaners that contain Phosphorus or Colorants
Ex: Windex Contains Vanadium Metal = Blue Colorant
Contains Sodium as well

Solution? –
Plenty of Cleaners that contain 100% Hydrocarbons

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Conclusion / Summary

- Catalysts can and have been used very successfully in Vent-Free and Vented Gas Appliances
- Can be used to augment "Visual and Aesthetics" of Flame
  - CO is eliminated to near zero
- Work with Catalyst Vendor on Sizing
  - Catalyst normally sized by exhaust flow rate
  - Exhaust Flow Rate Proportional to BTU output
- Under normal conditions, a Gas Appliance Catalyst should last as long as any other component

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Thank you for Attending
Any Questions?