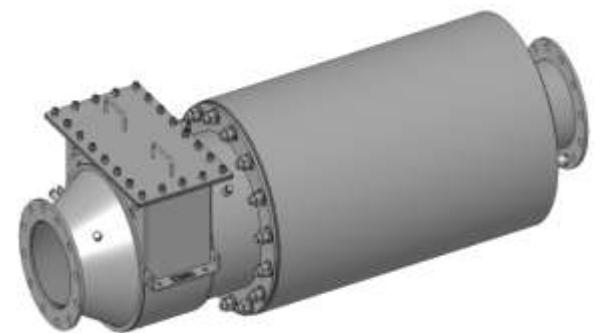
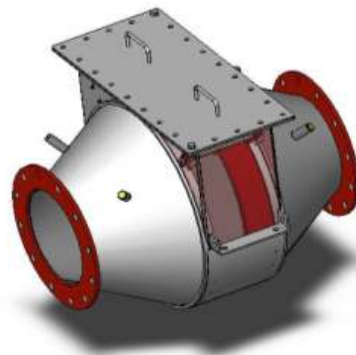
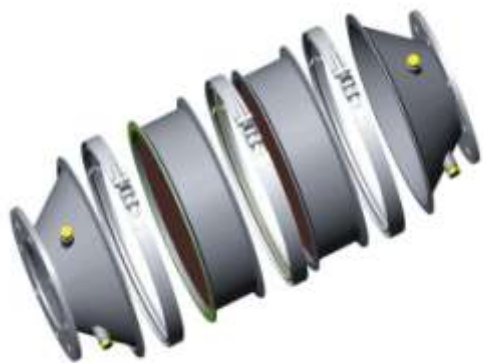




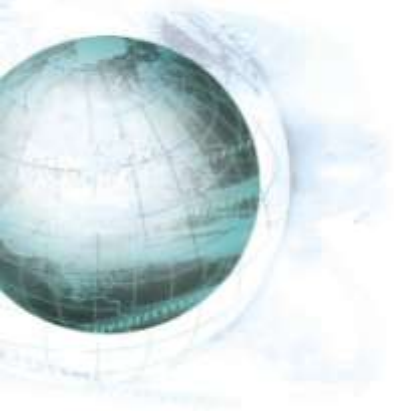
EPA STATIONARY COMPRESSION IGNITION (CI) RICE-NESHAP RULES 40 CFR Part 63



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TOPICS

- 1- Brief History
- 2 - EPA Definitions
- 3 - New EPA Regulation
- 4 - Catalyst Basics
- 5 - Catalyst Products
- 6 - Questions



Brief History

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History

- Catalytic converters were introduced in the mid 1970's model year vehicles to comply with Clean Air Act amendments
- Leaded gasoline was gradually phased out at this time with rising health concerns about lead poisoning and it contaminated the converters
- Main purpose was to reduce smog in Los Angeles
- Eventually, stationary engines were targeted...
- Just as lead was removed from gasoline, more recently sulfur has been reduced in diesel (ULSD) for the catalyzed DPF and DOC's

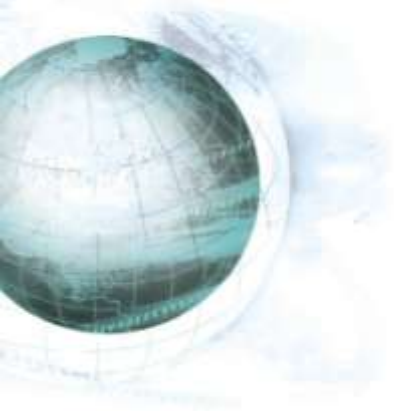
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Current Regulation Background

- The timeline for these new rules is due to a judicial consent decree between the EPA and the Sierra Club & Environmental Defense Fund
- In March 2009 the EPA had a proposed RICE-NESHAP rule for existing compression ignition (CI) & spark ignited (SI) engines
- On February of this year the EPA issued a final rule for CI engines & EPA obtained a 6-month extension for final emission standards for SI engines until August 10, 2010
- The SI covers in-use SI engines at area source constructed or re-constructed before June 12, 2006 and major source engines ≤ 500 HP of the same time period.

2010 RICE-NESHAP for In-Use Stationary Diesel (CI) Engines

- The EPA issued the final rule for in-use compression ignition (CI) engines on February 17, 2010 - compliance deadline of May 3, 2013
- CO will be used as a surrogate to measure the reduction of HAP's (i.e. formaldehyde, arsenic, benzene, etc..)
- Affected engines:
 - a) Used at area source & constructed/reconstructed before June 12-06
 - b) Used at major source, have a site rating ≤ 500 HP and constructed or reconstructed before June 12-06
 - c) Used at major source for non-emergency purposes have a site rating > 500 HP and constructed/reconstructed before Dec 19-02



EPA Definitions

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Major vs. Area Source



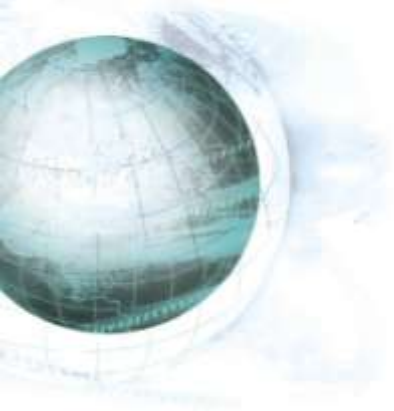
- Major source: is a site with the potential to emit a single HAP at a rate of 10 tons/year or a combination of HAP's at a rate of 25 tons/year
- Area Source: means any stationary source of HAP that is not a major source as defined above

CI vs. SI Engines

- Compression Ignition: means relating to a type of stationary internal combustion engine that is not a spark ignited engine
- Spark Ignited: Either a gasoline fueled engine; or any other type of engine using a spark plug (or other sparking device)...Dual fuel engines in which a liquid fuel (typically diesel fuel) is used for CI and gaseous fuel (typically natural gas) is used as the primary fuel at an annual average ratio of less than 2 parts diesel to 100 parts total fuel on an energy equivalent basis are spark ignition engines.

Emergency vs. Non-Emergency

- Emergency engines: engines that operate less than 100 hours per year and may also operate the engine as part of an emergency demand response (DR) program for a maximum of 15 hours per year when regional transmission organization has determined there are emergency conditions that could lead to a potential electrical blackout or grid failure
- Non-emergency engines: engines that operate >100 hours per year or used in peak shaving programs or to generate income for a facility to supply power to an electric grid or otherwise supply power as part of a financial arrangement with another entity with the exception of emergency DR where financial arrangements are limited to emergency power



New Emission Regulations

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Existing Stationary CI at Major Sources

Subcategory	Except during periods of startup
Non-Emergency CI $100 \leq \text{HP} \leq 300$	230 ppmvd CO at 15% O ₂
Non-Emergency CI $300 < \text{HP} \leq 500$	49 ppmvd CO at 15% O ₂ or 70% CO reduction
Non-Emergency CI >500 HP	23 ppmvd CO at 15% O ₂ or 70% CO reduction

Existing Stationary CI at Area Sources

Subcategory	Except during periods of startup
Non-Emergency CI $300 < \text{HP} \leq 500$	49 ppmvd CO at 15% O ₂ or 70% CO reduction
Non-Emergency CI >500 HP	23 ppmvd CO at 15% O ₂ or 70% CO reduction

Maintenance Practice Highlights

- change oil and filter every 1000 hours of operation (500 hours for emergency engines) or annually, whichever comes first, except that sources can extend the period for changing the oil if the oil is part of an oil analysis program
- inspect air cleaner every 1000 hours of operation or annually, whichever comes first
- inspect all hoses and belts every 500 hours or annually, whichever comes first, and replace as necessary

Demonstrating Compliance

- Install emission controls (oxidation catalysts) for NON-emergency engines > 300 HP to achieve $\geq 70\%$ CO reduction within 3-years
- Major source engines $100 \text{ HP} \leq 500 \text{ HP}$ and area source $300 \leq 500 \text{ HP}$ will require an initial performance test to demonstrate compliance
- Engines requiring DOC's $> 500 \text{ HP}$ will require an initial performance test and a repeat test every 8760 hrs and/or 3-years*

* area source non-emergency limited use CI engines $> 500 \text{ HP}$ repeat every 5 years and/or 8,760 hours

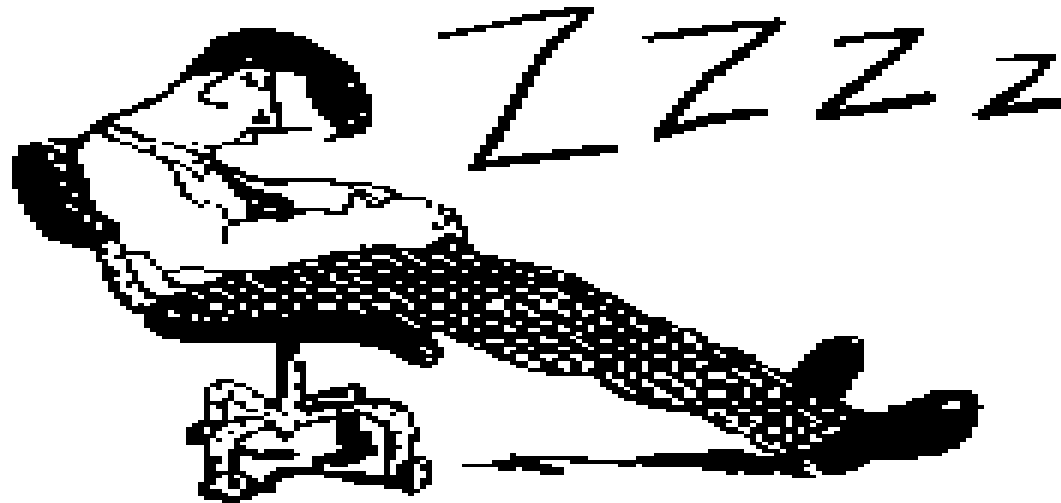
Engines with an Oxidation Catalyst

- Maintenance practices for engines with DOC's: need to maintain a $\Delta P < 2''$ w.c. across the converter from the initial baseline test and maintain operating temperatures between 450 - 1350 °F
- Non-Emergency engines >500 HP must continuously monitor and record the inlet temperature at the catalytic converter and the pressure drop across the catalyst must be measured monthly

Crankcase Ventilation



- Non-Emergency engines >300 HP at major or area source sites need to install an open crankcase filtration system or closed crankcase ventilation system if the engine does not originally have one to reduce metallic HAP emissions



Start-up, Shutdown & Malfunction (SSM)

- Startup, shutdown & malfunction; the rule relaxed startup regs & now allow a maximum of 30 min for startup & operators must minimize engine idling during startup
- EPA believes that any emissions during a malfunction and shutdown would be of short duration compared to the emission averaged during overall testing time (three one hour runs) and that engine should still be able to comply

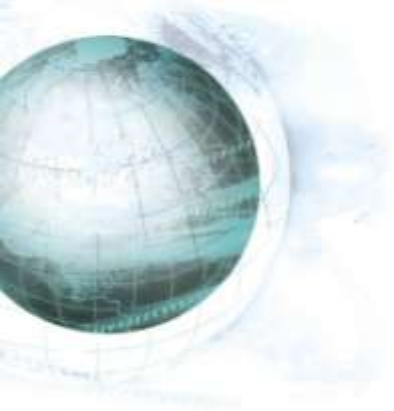


Diesel Fuel

- The final rule requires the use of ULSD (< 15 ppm sulfur) for non-emergency stationary diesel CI engines >300 HP and < 30 litres displacement at major & area source



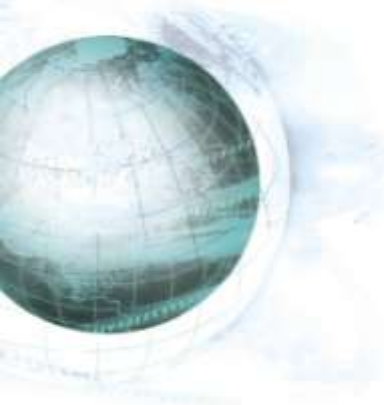
"In these troubled times, I thank God there's still one barrel left we can afford."



Catalyst Basics

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Catalyst Basics



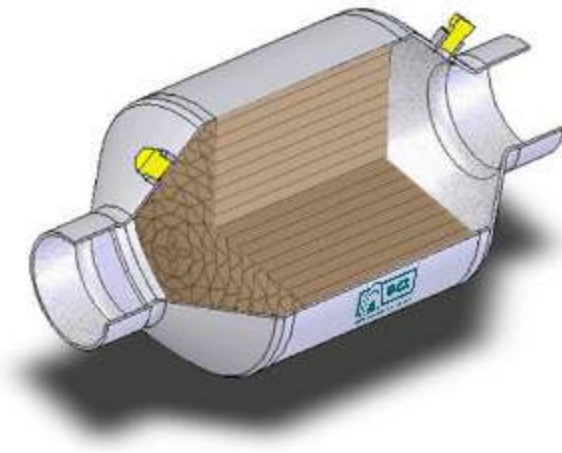
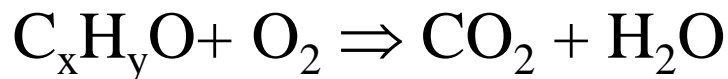
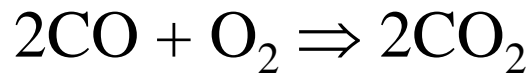
Q. What is a catalyst?

A. A material that alters the rate of reaction (lowers the required energy) and gives the desired products without being consumed in the reaction.

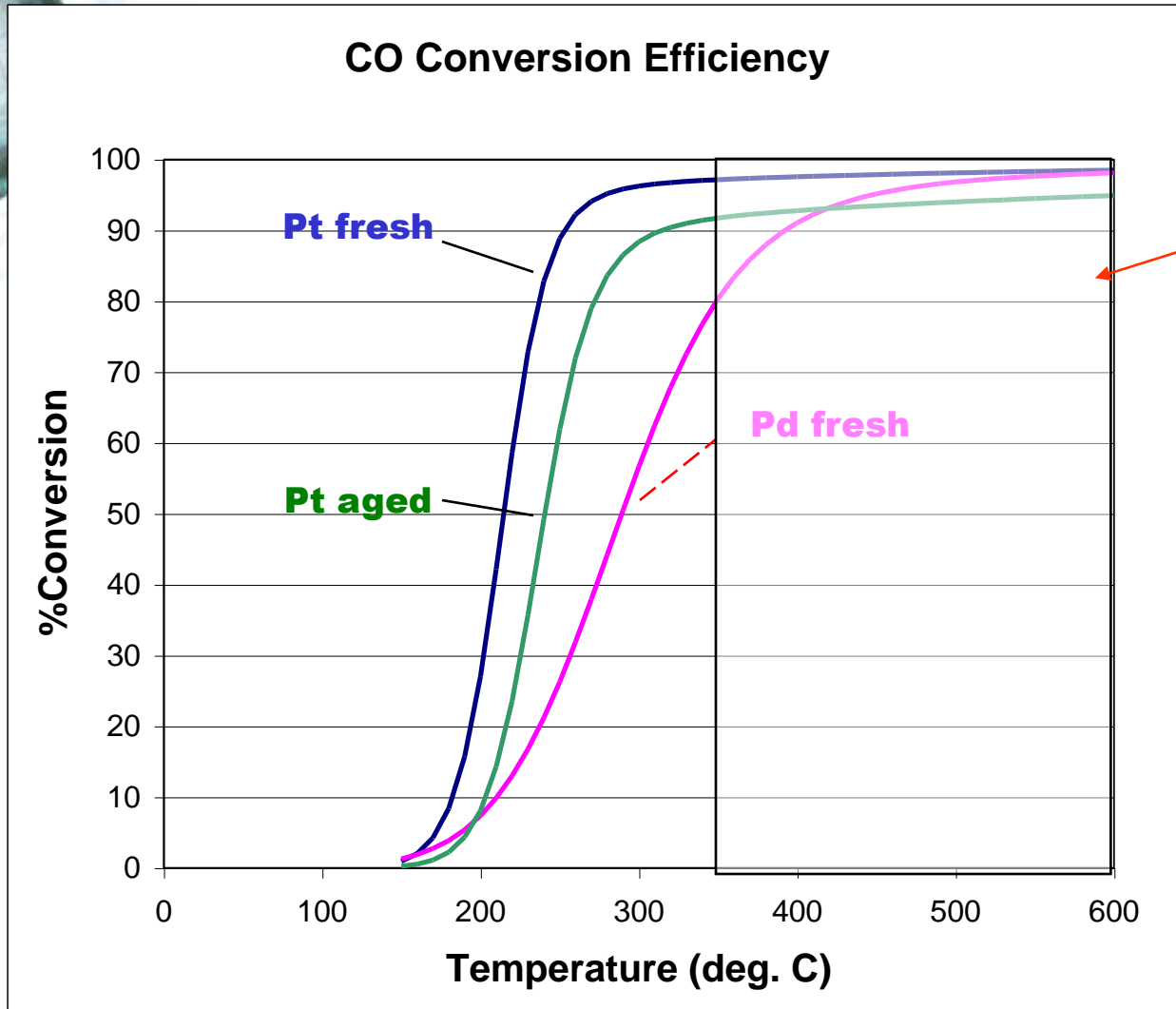
Oxidation Catalysts



- Used on lean combustion engines
- Sufficient oxygen in the exhaust is required to oxidize CO, NMHC and HAP's such as formaldehyde
- No effect on total NO_x levels in the exhaust



CO Light-Off Curves



Operating window

Pt catalyst is better for CO conversion

DCL data

Packaging Variables



Cell Density

- The larger the corrugations in the foil, the lower the backpressure, but the less surface area which equates to lower performance

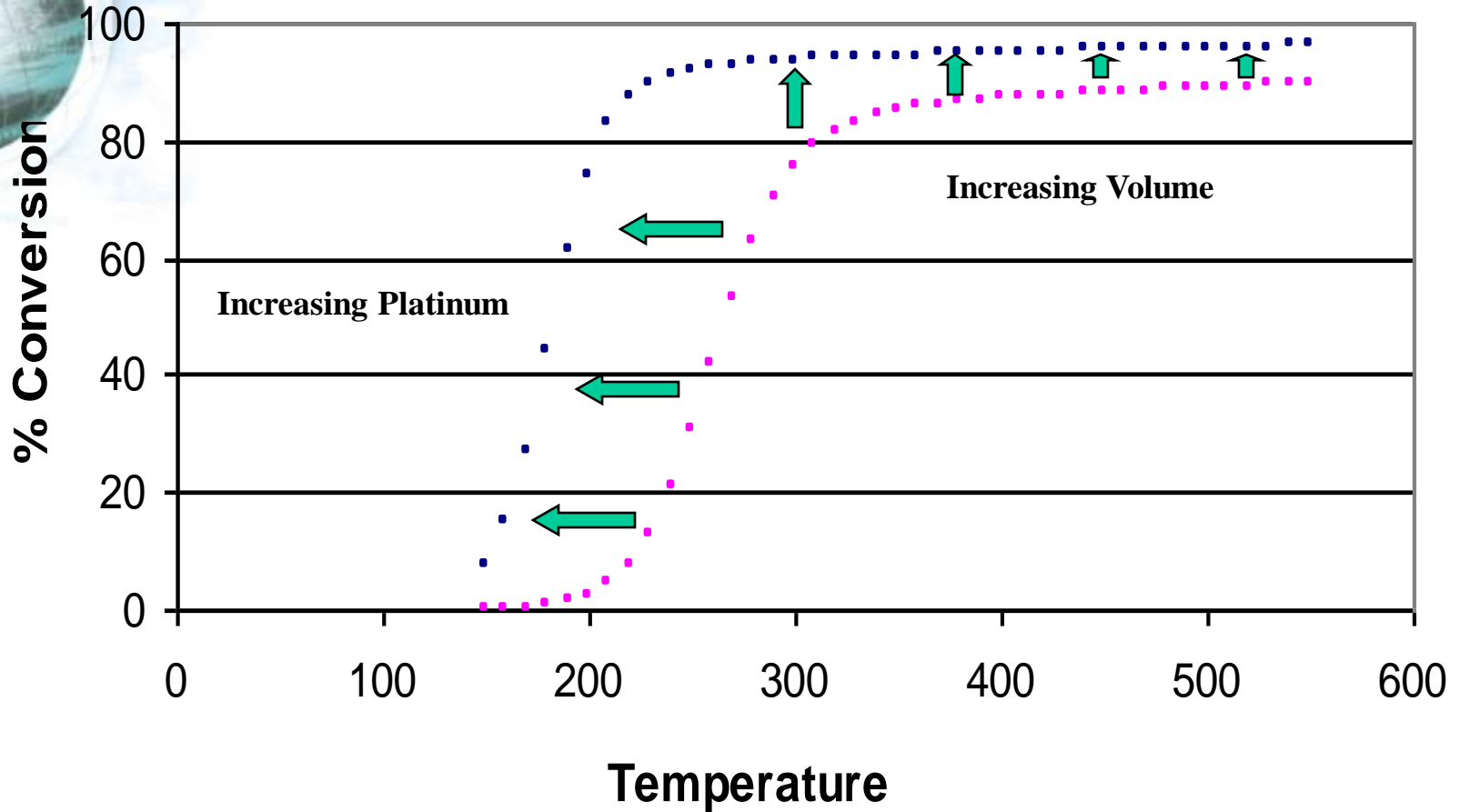
Catalyst Coating/Loading

- Different coatings for different objectives (ie- achieving CO reduction vs. VOC requires less precious metals)

Catalyst Arrangement

- Multiple elements in series to achieve really tough standards
- Vertical vs. horizontal flow
- Combination silencer vs. separate converter and muffler

Sizing & Selection



Sizing & Selection

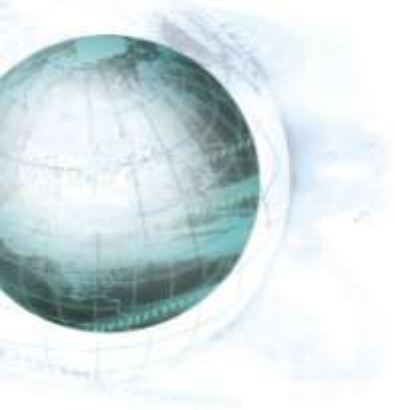


Primary Considerations:

- Engine Model/Type
- Maximum Rated Horsepower
- **Exhaust Temperature @ Max Power**
- **Exhaust Flow Rate @ Max Power**
- **Required Emissions Limits**

Secondary Considerations:

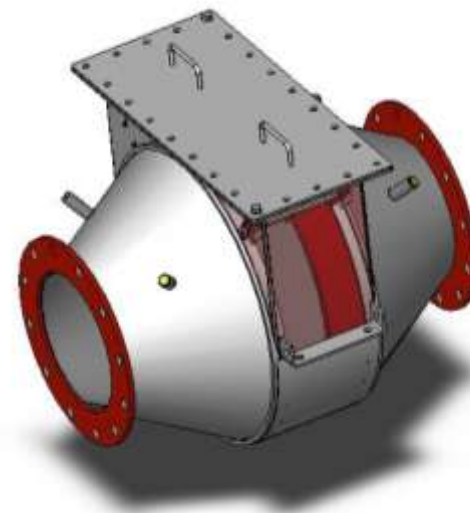
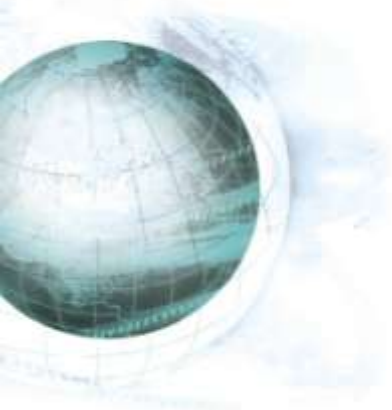
- Fuel Type
- Raw Exhaust Emissions Levels
- Pipe Connection Size
- Allowable Backpressure
- Sound Attenuation Level Required
- Space Constraints (Retrofit Considerations)



Products

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Terminology



Catalyst Element (when coated)

Substrate (when un-coated)

Catalytic Converter

**(which can contain 1
or more elements)**

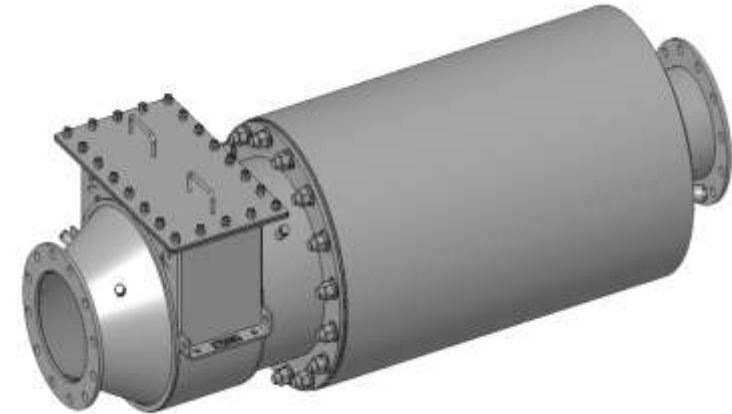
Various other terms are used in the industry, which can lead to confusion. For example, “catalyst” can refer to the complete catalytic converter, the catalyst element, or the precious metal material.

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Catalytic Silencers



- Combination catalytic converters and typically available in 3 standard silencer grades from a variety of manufactures:
 - Industrial (15-20 dBa)
 - Critical (25-35 dBa)
 - Hospital (35-40 dBa)
- Higher specialized noise requirements are available
 - Standard Carbon steel, SS304 optional

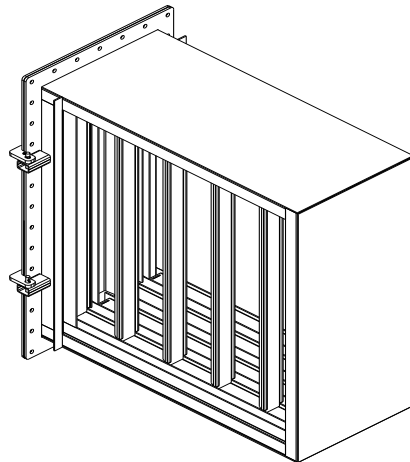


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Base Mounted Units



Catalyst housing integrated into large vertical silencers



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Exhaust After Treatment Technologies

	NO _x >90%	CO >90%	NMHC /VOCs 50-90%	PM 0-40%	PM 80-90%
Rich-Burn Gas engines	•3-way catalyst	•3-way catalyst	•3-way catalyst	N/A	N/A
Lean-Burn Gas engines	•SCR system	•Oxidation catalyst	•Oxidation catalyst	N/A	N/A
Diesel engines	•SCR system	•Diesel oxidation catalyst	•Diesel oxidation catalyst	•Diesel Oxidation catalyst	
		•Catalyzed filter	•Catalyzed filter		•Filter

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SUMMARY



- The EPA final rule and fact sheet are posted at:
<http://www.epa.gov/ttn/oarpg/new.html>

- Additional background information can be found at:
<http://www.regulations.gov>



QUESTIONS?



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