

# What is Retrofit Technology?

- Retrofit technology can be: *any change to an engine system above and beyond what is required by EPA regulations that improves the engine's emission performance:*
  - Catalyst or filter
  - Engine upgrade
  - Early engine replacement
  - Use of cleaner fuels or additives
  - Idling control equipment
  - Combination of above
- Retrofit Web site maintains a list of manufacturers and verified technology

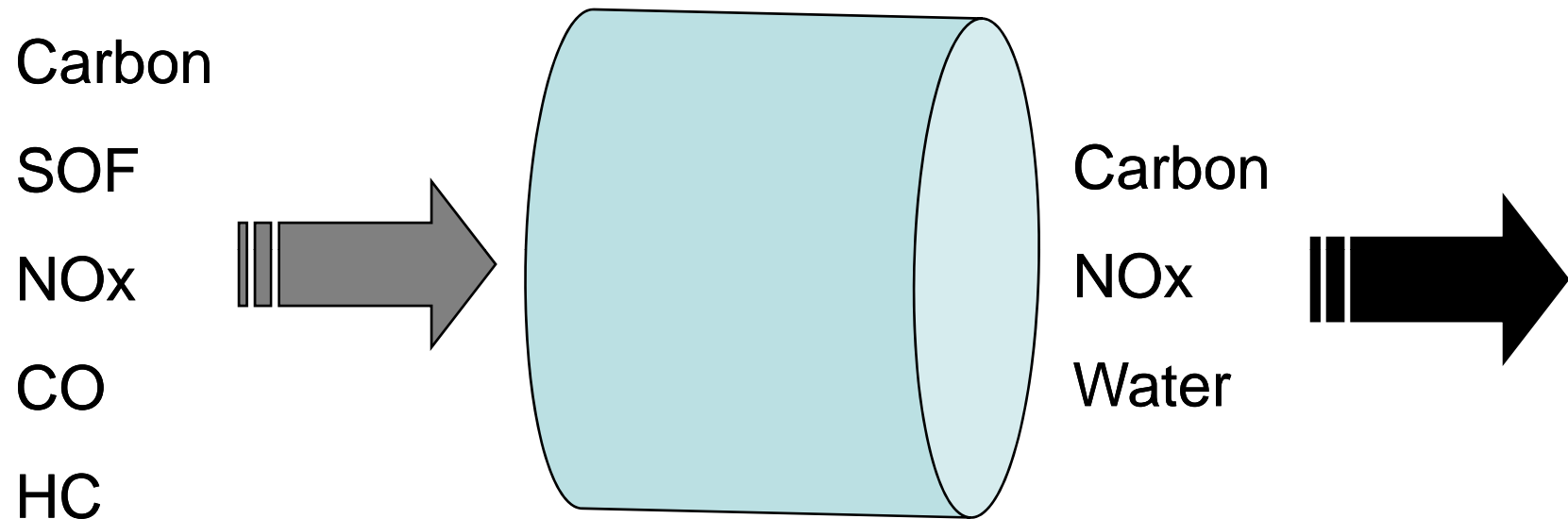
# Technology Selection

- Current Maintenance
- New Bus Purchases
- Fleet Make-up
- Engine Models & Years
- Driver Education & Support
- Duty Cycles
- Fuel Use & Storage
- Technology Choices
  - Catalyst or filters
  - Engine upgrade
  - Early engine replacement
  - Use of cleaner fuels or additives
  - Idling control equipment
  - Combination of above

# Technology Selection

- Confirm Verification
- Maintenance Requirements
  - Warning Systems / Options
  - Filter Cleaning Equipment
- Operating Conditions
  - Get Data Logging Results
- Improving Performance
- Warranty & Customer Support
- Feedback & Lessons Learned
  - In-use Testing Will Be Conducted
  - Experience with Grants
- Talk to EPA
  - OTAQ & Regions

# Diesel Oxidation Catalysts

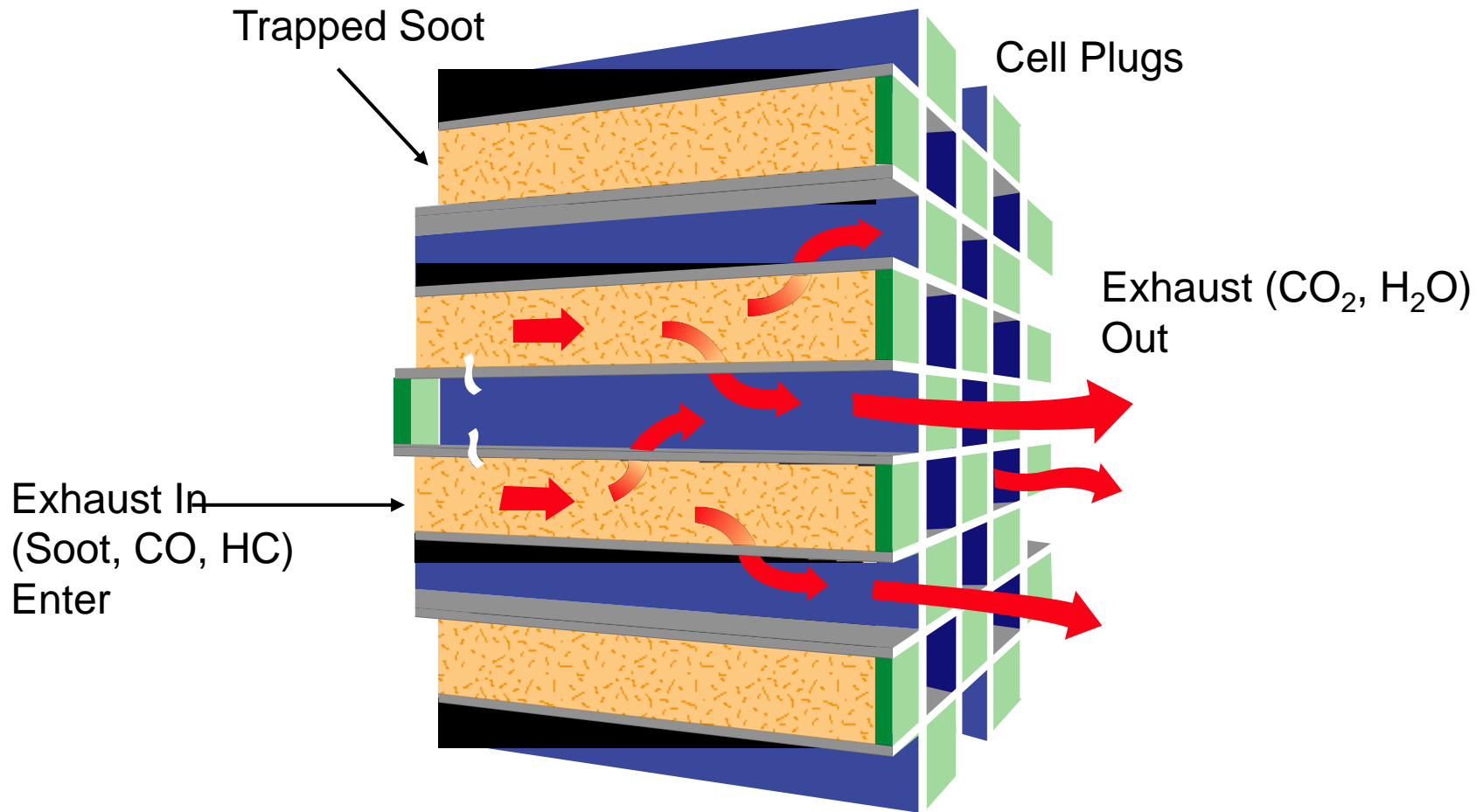


Oxidation catalysts oxidize carbon monoxide (CO), hydrocarbons (HCs) and the soluble organic fraction (SOF) to reduce particulate matter (PM), CO, HCs, and toxic emissions

# **Diesel Oxidation Catalysts Are Efficient and a Proven Technology**

- Hundreds of thousands have been retrofitted since the 1960s on highway, mining, materials handling and construction vehicles
- Durabilities in excess of 10,000 hours of operation
- Diesel oxidation catalyst control capabilities
  - PM 20 to 30% reduction
  - CO > 40%
  - HCs > 50%

# Diesel Particulate Filter Technology



# Diesel Particulate Filters Are Efficient

- Filter control capabilities
  - PM 80% to 90% reduction
  - CO > 75%
  - HCs > 85%

# **Key Considerations for Retrofit Programs**

# Consideration the following

- How long the vehicle/equipment is going to remain in service
- The condition of the engine is an important factor in making a decision whether to install retrofit control technology
- Retrofit at the time of engine rebuild can be advantageous
- For filter retrofit, one must consider: vehicle application, exhaust temperature (duty cycle), engine-out PM emissions, fuel sulfur level, and the regeneration strategy to be followed

# Consideration the following ...

- Retrofit Technology Check List
  - Model Year
    - Generally, only 1994 and newer should get PM filters
    - Some newer engines came with DOCs from the factory
  - Size
    - Properly sized control systems ensure low back pressure and maximum performance
  - Vehicle Integration
    - Space, accessibility and exhaust temperature are important vehicle integration issues
    - Devices are often installed in-line or as a muffler replacement

# Consideration the following ...

- Retrofit Technology Check List (cont.)
  - Fuel Type
    - For PM control, <15 ppm sulfur fuel allows for maximum emission control performance (even for DOCs) and best filter regeneration characteristics
  - Maintenance
    - Vehicles to be retrofitted should be properly and regularly maintained—key factor for success
    - Retrofit technologies should be maintained per their manufacturer's recommended procedures

# Frequently Asked Questions Concerning Retrofit Programs

- Costs
  - Costs depend on many factors including:
    - Number of vehicles retrofitted (sales volume)
    - Retrofit technology used (oxidation catalyst, filter, etc.)
    - Engine size (displacement)
    - Engine out emissions
    - Fuel quality
    - Exhaust temperature and duty cycle (These factors will affect which retrofit technology will be appropriate.)
  - Costs are expected to decrease as the market expands

# Frequently Asked Questions Concerning Retrofit Programs (cont.)

<b>Technology</b>	<b>Cost per Device/System (\$)</b>
Diesel Oxidation Catalysts (DOC)	425 to 1,150
Diesel Particulate Filters (DPF)	3,000 to 5,500
Combined Lean NOx Catalyst/DPF Systems	5,000 to 10,000
EGR Systems	13,000 to 15,000
SCR Systems	10,500 to 50,000

Notes: DPF costs are higher for active systems and systems that include backpressure monitoring (Year 2000 data).

# Frequently Asked Questions Concerning Retrofit Programs (cont.)

- **Drivability**
  - Properly selected retrofit technologies do not impair driving performance
- **Maintenance**
  - Oxidation and lean NOx catalysts are virtually maintenance free
  - Filters require very little maintenance (ash removal)
  - SCR maintenance, as per manufacturer's specifications
- **Effects on Engine Life**
  - Properly maintained engines and retrofit control systems do not shorten engine life

# Frequently Asked Questions Concerning Retrofit Programs (cont.)

- Fuel Penalties
  - Most oxidation and lean NO<sub>x</sub> catalysts have no effect on fuel consumption
  - Most filters have no effect on fuel consumption
- Warranties
  - Manufacturers provide various warranties as part of a purchase agreement

# Some Diesel Retrofit Web Sites

- U.S. EPA:
  - <http://www.epa.gov/otaq/retrofit>
- The Manufacturers of Emission Controls Association:
  - <http://www.meca.org>
  - Click on “Publications” to access MECA fact sheets and technical documents on diesel retrofit
- The Diesel Technology Forum:
  - <http://www.dieseltechnologyforum.com/>
- The California Air Resources Board’s Diesel Risk Reduction Program:
  - <http://www.arb.ca.gov/diesel/dieselrrp.htm>