

# DIESEL PARTICULATE FILTERS USED IN UNDERGROUND COAL MINES

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## PARTICULATE FILTRATION THEORY



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## CHOICES FOR DPM REDUCTION

“THERE IS NO SILVER BULLET”

- Maintenance
- Diesel particulate filters (soot traps)
  - Passive
  - Active
- Disposable diesel particulate ‘paper’ filters
- Alternative approaches
- Ventilation

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## MAINTENANCE

- What is proper maintenance?
- 100% buy in from management
- Regular scheduled maintenance
- Proactive emission reduction program
- Never be satisfied with where you are

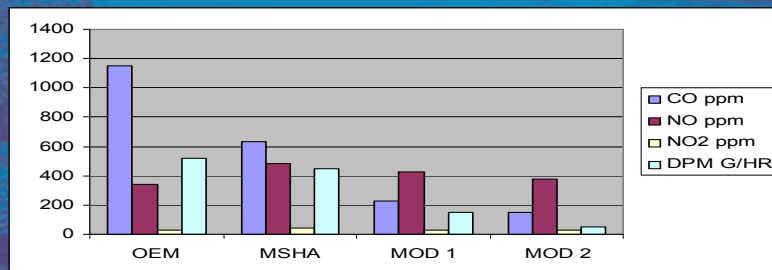
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## HOW BIG OF DIFFERENCE CAN IT MAKE?

- In 1997 CFC's fleet average concentrations of gases in raw exhaust were
  - 1597 ppm carbon monoxide
  - 997 ppm NO<sub>x</sub>
- In 2003 CFC's fleet average concentrations of gases in raw exhaust are
  - 158 ppm carbon monoxide
  - 458 ppm NO<sub>x</sub>

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## THE EFFECTS OF ENGINE TUNE ON THE EMISSIONS



	OEM	MSHA	MOD 1	MOD 2
CO ppm	1152	632	230	150
NO ppm	340	480	428	380
NO2 ppm	28	45	30	28
DPM G/HR	52	45 ?	14	5.3

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## PASSIVE SOOT TRAP

- The trap should regenerate itself
- The systems needs to be monitored for back pressure
- NO<sub>2</sub> might be a problem
- Relatively low cost

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## PASSIVE SOOT TRAPS



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## PASSIVE SOOT TRAPS

- PIB 02-04 warning about NO<sub>2</sub> production from platinum catalyzed soot traps for both metal/non metal and coal mines
- PIB 02-07 notice for coal only! Traps shall not increase NO<sub>2</sub> emissions

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## ACTIVE SOOT TRAP

- No NO<sub>2</sub> production
- Require space where filters can be regenerated safely
- Need a power supply
- Designed to trap soot during one or more shifts
- Relatively high cost

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## ACTIVE SOOT TRAP ON-BOARD SYSTEM



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## ACTIVE SOOT TRAP OFF-BOARD SYSTEM



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## EVALUATION OF DPF SYSTEMS IN COAL MINES

- Passive systems
  - Cordierite coated with platinum catalyst
    - Excess of NO<sub>2</sub>
  - Cordierite coated with base metal catalyst
    - So far more than 100 hours in operation

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## EVALUATION OF DPF SYSTEMS IN COAL MINES

- Active systems
  - Silicon carbide on-board el. regeneration DPF system
    - Insulating filter caused failure of electrical components
    - Redesigned, works well
    - Trouble free 300 hours

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## EVALUATION OF DPF SYSTEMS IN COAL MINES

- Silicon carbide off-board el. regeneration DPF systems
  - DPF accumulate engine pm output during 12 hour shift
  - At the end of shift the unit is replaced with spare one and sent for regeneration
  - Regeneration station is located in maintenance shop
  - Regeneration takes 40 min. to two hours
  - Regeneration schedule should be religiously followed
  - The regeneration process should be supervised by trained personnel
  - This approach is labor intensive and require changing operator's attitude

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## DISPOSABLE DIESEL PARTICULATE 'PAPER' FILTERS

- Heat exchanger
  - Wet (water scrubber and make-up tank)
  - Dry (air-to-water)
- Filter holder + 'paper' filter element
- Water separator (optional)
- Designed for in-by coal vehicles
  - Exhaust temp. Requirements (cooled exhaust)
  - Surface temp. Requirements (water jacketed exhaust manifold)
- High installation cost

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# DISPOSABLE DIESEL PARTICULATE 'PAPER' FILTERS - DRY SYSTEM



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# DISPOSABLE DIESEL PARTICULATE 'PAPER' FILTERS – DRY SYSTEM



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## DISPOSABLE DIESEL PARTICULATE 'PAPER' FILTERS - WET SYSTEM



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## DISPOSABLE DIESEL PARTICULATE 'PAPER' FILTERS

- Advantages
  - Relative simple to replace filter
- Disadvantages
  - Complex and expensive
  - Potential for fire
  - Short filter life
  - Wet system require maintaining water level in scrubber
  - Dry system require frequent heat exchanger cleaning

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## EVALUATION OF DISPOSABLE FILTERS

- Not all media has adequate properties
  - Most of the filters available on market are designed as air intake filters
- Tests showed low efficiency of certain filter media
  - Confusion
  - Use only verified media
- Fire hazard
  - High temperature filters
    - For wet systems
    - For out-by vehicles

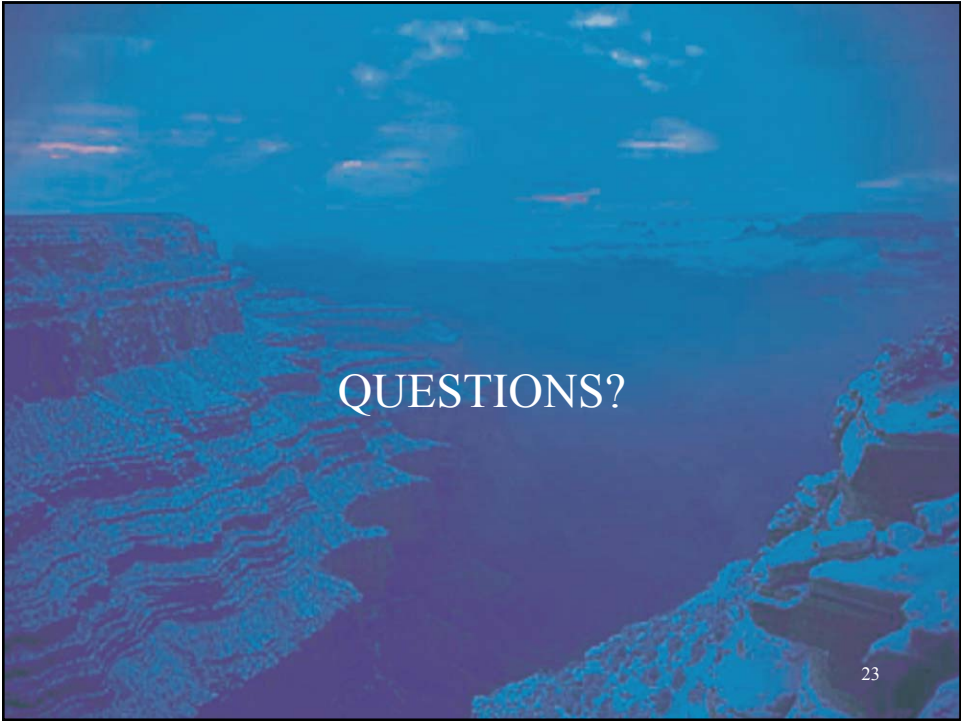
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## RETROFITTING DIESEL ENGINES OPERATED ON HIGH ELEVATIONS WITH DPFs

- Naturally aspirated and turbocharged engines should be adjusted for altitude prior to retrofitting them with DPFs
  - DPM and gaseous emissions are significantly affected by altitude
  - DPF system will be overwhelmed by DPM

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QUESTIONS?