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Johnson Matthey
Inspiring science, enhancing life

Innovation of DPF's from on/off road to underground mining

Stan Mack
Making underground mining air safer and healthier

MDEC 2018

Working in confined spaces requires enhanced attention to safety and health



Air quality is essential to safe, healthy, and productive operations

Johnson Matthey developed the **particulate/NO₂** technology to clean the exhaust from diesel engines and diesel particulate filters in confined spaces

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Innovation from on-road ⇨ off-road ⇨
underground mining

⇨ **On-Road**

- *Low temperatures* required catalytic soot filters (CRT®)
- *Control of NO₂* to <20% over engine out (AdvCRT®)



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Innovation from on-road ⇨ off-road ⇨
underground mining

⇨ **Off-Road**

- Diesel-Oxidation catalysts (DOC)
- Diesel-Particle-filter (DPF)
- 4-Way (combination) Diesel-Systems (SCRT)



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Innovation from on-road ⇨ off-road ⇨
underground mining

⇨ **Underground Mining** - Active control of NO_x

- Control of NO_x to >90% (SCRT®)
- Control of NO₂ to <20% over engine out emissions (Mining CRT LoNO₂)
- Control NO₂ to ≤ engine out emissions (Mining CRT Ultralow NO₂)



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Diesel Particulate Filters

DPF Regeneration

Passive systems:

regenerate without external assistance:

CRT® and CSF (catalysed soot filters)

Easy to install and operate

Active systems:

requires external input to enable regeneration:

Electrical heaters, Burner systems, Fuel Borne Catalyst

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Passive Diesel-Particulate filter

Advantages of passive diesel-particulate filters

Starts to regenerate at very low 220 °C to 250°C during engine operation

Need no additional energy

No operator intervention

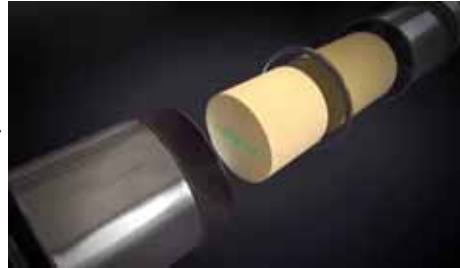
Replaces the original muffler/silencer

Simply built-up

Less maintenance

Suitable for retrofit and OE-fit

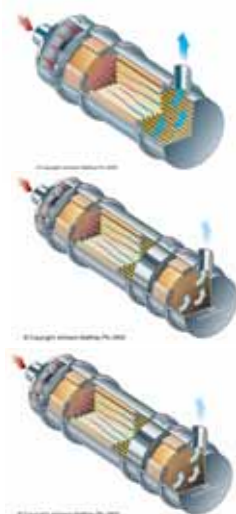
Can be used with nearly all diesel engines



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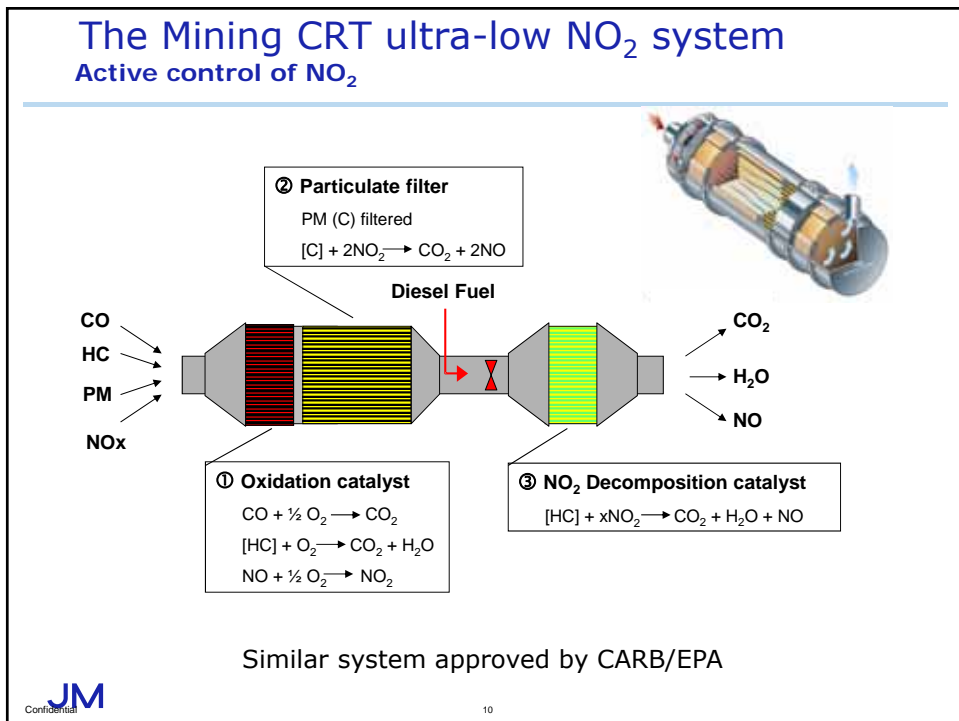
Passive Diesel-Particulate Filter

Advances from on-road to off-road, and now to underground

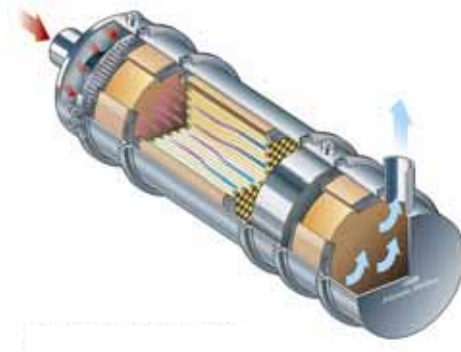


- DPF-(C)CRT for continuously filter regeneration during engine operation at above **220°C/250°C**, Uses low sulphur (< 50 ppm) fuel [CRT® is a **CARB and VERT certified** particulate filter].
- Actively reduce NO₂ emissions to no more than 20% above engine out emissions. [AdvCART is a **CARB certified** filter]
- Control NO₂ emissions at or below engine out emissions. [Mining CRT]

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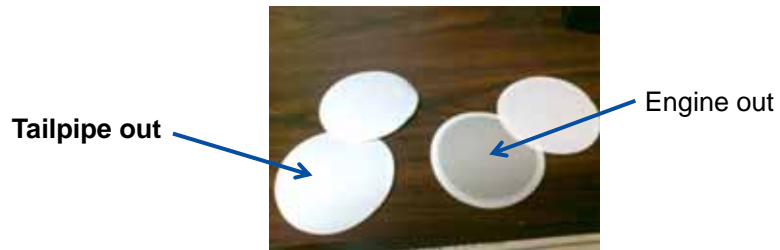
Particulate and NO₂ Reduction Johnson Matthey Mining CRT



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Phase I Mining-CRT[®] testing at CANMET Lab in Ottawa Mining CRT on test stand

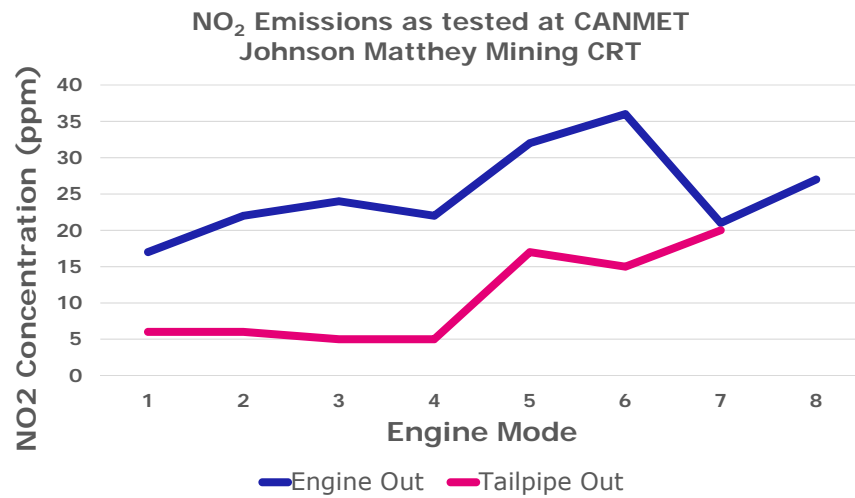
8-Mode DPM by mass



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The Mining CRT – 8 mode test at CANMET

NO₂ controlled to at or below engine out emissions



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Phase I Mining-CRT Testing - CANMET Lab Summary

- Mining-CRT[®] function successfully demonstrated over 8-Mode and transient Mode
- Low HC-injection rates (max.190 ml/hour)
- Outstanding DPM reduction
- NO₂ tailpipe out is less than engine out emissions over cycles tested

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Phase II Ming-CRT[®] Surface Testing At Totten Mine
Filter system specification

Filter type:	Johnson Matthey Mining-CRT 2 x 2013SL
Regeneration:	Catalytic, continuously during operation
Requirements:	ULSD Fuel, S< 50ppm Exhaust gas temperature >250°C for >50% of the operational time
Particulate reduction:	> 99% by particulate number
NO ₂ , CO and HC reduction:	Reduction
Filter body:	Stainless Steel

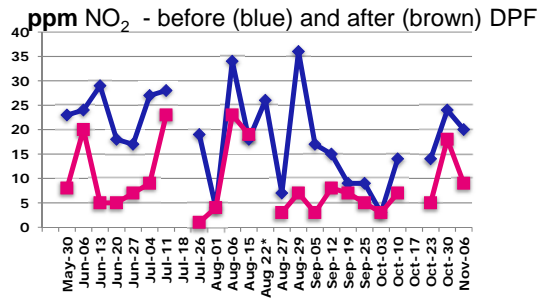


Phase II Ming-CRT[®] Surface Testing At Totten Mine
ECOM results

	NO₂ Intake (ppm)	NO₂ Exhaust (ppm)	Reduction
Dual Torque Stall Test #1 @ 1500 rpm	11	8	27%
Dual Torque Stall Test #2 @ 1500 rpm	10	8	20%
Dual Torque Stall Test #2 @ 1500 rpm	10	9	10%

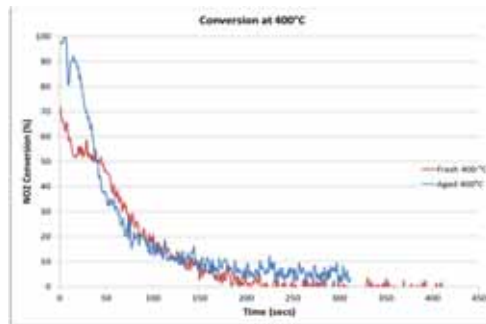


Phase III Mining-CRT® Underground Testing at Copper Cliff
Real life emission testing



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SCAT testing of NO₂-decomposition catalyst after 2,000 hours



Results of the aged core are that at 400°C storage did not changed. At all tested temperatures results indicate that there is still adequate conversion to reduce NO₂ even after 2000Hours. By this results a lifetime >5,000 hours can be expected.

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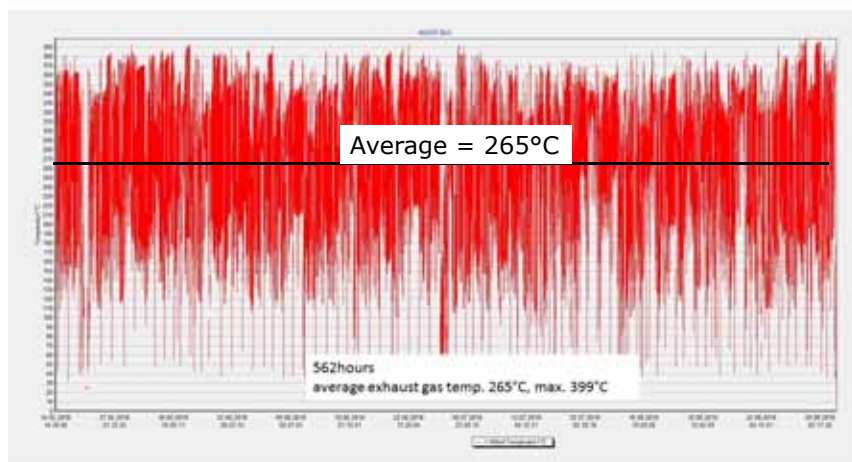
Phase III Mining-CRT® Testing – Underground testing Summary

The Mining-CRT

- is very effective in removing diesel aerosols
- is also effective in removing CO and HC emission
- does not exhibit adverse effects on NO₂ emissions

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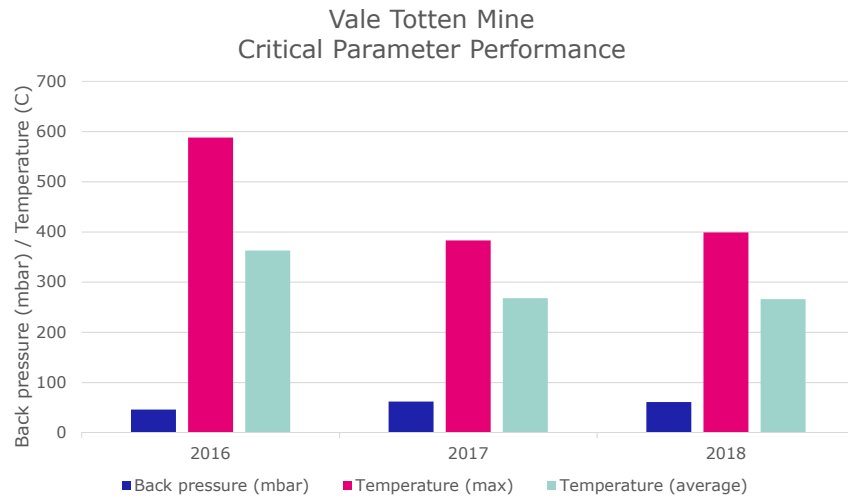
Vale Copper Cliff Mine Mining CRT Typical operating temperatures allow regeneration



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Vale Totten Mine Mining CRT in operation Performance continues after over 1,300 hours



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Applications

Material handling



Agriculture



Quarry machinery



Railway



Construction



Generators



Mining
+ tunneling



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Thank You

Questions?

