Progress on NH_3-SCR Catalyst for NO_x Reduction Applicable to Mining Diesel Engines

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Outline

- Background
- Catalyst aging
- Evaluation of fresh and aged catalyst using catalyst testing unit (CTU)
- Preparation for engine test
- Testing of aged catalyst on engine
  - Light-duty engine test
  - Mining engine test
- Results
- Conclusions

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Background

- Objective
  - Development of new materials for the catalytic reduction of NOx from diesel vehicle exhaust
  - Evaluation of catalyst stability
- Testing of aged catalyst
  - Bench scale
  - Prototype catalytic converter (PCC)
  - Engines: light-duty and mining
- Applications
  - On- and off-road diesel vehicles

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Accelerated Aging Procedure

- Aging procedure with used engine oil:
  - 15W40 oil run on Kubota V3300TE
- Aging of catalyst particles
  - Used engine oil was added to cover catalyst particles
  - After 2 h catalyst was filtered, dried at 120 °C overnight
  - Calcined at 550 °C for 6 h
- Aging of prototype catalytic converter
  - Added ~500 ml of used engine oil in PCC core
  - Left to soak, dried at 120 °C overnight
  - Calcined at 550 °C for 6 h
- Evaluation of aged particles and PCC using same conditions as fresh catalyst.

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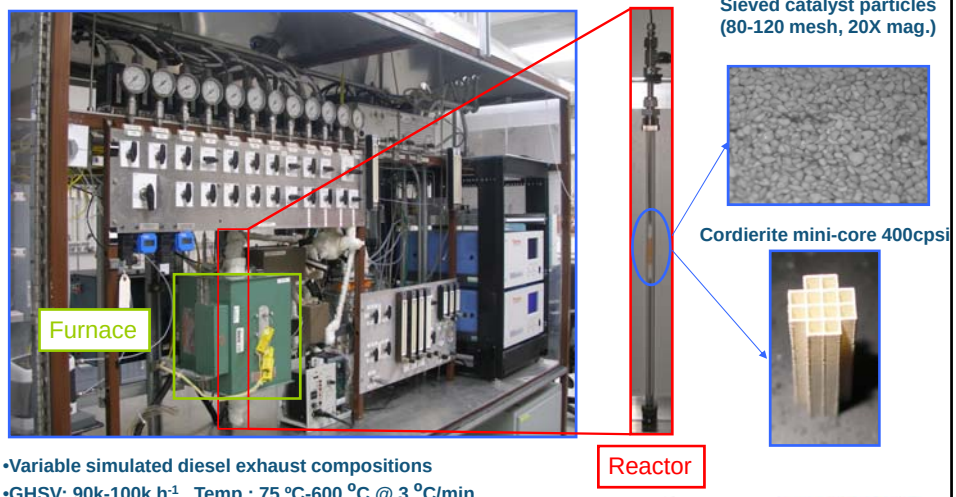
Catalyst Testing Unit (CTU)



- Variable simulated diesel exhaust compositions
- GHSV: 90k-100k h^{-1} , Temp.: 75 ºC-600 ^{o}C @ 3 ^{o}C/min
- Feed composition: 5-10% H_2O, 500-800 ppmv NO_x, 5-17% O_2
- Reductant: 500-800 ppmv NH_3

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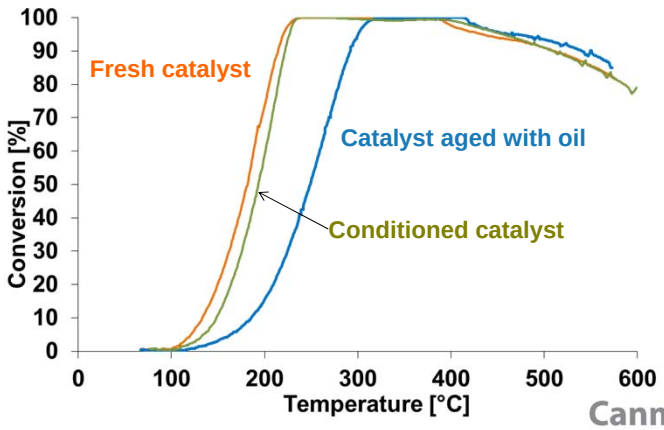
$DeNO_x$ Activity of Fresh and Aged NH_3-SCR Catalyst Tested as Particles



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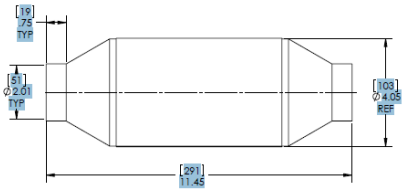
Prototype Catalytic Converter

- Manufactured by DCL International Inc.
- CanmetENERGY catalyst
- Cordierite core (400 cpsi)
- Stainless steel can
- 1.0 L, loading: 206 g/L_{sub}



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Engine Tests of Fresh and Aged PCC

- Environment Canada
  - Various steady states at predetermined temperatures
  - Upstream Catalyzed Diesel Particulate Filter (CDPF)
  - Full flow
  - Reductant: NH_3 (g)
- CanmetMINING
  - ISO 8178(C1)
  - Progressive load increase test at fixed RPM
  - Upstream Catalyzed Diesel Particulate Filter (CDPF)
  - Split flow
  - Reductant: NH_3 (g)

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Engine Specifications and Test Parameters

Test Facility	Environment Canada	CanmetMINING	
Engine type/size	VW turbo diesel, 1.9 L	DDEC series 60, 11.1 L	
Cylinders	4	6	
Maximum power	88 bhp @ 3750 RPM	325 bhp @ 2100 RPM	
Test	Various steady states at predetermined temperatures	ISO8178 (C1)	Progressive load
GHSV (k, h^{-1})	~34-120	~6-98	~45-60
Engine speed (RPM)	~1600-1900	600-2100	1260
Torque (lb.ft)	~35-59	0-1075	26-1074
Power (bhp)	~10-22	0-312	26-258

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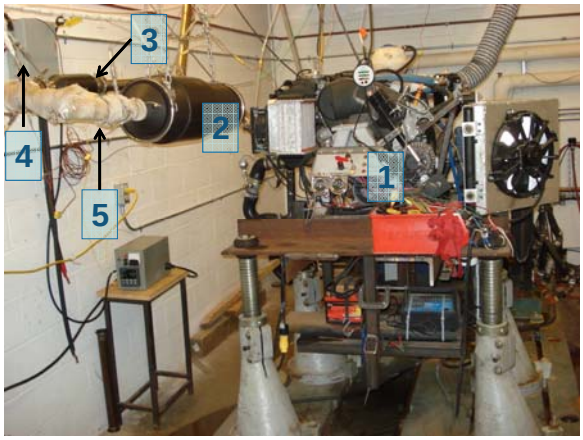
Engine Test PCC Setup at Environment Canada



1. Engine
2. CDPF
3. 1 L NH_3-SCR PCC
4. Heated sampling line
5. Exhaust pipe

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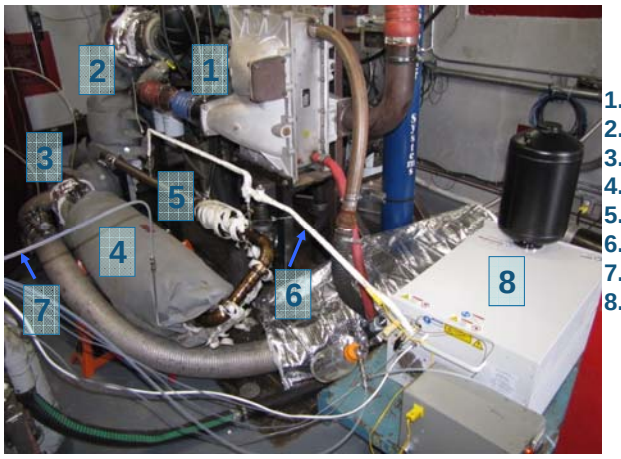
Engine Test PCC Setup at CanmetMINING



1. Engine
2. Engine exhaust pipe
3. Flow Splitter
4. CDPF
5. 1 L NH_3-SCR PCC
6. Heated sampling line
7. Reductant delivery line
8. FTIR

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Modified Set-up of PCC Engine Test

Electronically controlled, exhaust back pressure valves

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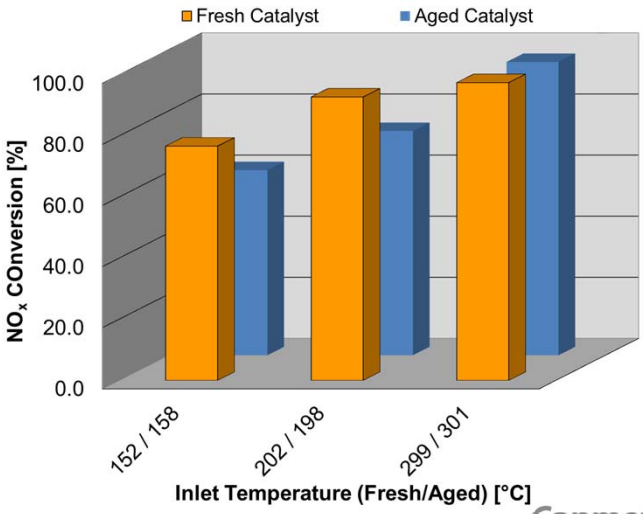
Results of PCC Evaluated on Light-Duty Engine



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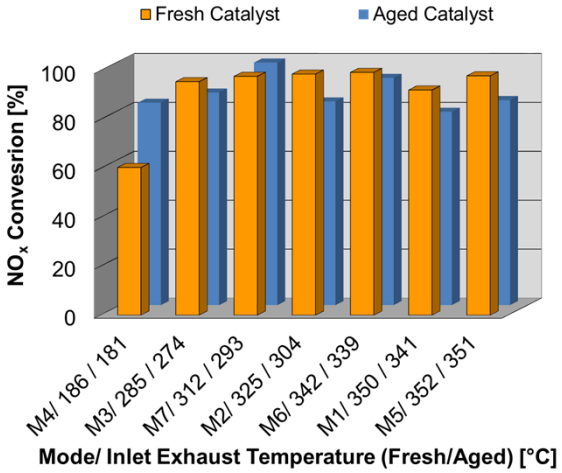
Results of PCC Evaluated on Mining Engine ISO8178 test



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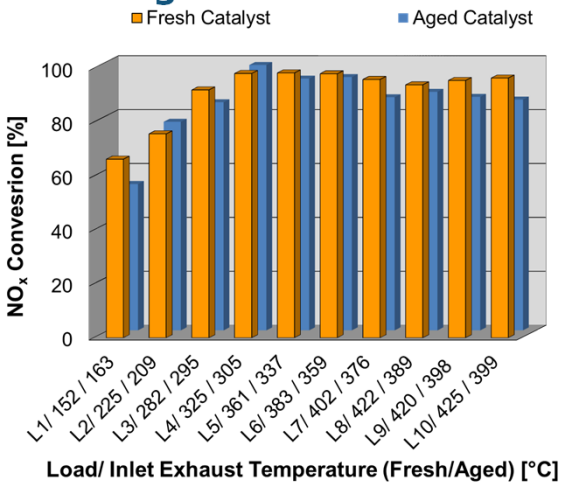
Results of PCC Evaluated on Mining Engine Progressive Load test



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Conclusion

- DeNO$_x$ catalyst aged and evaluated for DeNO$_x$ performance
  - Particles on CTU
  - PCC Light-duty diesel engine
  - PCC Mining Diesel engine
- Particles
  - Fresh and aged particles attained 100% NO$_x$ conversion
  - NO$_x$ conversion shifted to higher temperatures
- Engine Tests
  - Comparable NO$_x$ conversion for fresh and aged PCC on light-duty engine
  - Aged catalyst tested on mining engine showed high NO$_x$ reduction activity at low and high temperature with small variations depending on the temperature.

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- **Thank you!**
- **Questions?**

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