



Field Experience with DPFs for Off-Road Engines Operating on Biodiesel

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Outline

- Introduction
- Engine and DPF
- Filter failure problems
- Analysis of fuel, ash
- Summary

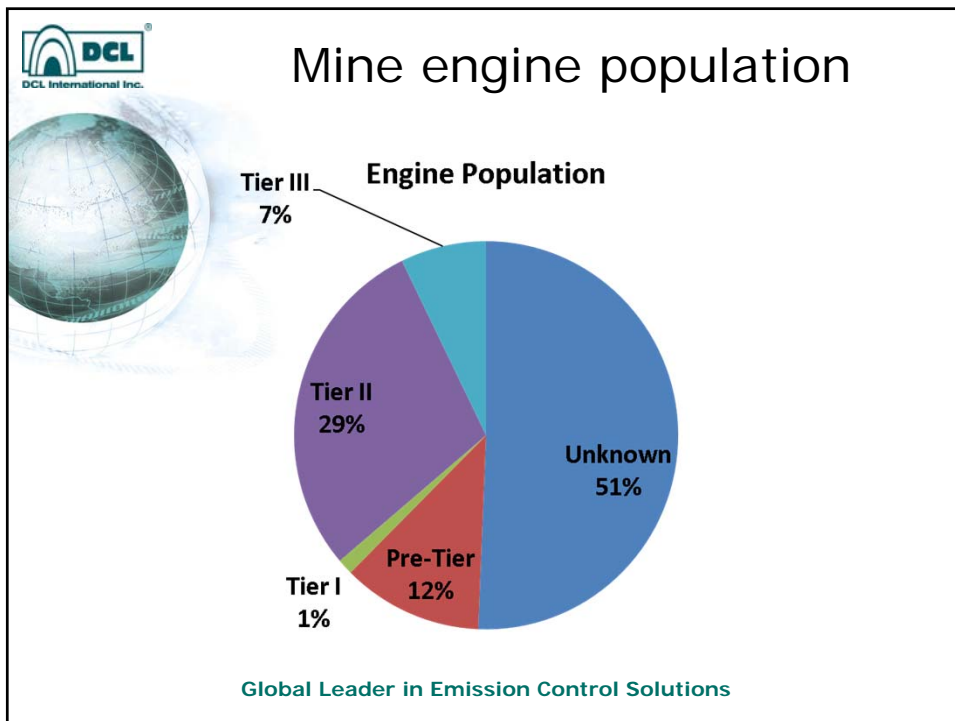
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Engine models

Engine model	Tier
Detroit Diesel 50	2
Detroit Diesel 6V92TA	1
Detroit Diesel 60	2
Detroit Diesel 6V92TA	1
Deutz BFM1013	
Deutz F6L912W	2
Deutz BF4L2001	2
Deutz F6L914W	
Caterpillar 3054E	
Caterpillar C7	3
Mercedes OM904LA	2

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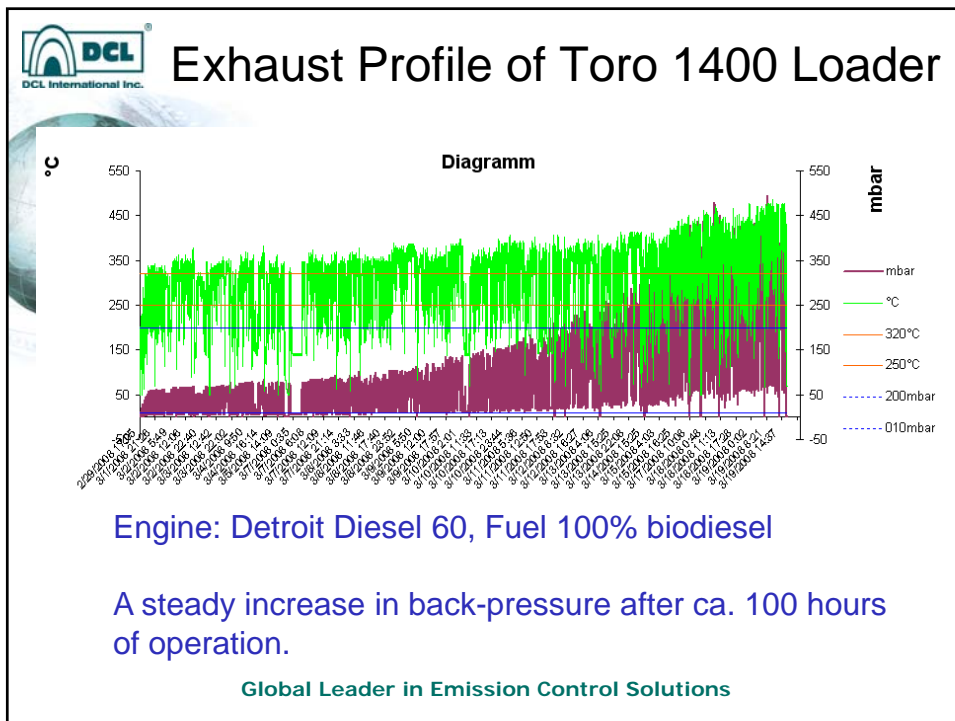



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DPF Specifications

Filtration Material	Wall flow cordierite
Cell Density	200 cpsi
Coating	Platinum group metals on proprietary washcoat
Regeneration Method	Passive continuous regeneration

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 **BET Surface Area of DPF Washcoat**

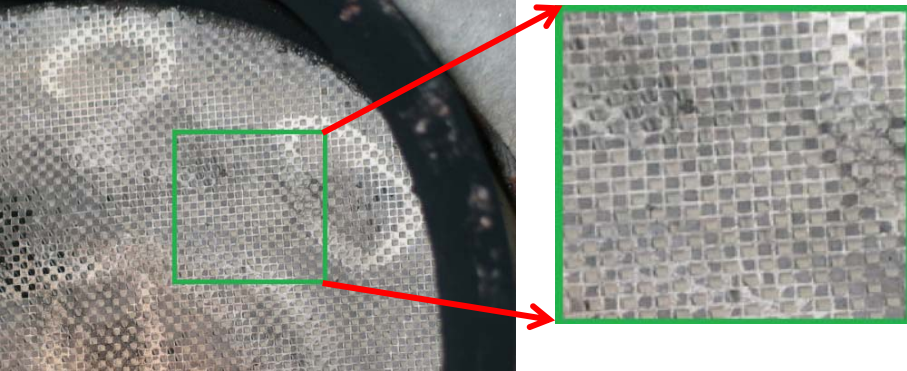
Conditions	Unit	BET area
Fresh	m ² /g	87.8
100 h in service	m ² /g	60.0

BET theory is an important analysis technique for the measurement of the specific surface area of a material.

The surface area of catalysts is an important factor in catalytic activity.

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 **Visual inspection**



Filter cells are plugged by whitish sooty materials. Collecting the sooty materials, >20wt% is ash.

- Possible sources of ash: lube oil, biodiesel, dust, etc.
- Elemental analysis may help find the source of the ash.

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 **Elemental Analysis of Ash**

Element	Concentration
Name	Mass%
Magnesium	4.269%
Calcium	20.057%
Zinc	4.315%
Sulphur	8.825%
Phosphorus	10.114%
Aluminium	1.515%
Silicon	1.080%
Iron	4.231%
Copper	0.363%

Derived from biodiesel?

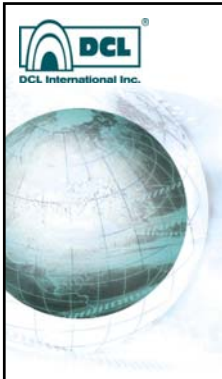
Derived from dust and/or lube oil?

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 **Summary of Fuel Analysis**

Test	Method Referenced	Results	ASTM D6751-06a max. (biodiesel)	Units
Sulfur	D5453	3.7	15 (S15 grade)	ppm
Water and Sediment	D2709	<0.025	0.05	vol%
Sulfated Ash	D874	<0.001	0.020	mass%
Ash	D482	<0.001	0.01	
Phosphorus	D4951	<0.001	0.001	mass%
Calcium (Ca)	EN14538	27.2	5 (Ca + Mg)	ppm
Magnesium (Mg)	EN14538	10.0	5 (Ca + Mg)	ppm
Sodium (Na)	EN14538	2.2	5 (Na + K)	ppm
Potassium (K)	EN14538	<1	5 (Na + K)	ppm

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Conclusions

- Cause of DPF failure is ash deposits
 - Magnesium and calcium source is biodiesel.
 - Ca and Mg in biodiesel were above ASTM maximums.
- Zn and P levels suggest high lube oil consumption.
 - Possible cause engine maintenance or lube oil dilution by the biodiesel.

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