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Effect of Biodiesel Blended Fuel on Emissions of a Diesel Engine Equipped with DST® Emission Control Technologies

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#07-121

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Background Biodiesel

- Produced by reacting soybean or canola oil derivatives with methanol.
- Very low sulphur content.
- Very low aromatic content (or PAH's)
- About 11% oxygen content (petrodiesel 0%)
- Higher cetane, viscosity and cold flow point.
- Lower heating value.
- Better lubricity.
- Higher flashpoint.
- No toxicity or low toxicity

2

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Petro and Biodiesel

- Biodiesel (B100) conforms to ASTM D6751-06b Standard - Methyl Ester
- Dieseldiesel conforms to CGSB 3.16 Standard
- Biodiesel (B50) mixed 50/50 volumetric basis in laboratory
- Biodiesel (B52) by chemical analysis

3

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Analyzed Fuel Properties

Property	Diesel	B100	B50
Sulphur, ppm	310	6.2	137
Oxygen, wt%	--	10.7	5.75
Density @ 15°C, kg/m^3	818.10	885.7	852.3
Specific gravity, 60/60°F	0.8185	0.8865	0.853
Carbon, wt%	88.28	78.4	82.86
Hydrogen, wt %	13.38	11.65	12.35
Nitrogen, wt %	24.9 ug/g	<0.5	<0.5
Water content, wt%	--	0.11	0.05
Total acid Number, mg/g	--	0.098	0.059

4

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Analyzed Fuel Properties

Property	ASTM Test	Specifications	B100	B50
Free glycerin, %mass	D-6584	Max. 0.020	0.001	--
Total glycerin, % mass	D-6584	Max. 0.240	0.545	--
Monoglycerides, %mass	D-6584	--	0.384	0.224
Diglycerides, %mass	D-6584	--	0.978	0.535
Triglycerides, %mass	D-6584	--	2.856	1.664

5

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EPA Biodiesel Report 2002

- Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions.
- Based mostly on heavy-duty, on-highway engines.
- Large number of engines and test data incorporated into a database.

6

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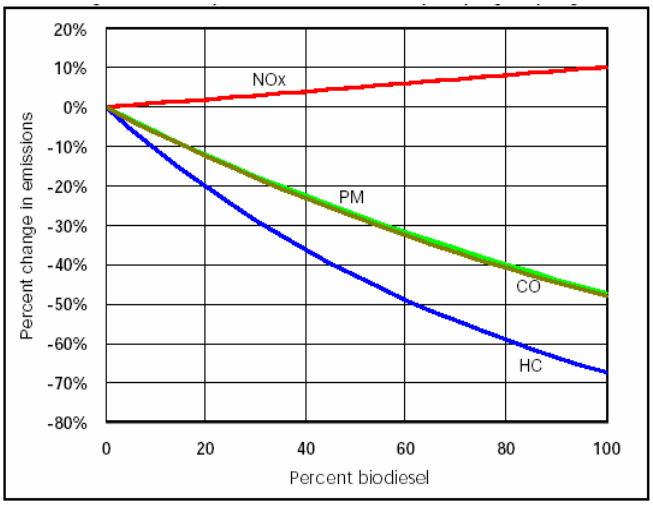
EPA - Report 2002 (Composite)



7

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EPA Report - 2002
NIOSH - MDEC 2005

- EPA - Conclusions generally indicate a decrease in CO, DPM and increase in NOx with Biodiesel
- NIOSH - Conclusions indicate a decrease in PM with the use of disposable Filter Cartridges (DFC)

8

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Engine Dynamometer Testing

- Test Lab: NRCan, CANMET-MMSL, Ottawa
- Accreditation: ISO 9001-2000, ISO/IEC 17025
- Test method: ISO 8178-1
- Test data: 8-modes of ISO 8178-C1
- Baseline test: Mining diesel CGSB-3.16, 310 ppm sulphur
- Fuel B50 test: 50/50 mix Biodiesel and CSA fuel, 137ppm sulphur
- Testing: Isuzu 6BG1-MAP 116hp engine with DST® powerpack

9

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Engine Installation in the Test Cell

10

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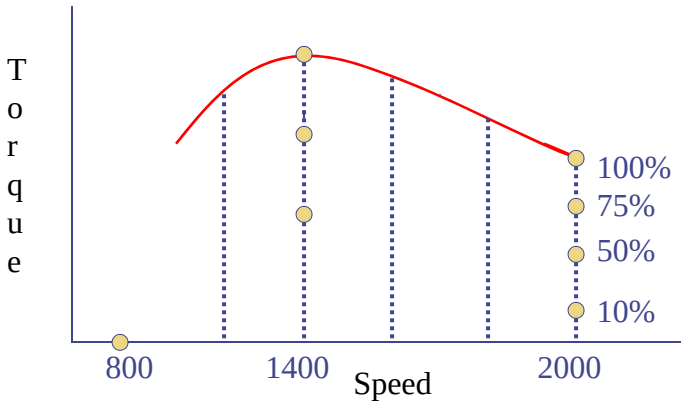
ISO 8178-C1 Test Cycle



11

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Test Measurements

- Engine parameters
  - Speed, torque, power, fuel rate, exhaust temperature
- Exhaust gases
  - CO, CO_2, NO, NO_x, O_2, THC
  - Particulates (DPM)
- Calculations
  - Emission rate in g/h
- Measurements taken after the DST® exhaust treatment

12

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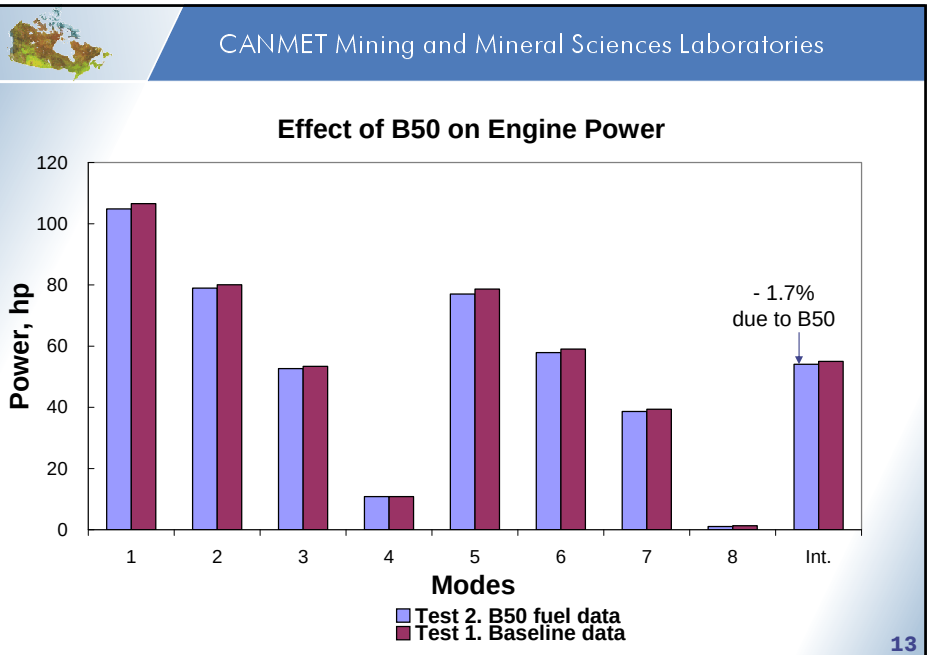

13

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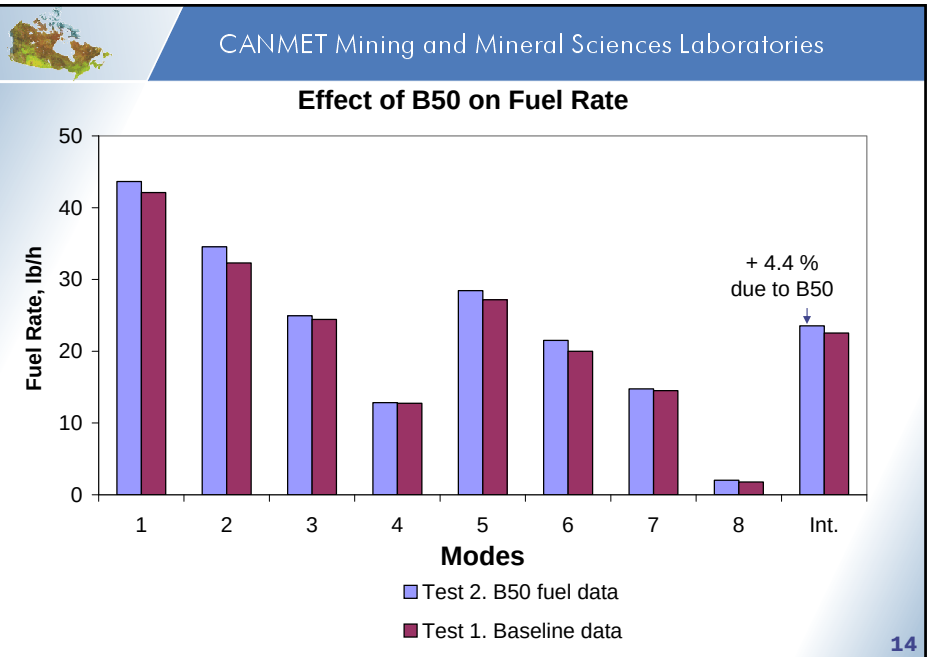

14

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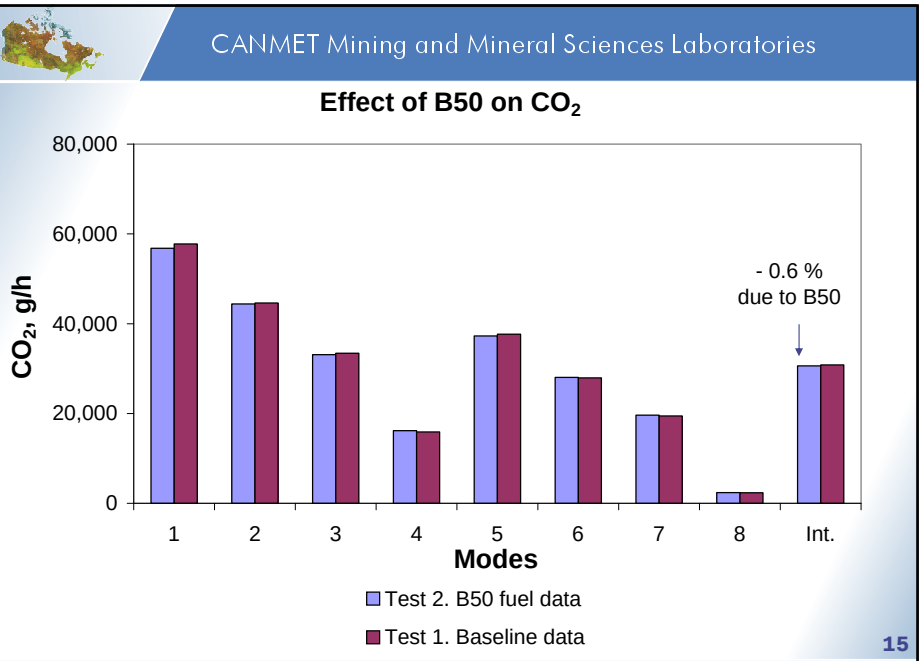

15

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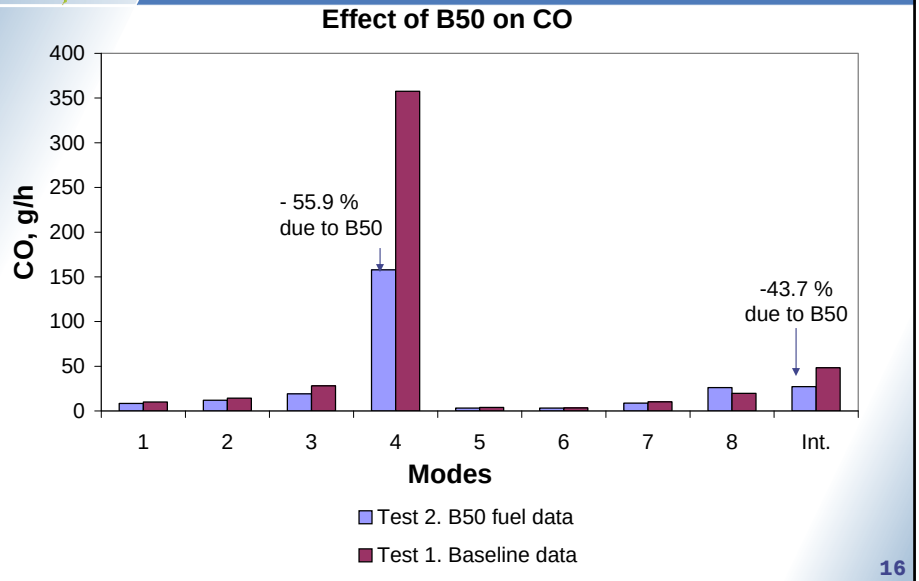

16

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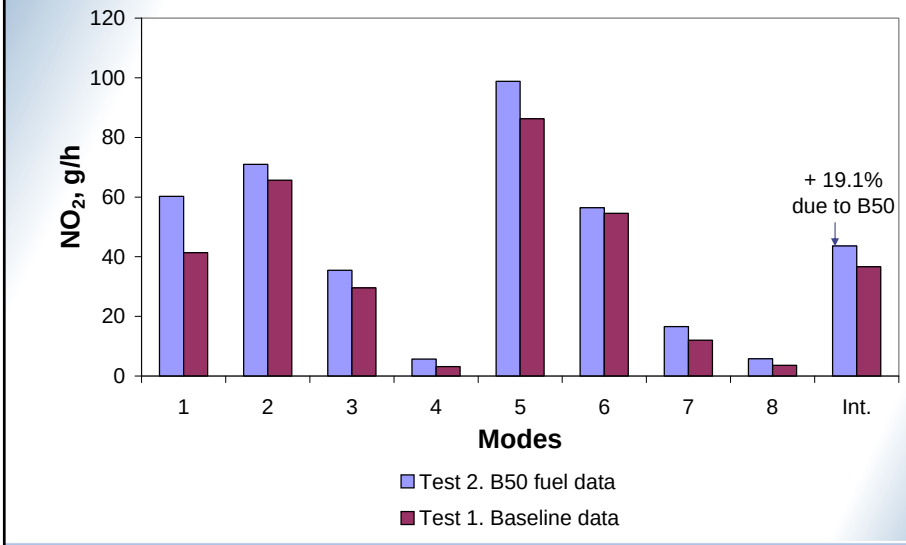

17

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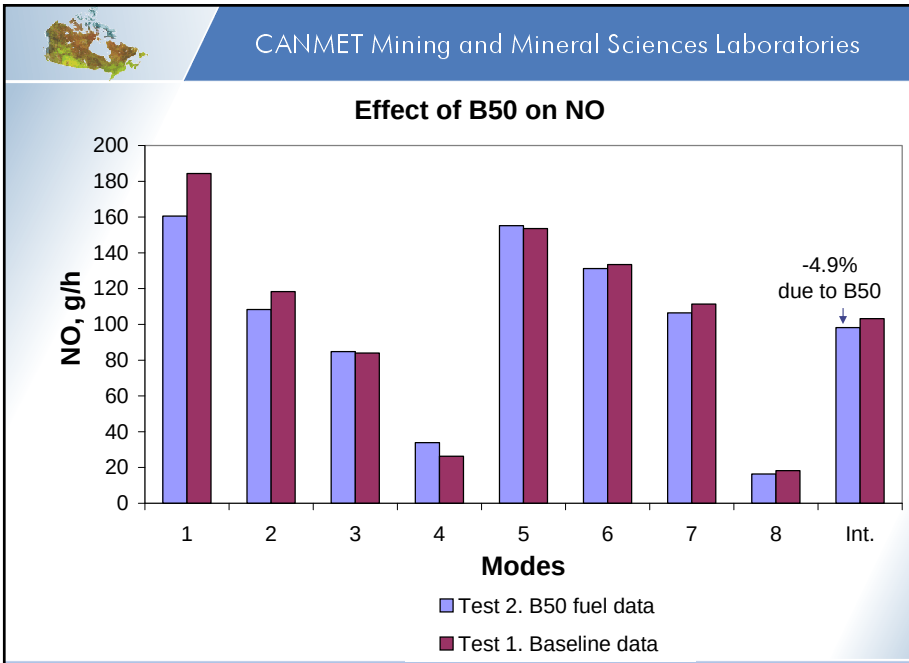

18

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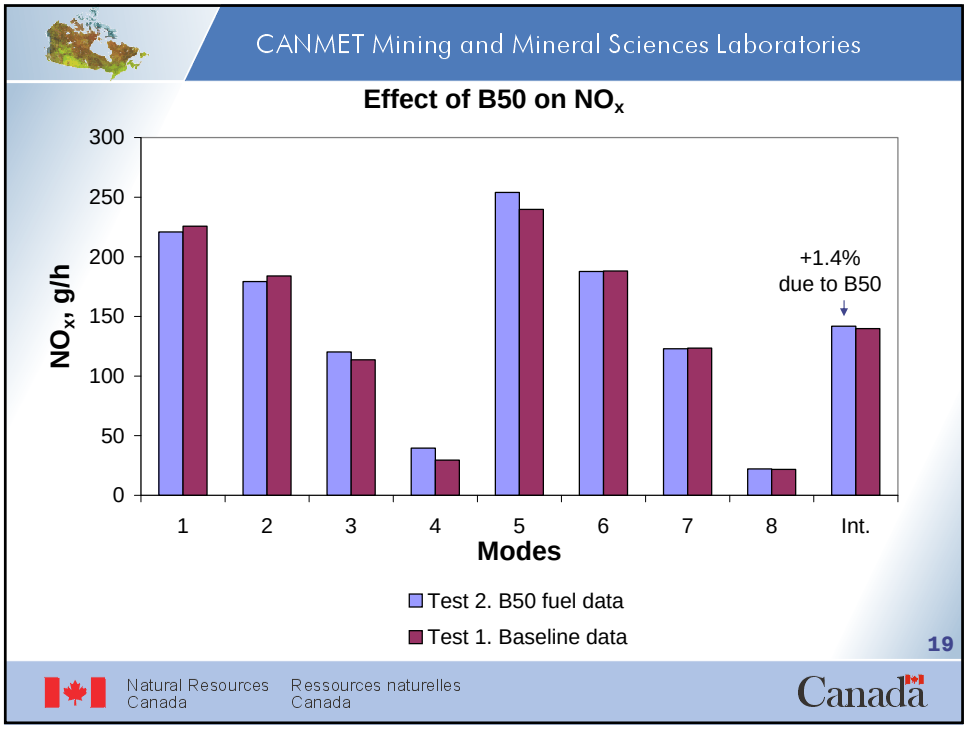
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Effect of B50 on NOx
NOx, g/h
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
Int.
Modes
+1.4%
due to B50
Test 2. B50 fuel data
Test 1. Baseline data
19
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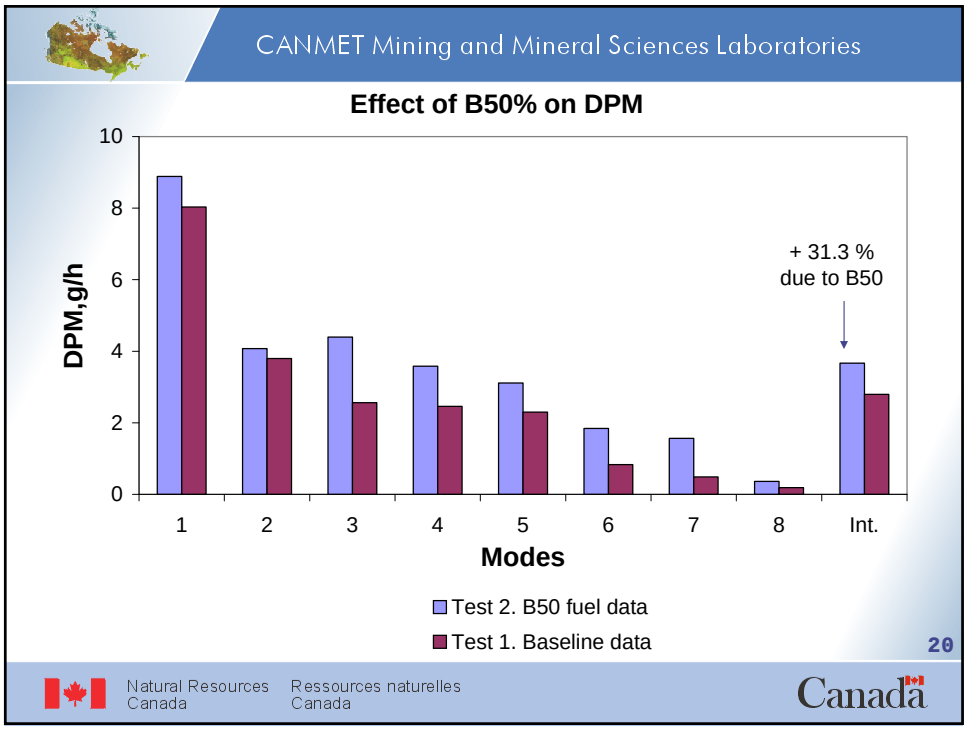
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Effect of B50% on DPM
DPM,g/h
10
8
6
4
2
0
1
2
3
4
5
6
7
8
Int.
Modes
+ 31.3 %
due to B50
Test 2. B50 fuel data
Test 1. Baseline data
20
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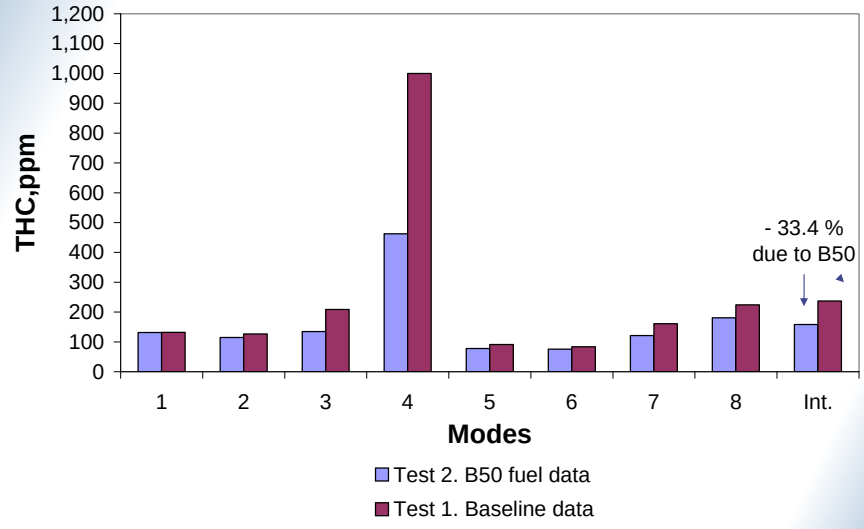

21

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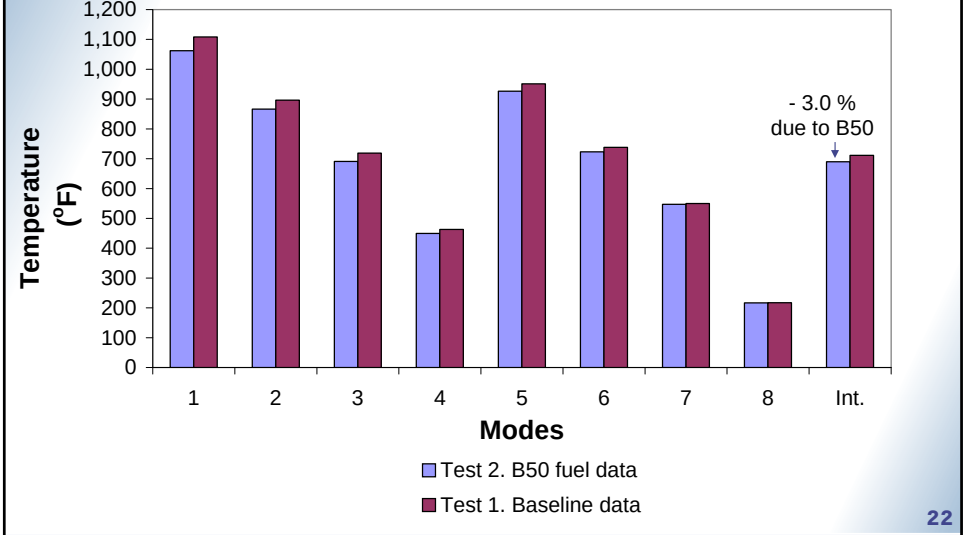

22

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Effect of B50 on Power, Fuel & Emissions (8-Mode Integrated Value)

	Base-line	B50	Change %	Comments
Power (hp)	55	54	-1.7	-
Fuel (lb/h)	22.5	23.5	+4.4	-
CO_2 (g/hr)	30811.6	30618.0	- 0.6	
CO (g/hr)	48.3	27.2	- 43.7	All Modes
NO_2 (g/hr)	36.6	43.6	+19.1	All Modes
NO (g/hr)	103.2	98.2	- 4.9	-
NO_x (g/hr)	139.8	141.8	+ 1.4	-
DPM (g/hr)	2.8	3.7	+ 31.3	All Modes

Findings

- The overall effect on DPM reduction is primarily dependent on filtration efficiency and catalyst properties.
- The reduction in HC and CO and slight increase in NOx is consistent with that reported in EPA 2002 and catalytic properties.
- The DST® filtration package could provide a low temperature filter solution for the reduction of DPM without the need for high exhaust temperature for regeneration.