

The cover slide features a collage of images at the top: a snowy forest, a modern building, an offshore oil rig, a satellite dish, and a mining site. Below the collage is the text 'NATURAL RESOURCES CANADA - INVENTIVE BY NATURE'. The main title is 'Impact of Low Level Biodiesel Blended Fuel on Emissions of an Underground Mining Diesel Engine'. The authors are 'Brent Rubeli and David Young' from 'CanmetMINING', with the identifier 'WF36251999'. The event is the '2019 MDEC Conference'. The bottom of the slide has the Natural Resources Canada logo and the word 'Canada'.

NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Impact of Low Level Biodiesel Blended Fuel on Emissions of an Underground Mining Diesel Engine

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2019 MDEC Conference

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The introduction slide has a green header with the number '2'. The title is 'Introduction'. It contains four bullet points. The bottom of the slide has the Natural Resources Canada logo and the word 'Canada'.

Introduction

- Ontario now mandates at least 4% biodiesel (B4) in diesel fuel. This is averaged so some areas may have more or less blend depending on the local supply chain.
- There is a possibility that some mines may receive B5-B20 blend levels due to this program.
- OMA has concerns about the requirements for renewable content in diesel fuel above B5, despite the GHG benefits, as prior work has shown some increase in NOx emissions which may be an issue for underground operations.
- CanmetMINING has conducted several prior studies on biodiesel and recently conducted a new study on low-level blends for the OMA.

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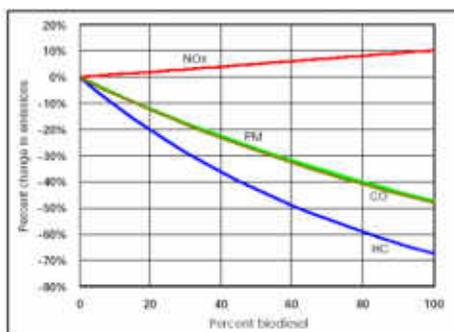
Project Scope

- Funding was unavailable for a comprehensive study so a literature study was conducted to refine the project.
- Information is available on B20 to B100 from many sources since these blends have the largest effect on emissions.
- Information on B1-B5 are available based on research conducted for manufacturer’s warranty and regional air quality
- The following test matrix was used to refine the project.

Test Matrix					
	Biodiesel Blend Rate (%)				
	0	5	10	15	20
Baseline		x	x	x	x
Feedstock 1	x				
Feedstock 2	x				
Feedstock 3	x				
Baseline		x	x	x	x

Literature Review

- Large numbers of studies for B20-B100 blends.
- EPA published a comprehensive report in 2002.
- Studies also performed at the B1-B5 level for air quality modeling and engine compatibility research.



- Generally: decrease in CO, DPM and HC emissions for increasing blend rate with a small increase in NOx.
- No significant changes in emissions at the B1-B5 level.
- CANMET project will focus on the gaps at the B5, B10, and B15 level as well as the NO and NO2 split.

Methodology

- The project was refined to just three blends, B5, B10 and B15 (D6751) and the baseline mines diesel fuel (CGSB 3.16).
- The blending was done on-site using biodiesel provided by BIOX corporation from fresh vegetable oil feedstock.
- Fresh vegetable oil feedstock can have the most effect on NOx emissions and so was chosen to be a worst case.

ASTM D7371 Biodiesel Blend Rate		
Fuel	Target Blend (%)	Result (%)
CGSB Mines Fuel	0	<1.00
BIOX Biodiesel	100	>99.99
B5 Blend	5	5.35
B10 Blend	10	9.62
B15 Blend	15	14.95



Engine Dynamometer Testing

- Test Lab: CanmetMINING, Ottawa
- Accreditation: ISO/IEC 17025
- Test method: ISO 8178-1
- Test data: 8-modes of ISO 8178-C1
- Baseline test: Mining diesel fuel, ~6 ppm sulphur
- Fuel blended B5, B10 and B15 test and mining fuel.
- Testing: Detroit Diesel Series 60 engine, 325 hp, MSHA/CANMET.



7

Test Results - Integrated

- Engine parameters: speed, torque, power, fuel rate.
- Exhaust gases, CO, CO₂, NO, NO_x, O₂, THC
- Particulates (DPM)
- Calculations - Emission rate in g/hr and g/bhp-hr

Engine parameter	unit	Baseline Fuel	Biodiesel 5%	Biodiesel 10%	Biodiesel 15%
Speed	rpm	1623	1623	1624	1623
Torque	lb.ft	525	526	525.9	526
Power	hp	170.6	171.0	171.0	171.0
Fuel rate	lb/hr	62.0	62.1	62.6	63.0



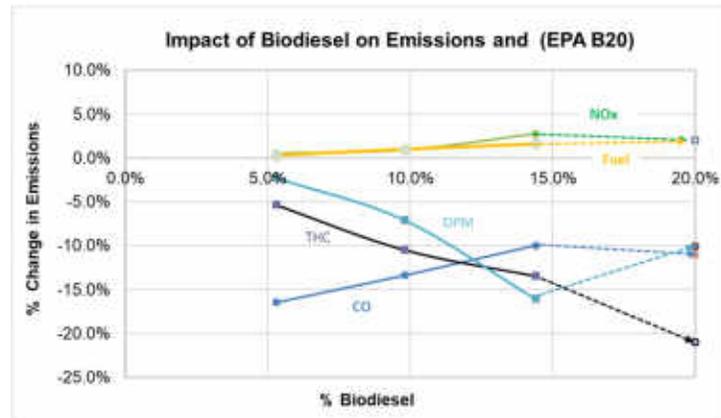

8

Test Results: Change from Baseline

Parameter	Biodiesel 5%	Biodiesel 10%	Biodiesel 15%	EPA
CO ₂	0.4%	0.0%	0.1%	-
CO	-16.5%	-13.4%	-10.0%	-11.0%
NO ₂	-7.5%	-3.9%	4.2%	-
NO	1.1%	1.3%	2.6%	-
NOX	0.5%	0.9%	2.7%	2.0%
THC	-5.3%	-10.5%	-13.5%	-21.0%
DPM	-2.3%	-7.1%	-16.1%	-10.1%
Fuel	0.3%	1.0%	1.6%	2.00%




Effect of B5, B10, and B15 on Emissions



Conclusions

- The lower level blends were found to significantly reduce emissions of CO, THC and DPM at all blends rates with the exception of DPM at the B5 blend rate which was not considered significant.
- There was no significant increase in the NOx emissions.
- These results are consistent with those projected by the literature including the EPA report (EPA 2002).
- There was an increase in fuel consumption with increasing blend rate due to the lower energy content of biodiesel.
- The biodiesel blends all had a flashpoint identical or higher than the base mines diesel fuel.

Recommendations

- This study was limited in scope and did not examine any effects on exhaust toxicity or the effects of feedstock source material on emissions.
- It is recommended that the OMA consider a literature review and more comprehensive future study on the effects of feedstock and toxicity.
- Fuel safety is expected to be the same or better than mines diesel fuel however the fuel handling and storage procedure may need to be reviewed.

Questions?