CASE STUDY

British Columbia
Municipalities Biodiesel Pilot Project, 2004

BACKGROUND
The BC Municipal Fleet Managers Group (MFMG) is a voluntary group of fleet managers representing about 40 municipalities located primarily in the Lower Mainland and southern part of the province. This group meets quarterly to share information and address issues of common concern such as strategies to reduce vehicle emissions and improve air quality.

The MFMG has reviewed a variety of strategies to reduce emissions ranging from changing operational procedures to adopting new engine technologies to using fuel additives such as Purinox and eDiesel. At the June 2003 meeting of the MFMG there was a detailed presentation and discussion on Biodiesel, how it is produced, the emissions benefits and some information on other fleets that were using and/or testing this fuel.

Shortly after this meeting MFMG members were asked to participate in a GVRD study to look at strategies to reduce emissions from heavy-duty diesel vehicles in the GVRD area.

A total of eight different emission reduction strategies were short-listed based on cost effectiveness and technical feasibility. Biodiesel was one of the strategies for which further action was suggested.

OVERVIEW OF THE BIODIESEL PILOT PROJECT
The MFMG decided to conduct a pilot test of Biodiesel as a strategy to reduce vehicle emissions. The decision was made, for fuel supply and equipment logistics reasons, to have a small group of municipalities (the Tier 1 Group) participate in the pilot project. The results of the pilot project would then be shared with all members of the MFMG and others.

The six municipalities in the participating Tier 1 Group were Burnaby, Delta, North Vancouver, Richmond, Vancouver and Whistler. The pilot project was designed as a controlled study to have each municipality in the Tier1 Group operate two base vehicles running on conventional diesel simultaneously with two similar units running on Biodiesel. Canadian Biofuels Technology Inc supplied each municipality with two 1000-litre totes of Biodiesel. The low volumes and high transport costs resulted in a premium price of $1.28 per litre of Biodiesel. Data were kept on fuel usage and oil analysis, feedback from operators was documented, and issues related to fuel mixing and dispensing were noted. The engine types utilized included Cat, Cummins, Detroit, Kubota, Ford, International, GM, Pugeot, John Deere, and New Holland.

In addition, in a technical first for the Lower Mainland, Westport Innovations and Finning Corporation teamed up to do a comprehensive “real time” emissions test and analysis of a few of the vehicles that used Biodiesel in this pilot project. Through the efforts of the MFMG to organize the testing, Westport Innovations transported half a million dollars worth of emissions testing

equipment to Finning's dynamometer facility to enable emissions to be tested on vehicles simulating "on-road" conditions.

The MFMG arranged for an independent consulting engineer to review, analyze and produce a summary of the emissions data produced from the Westport/Finning testing.

The MFMG was also successful in obtaining funding for most of the costs of this pilot project from both the FCM (Federation of Canadian Municipalities) under its Green Municipal Enabling Fund, and the GVRD's Sustainable Environmental Fund.

RESULTS OF THE BIODIESEL PILOT PROJECT

1. Fuel Storage / Mixing Issues

Biodiesel for the pilot project was first delivered as a B100 product (100% Biodiesel) at the end of January 2004 when the temperatures were around 5°C. As the B100 was stored in a separate tank each municipality was required to bring the temperature of the B100 product to 15°C, well above its cloud point of 2-4°C, before mixing it with conventional diesel to make a B20 (80% Petrol diesel/20% Biodiesel) mix. Once mixed at B20, the product was stored outside in the typical temperatures experienced in the Lower Mainland. There were no reported problems with the mixed fuel.

2. Fuel Dispensing Issues

Tier 1 Group reported none.

3. Operational Issues

The Tier I Group reported no problems with drivability. One municipality reported their drivers commented that there was increased power in the vehicles running Biodiesel.

4. Fuel System Issues

Biodiesel has solvent properties, so the first blended fuel used may plug fuel filters as it picks up residual petroleum diesel film from inside the fuel system. Filters were changed as required during the pilot test period and no issues were encountered.

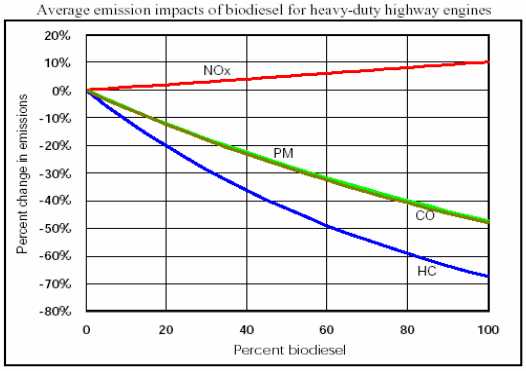
5. Oil change issues

None were reported.

6. Emissions Test Results

Phase I Testing:
This testing was carried out on January 28, 2004 at the Finning facility in Port Kells. The objective of the tests was to confirm that the changes in emissions using B20 were consistent with those published by the US Environmental Protection Agency (EPA) (see graph below).

The emissions testing equipment provided by Westport Innovations were able to measure changes in CO2, CO and NOx. The conclusions of the testing were that the pilot project results were consistent with EPA within an acceptable range based on the small sample size.



EPA published emissions data for Biodiesel

Wesport/Finning Emissions Testing Program

Phase II Testing:
This testing was carried out on February 25th, 2004 at the Finning facility. The objective of the tests was to supplement the data from the Phase I testing and confirm that the changes in emissions using B20 were consistent with those published by the EPA. During Phase II testing there was a fuel pump failure on the truck running biodiesel, which invalided the test results. The fuel pump failure was not related to the use of Biodiesel.

CONCLUSIONS
Based on the emission test results and the lack of any operational issues on the Tier 1 Group's test vehicles, Biodiesel (B20) does reduce emissions in line with the US EPA published reductions with no operational issues. The British Columbia government's exemption of Biodiesel from fuel tax in 2004 also makes the use of Biodiesel more cost effective as a strategy for reducing emissions from the diesel engine fleet.

PROPOSED TEST SEQUENCE FOR Biodiesel B20

Rev B

January 9, 2004

Legend

FM: Fleet Manager or his designate

DMTS: de Leeuw Managerial & Technical Services

BTA:

SOS:

Test vehicle: Vehicle to burn B20

Comparative vehicle: Vehicle to burn standard fuel

No.	Activity	Tasks	Duration	Responsibilities	Notes
1	Confirm protocols	Get all fleet agreement on stages and timing for pilot		FM	
2	Select vehicles	Select test and comparative vehicles for test.		FM	The two vehicles must be of the same type, of the same vintage, of similar mileage, in similar applications and in similar condition.
3	Service vehicles	Service vehicles – change oil, oil filter, fuel filter.		FM	Both vehicles must be in good running order for the test.

4 – Baseline test period, 5. – Fuel conditioning period, 6 – Additive test period

No.	Activity	Tasks	Duration	Responsibilities	Notes
4.1	Test emissions	Measure exhaust emissions and opacity* at start of test period.		FM for tests at Finning FM for opacity DMTS as necessary	*Opacity testing location TDB based on equipment availability
4.2	Fill tanks	Fill fuel tanks and read odometer readings at start of test.		FM	
4.3	Operate vehicles - diesel	Operate both vehicles on the same standard fuel.	40 operating hours	FM	

No.	Activity	Tasks	Duration	Responsibilities	Notes
4.4	Log fueling data start	Read amount of fuel added, odometer reading and operating hours during test period.		FM	
4.5	Log daily operating data	Operator daily recording of observations on performance.	For duration of baseline period.	FM	Use B20 Pilot Operator Log
4.6	Log fuel data - end	Read amount of fuel added, operating hours and odometer reading at end of test period.		FM	
4.7	Oil analysis	Measure contaminants in lubricating oil in both vehicles.		SOS for oil analysis DMTS as necessary	
4.8	Calculate fuel economy.	Calculate fuel economy.		DMTS	
5.1	Blend B20	Record ambient and diesel temperature on day of diesel delivery. Blend B100 with diesel for B20 blend Retain B20 sample (500ml)		FM to supervise blending	Ensure diesel is >10˚C for blending with B100 (See Notes below)
5.2	Analyze fuel	Measure cetane index and other properties with and without additive.		TBD for testing DMTS as necessary	Requires a treated fuel sample (B20) and an untreated fuel sample (diesel) from the same fuel batch.
5.3	Fuel test vehicle	Fill fuel tank of test vehicle with treated fuel. The treated fuel sample must contain one part methyl ester to 4 parts of fuel.		FM for dosing. DMTS as necessary	
5.4	Operate test vehicle	Operate test vehicle on treated fuel.	80 op. hours, or 1 fillup, whichever occurs first	FM	
5.5	Log daily operating data	Operator daily recording of observations on performance.	For duration of fuel conditioning period.	FM	Use standard Operator Log sheet to record performance observations
5.6	Change oil & filters	Change oil, oil filters *and* fuel filters in both vehicles.		FM	

No.	Activity	Tasks	Duration	Responsibilities	Notes
5.7	Operate B20 vehicle	Operate test vehicle on treated fuel.	80 op. hours, or 1 fillup, whichever occurs first	FM	
5.8	Oil analysis	Measure contaminants in lubricating oil in test vehicle. Compare results with those of baseline period.		FM for testing DMTS as necessary	
5.9	Change oil & filters	Change oil, oil filters and fuel filters in both vehicles.		FM	
6.1	Fuel test vehicle	Fill fuel tank of test vehicle with treated fuel and fill fuel tank of comparative vehicle with standard fuel. Read odometer readings at start of test.		FM for fuelling and odometer readings DMTS for assistance	The treated fuel must contain 1 part methyl ester for 4 parts diesel.
6.2	Operate vehicles	Operate vehicles on treated and untreated fuels respectively.	40 HOURS = operating hours, based on 1 fillup	FM for fuelling DMTS for assistance	
6.3	Log fueling data start	Read amount of fuel added, odometer reading and operating hours during test period.		FM	
6.4	Log daily operating data	Operator daily recording of observations on performance.	For duration of fuel conditioning period.	FM	Use standard Operator Log sheet to record performance observations
6.5	Log fueling data end	Read amount of fuel added, operating hours and odometer reading at end of test period.		FM	
6.6	Test emissions	Measure exhaust emissions and opacity at end of test.		FM for tests at Finning FM for opacity DMTS as necessary	

No.	Activity	Tasks	Duration	Responsibilities	Notes
6.7	Oil analysis	Measure contaminants in lubricating oil in both vehicles. Compare the differences for the baseline period with the differences for the test period.		FM for testing DMTS as necessary	
6.8	Evaluate emissions	Estimate change in exhaust emissions, fuel economy, and performance attributable to B20		DMTS	Examine quantitative and qualitative attributes.

7 - Report

No.	Activity	Tasks	Duration	Responsibilities	Notes
7.0	Prepare report	Prepare report of analysis and findings.		DMTS	

NOTES:

Blending and Storage

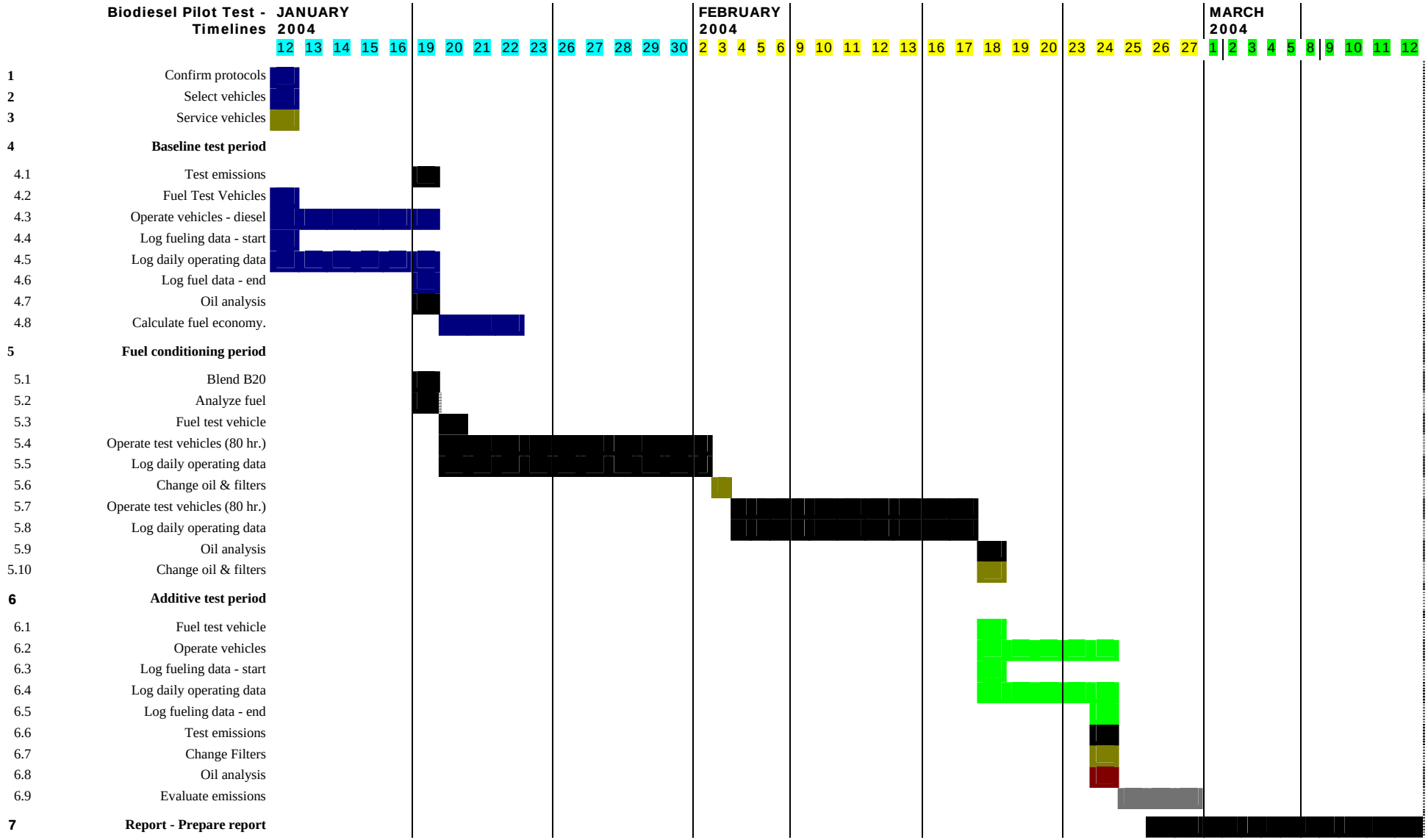
- The Methyl Ester (B100) should be stored indoors >10˚C above it's cloud point
- The B100 we are using is yellow grease methyl ester with a cloud point of 2˚ - 4˚C – therefore store it above 15˚C
- We should be blending with diesel that is >10˚C.

If this is not possible then see the guidelines below for doing a gradual blend. (For a more complete set of guidelines, download the .pdf from the link below.) Note also that since the release of this document there has been extensive use of B20 in cold weather, and that, as the NREL document says, "laboratory tests appear to be more conservative than field experience."

Cold Weather Blending and Storage Guidelines

Excerpt from NREL/TP-580-30004 September 2001 8 Reference: http://www.ott.doe.gov/biofuels/pdfs/biodiesel_handling.pdf
Temperatures are in Fahrenheit.
Like any diesel fuel, biodiesel can gel at low temperatures. Some types of biodiesel freeze at higher temperatures than others, depending onthe level of saturated components in the fuel.

- Pure biodiesel should be stored at temperatures at least 15 degrees higher than the pour point of the fuel (30ₒF to 56ₒF). A storage temperature of 45ₒF to 50ₒF is fine for most B100.
- Blends of biodiesel and diesel should be stored at temperatures of at least 15 degrees above the pour point of the blended fuel.
- Pure biodiesel can be stored underground in most cold climates, but above ground fuel systems should be protected with insulation, agitation, heating systems, or other measures if freezing weather is common. This precaution includes tanks, pumping equipment, andthe vehicles themselves.
- Blended fuels can be stored below ground in most climates. Above ground storage should consider special precautions if temperatures routinely fall below the pour point of the blended fuel.
- Biodiesel can be splash blended with no problems if the diesel fuel temperature is 50ₒF or higher. If biodiesel is blended with cold diesel fuel (fuel temperature is less than 45ₒF to 50ₒF), the saturated compounds in the biodiesel can crystallize and plug fuel filters and fuel lines. If crystals have already formed the solutions include:
    - See if they disappear as the fuel warms with ambient weather conditions
    - Heat the fuel to above 100oF or until the crystals dissolve
    - Filter the solid fuel crystals out. They can be reused when they melt.
- To prevent forming crystals, blend biodiesel with #1 diesel in a 50:50 mix first (make sure the temperature of the kerosene is above45oF), then blend the biodiesel-kerosene mix into the cold diesel fuel. Do not forget to adjust your blending formula so that you end up with a 20% blend of biodiesel in the final fuel.


Biodiesel Pilot Test - Timelines
JANUARY 2004
FEBRUARY 2004
MARCH 2004
12 13 14 15 16 19 20 21 22 23 26 27 28 29 30 2 3 4 5 6 9 10 11 12 13 16 17 18 19 20 23 24 25 26 27 1 2 3 4 5 8 9 10 11 12
1 Confirm protocols
2 Select vehicles
3 Service vehicles
4 Baseline test period
4.1 Test emissions
4.2 Fuel Test Vehicles
4.3 Operate vehicles - diesel
4.4 Log fueling data - start
4.5 Log daily operating data
4.6 Log fuel data - end
4.7 Oil analysis
4.8 Calculate fuel economy.
5 Fuel conditioning period
5.1 Blend B20
5.2 Analyze fuel
5.3 Fuel test vehicle
5.4 Operate test vehicles (80 hr.)
5.5 Log daily operating data
5.6 Change oil & filters
5.7 Operate test vehicles (80 hr.)
5.8 Log daily operating data
5.9 Oil analysis
5.10 Change oil & filters
6 Additive test period
6.1 Fuel test vehicle
6.2 Operate vehicles
6.3 Log fueling data - start
6.4 Log daily operating data
6.5 Log fueling data - end
6.6 Test emissions
6.7 Change Filters
6.8 Oil analysis
6.9 Evaluate emissions
7 Report - Prepare report