Issue 3 – May 2003

BIOBUS Newsletter

BIOBUS Project

Blazing a Path to the Future *– The scale of the* ***BIOBUS*** *project earned it mention as the most important initiative of its kind in North America. It has opened the way to a more environmentally conscious view of public transit and now serves as a showcase for transit authorities and users alike.*

Solid Partnership

The ***BIOBUS*** project was a joint effort by the Canadian Renewable Fuels Association (CRFA), the Fédération des producteurs de cultures commerciales du Québec (FPCCQ), Rothsay/Laurenco and the Société de transport de Montréal (STM). Rothsay/Laurenco produced pure biodiesel for the project and supplied biodiesel blend to STM's Frontenac terminal, which provided 155 buses and the entire infrastructure used to test the fuel. The Canadian and Quebec governments both made major contributions to project funding.

Three Major Objectives

The BIOBUS project ran for one year, from March 2002 to March 2003, during which the following objectives were pursued:

- test the use of biodiesel as a source of supply for public transit
- assess the viability of the fuel as part of the routine operation of a bus fleet, particularly in cold weather
- measure biodiesel's environmental and economic impact

Why Biodiesel?

Biodiesel, a methyl ester produced from a chemical reaction between methanol and either vegetable oil or animal fat, helps significantly curb polluting emissions, greenhouse gases (GHGs) and urban smog. It could prove to be a prime alternative for public transit since it:

- promotes sustainable transportation because it is produced from local, renewable resources;
- helps significantly in the reduction of greenhouse gas (GHG) and polluting emissions; and
- is easy to use, since no changes are needed either to the existing infrastructure for fuel distribution and delivery or to the diesel engines of buses.

Summary of Project Results

This issue of the ***BIOBUS*** Newsletter contains the summary of the project's Final Report entitled *Biodiesel Demonstration and Assessment with the Société de transport de Montréal (STM)*, published in May 2003. A softcopy of the report is available on the STM web site (www.stm.info).

Winners of the AQTR's 2003 environmental award for technical achievement, the BIOBUS project team poses proudly with Minister Serge Ménard in front of a bus decked out in the project's colours.

Photo: Normand Huberdeau / NH Photographes

Canada Québec

STM

A MEMBER OF THE GROUP MAPLE LEAF FOODS INC.

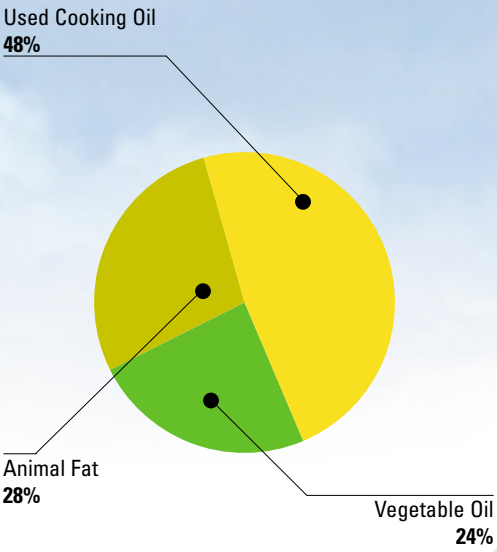
Fédération des Producteurs de Cultures Commerciales du Québec

Canadian Renewable Fuels Association

Supplying Biodiesel to the STM

Over the duration of the ***BIOBUS*** project, Frontenac terminal buses consumed some 550,000 litres of pure biodiesel (24% based on vegetable oil, 28% on animal fat and 48% on used cooking oil) in 5% (B5) and 20% (B20) blends with petrodiesel. Despite three interruptions in blend delivery during the year, the STM did not encounter any major problems either from a maintenance or customer service standpoint. Quite the contrary, using biodiesel had very positive effects.

Quantity of Biodiesel Used



Physicochemical Characteristics of Biodiesel Blends

ASTM D 6751-02 is the only biodiesel standard recognized in North America, and applies only to pure biodiesel (B100). To ensure product quality, it was thus necessary to assess the physicochemical properties of biodiesel blends with STM reference petrodiesel.

Accordingly, an independent lab determined the characteristics of biodiesel from the three sources used (vegetable oil, animal fat and used cooking oil) in both 5% and 20% blends. The results confirmed that the pure biodiesel produced by Rothsay/Laurenco complied with ASTM D 6751-02. Key test findings are given below.

Lubricity

- Even at low concentrations, lubricity (the lubricating power of biodiesel blends) is clearly superior to that of petrodiesel. Consequently, engine wear is reduced and engine life increased. Biodiesel could thus be a valuable additive to future very-low-sulphur (<15 ppm) diesel fuels.

Cloud Point and Filterability

- It is safe to use in cold weather biodiesel having a cloud point of -15°C or lower. It is necessary, however, that the petrodiesel is not at temperature below the biodiesel's cloud point during blending. In fact, neither the cloud point of B100 nor that of the final blend dictates the solubility of biodiesel in low-temperature petrodiesel.

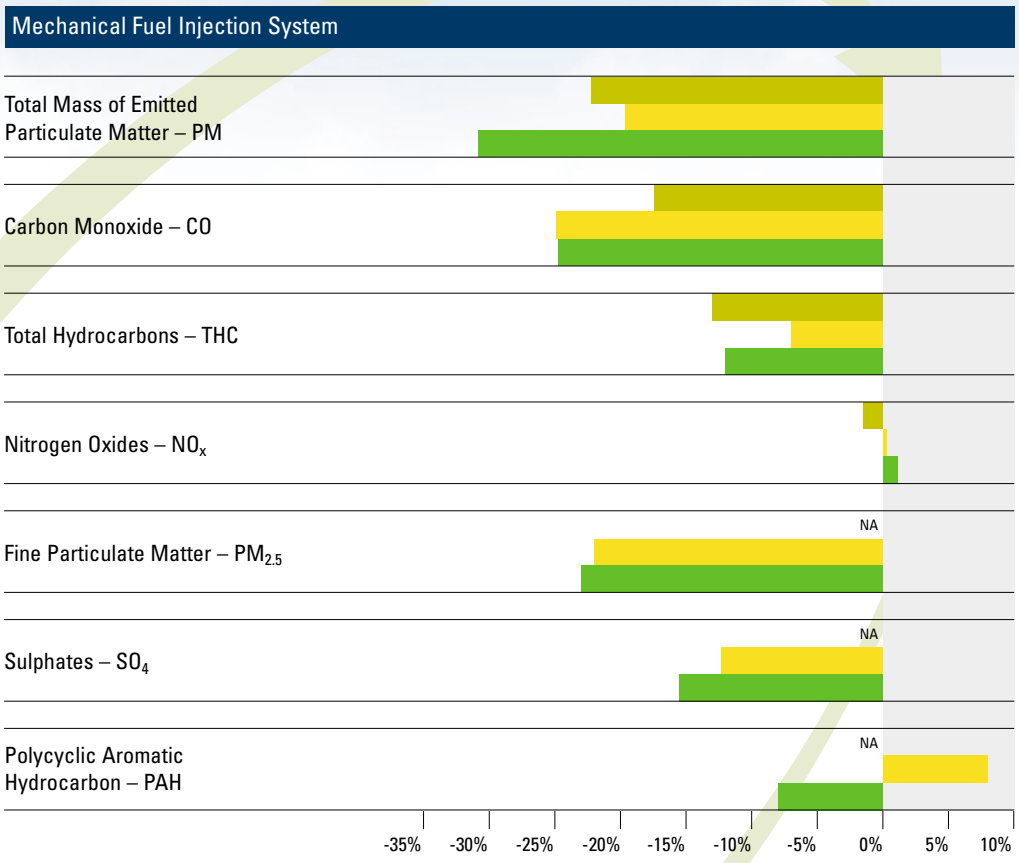
Cetane Number

- Having a higher cetane number than STM reference petrodiesel, pure biodiesel improves the ignition performance of blends and reduces NO_x emissions.

Energy Efficiency

- The energy efficiency of biodiesel blends is comparable to that of petrodiesel. Furthermore, blends have no significant effect on power, maximum torque and fuel consumption of a diesel engine with mechanical fuel injection.

Percent Emission Reduction with B20 vs. STM Reference Petrodiesel



Emission Measurements

The only measurements made were direct tailpipe emissions. It can be generally concluded from the results that biodiesel both reduces polluting and GHG emissions, be they regulated (PM, CO, THC and NOx) or unregulated (SO_4, PAH, CO_2 and $PM_{2.5}$), and helps reduce urban smog. The chart below shows how much lower emission are with B20 than with STM reference petrodiesel.

Direct Carbon Dioxide (CO_2) and Greenhouse Gas (GHG) Emissions

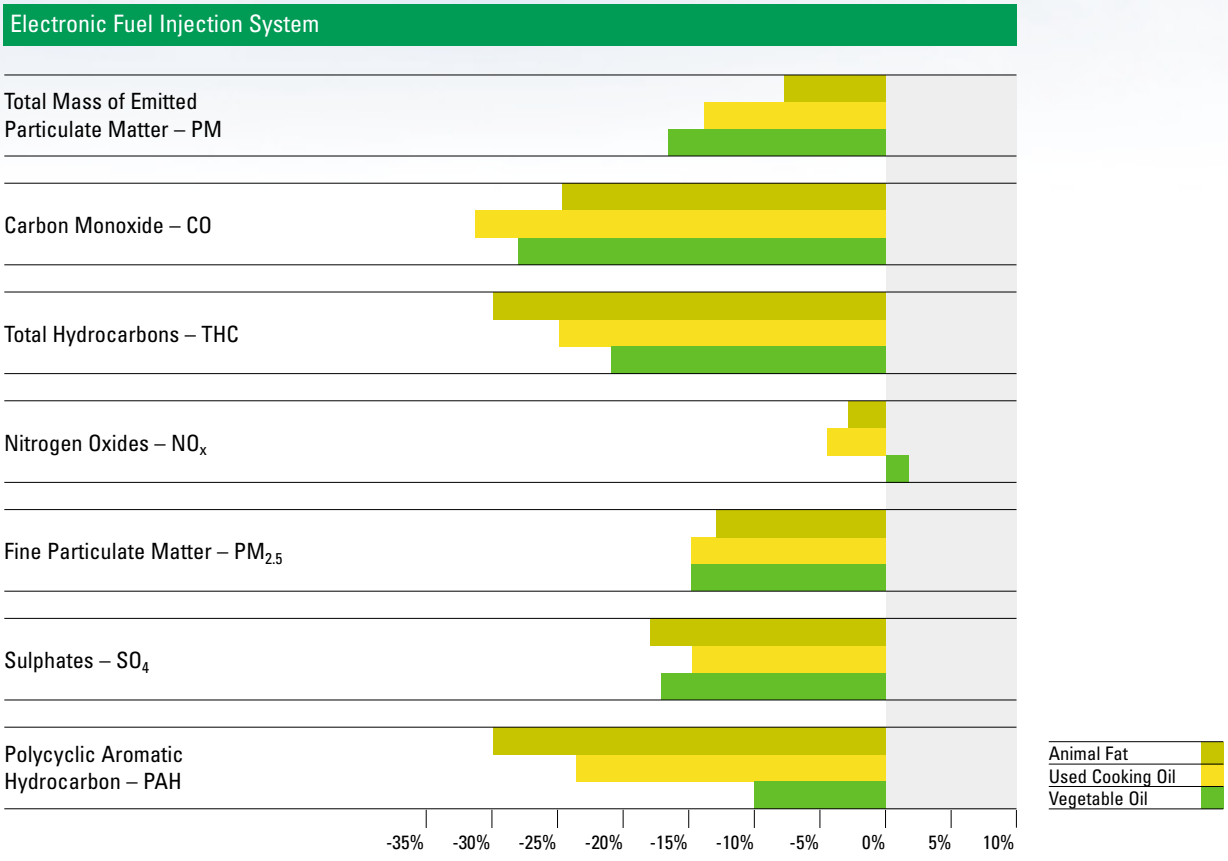
For the diesel engines studied, direct CO_2 emissions were around 600 g per unit work produced (bhp-h); whereas, N_2O and CH_4 emissions were in the milligram range. Even if significant variations were found for N_2O and CH_4 emissions, the impact on the overall GHG balance would have been negligible. Thus CO_2 is the only GHG considered in the final report.

Biodiesel helps reduce GHG emissions because it comes from animal or plant biomass with a life cycle of a few years. Unlike petrodiesel, it is a renewable energy source. Variations in tailpipe CO_2 emissions are negligible. Accordingly, variations in fuel consumed per unit work are not significant and engine energy efficiency is unchanged by adding biodiesel.

Baseline GHG emissions for both engine types are around 2.59 kg of CO_2 per litre of STM reference petrodiesel. As a working hypothesis, we can suppose that every litre of pure biodiesel (B100) used to replace a litre of petrodiesel reduces GHGs by 2.33 kg of CO_2. This figure is based on the assumption that biodiesel avoids 90% of the emissions from reference petrodiesel because it contains 10% methanol used for esterification and obtained from natural gas (non-renewable fossil energy).

Impact of Biodiesel Use by Urban Transit Authorities on Annual CO_2 Emissions

The BIOBUS project demonstrated that it was viable for public transit authorities to use biodiesel. Under the project, a total 550,000 litres of pure biodiesel in 5% and 20% blends were consumed by Frontenac terminal buses between March 2002 and March 2003, leading to a reduction in CO_2 emissions of roughly 1,300 tons. Since the results show that the reduction in polluting and GHG emissions was significant, it can be stated that resorting to biodiesel Quebec- and Canada-wide would help reduce such emissions even further.



The accompanying table gives a rough idea of the impact B20 would have on annual CO_2 emissions, assuming that a four-stroke Cummins engine with mechanical fuel injection is representative of bus fleets across Quebec and Canada.

Specific Impacts

Studies also showed how emissions using biodiesel varied depending on engine type, concentration of biodiesel in the blend, and source of biodiesel. It was found that biodiesel reduced several polluting emissions and did so more noticeably with electronic fuel injection than with mechanical fuel injection (particularly for NO_x and PM). It cannot be concluded, however, that emission reductions were proportional to the concentration of biodiesel in the blend, nor can one source of biodiesel be singled out as more beneficial.

Impact of Biodiesel on Bus Fleet Operations and Maintenance

From an operational standpoint, using biodiesel did not result in any incident compromising continuity of service. No variation in fuel consumption can be substantiated from the data as a whole. Mechanical maintenance was unproblematic during and after the cutover to biodiesel for most buses, including both older models with 25-µm fuel filters and later models with electronic fuel injection systems. Even the four vehicles having a Cummins engine with electronic fuel injection, used to test the potentially most problematic biodiesel blends (cooking-oil-based B20 and animal-fat-based B20) over the coldest period of winter, ran nearly 10,000 km each without any problems.

Biodiesel thus caused neither bus-related mechanical problems, notably to the fuel injection system, nor any degradation of elastomer components in contact with the fuel. The cleansing period was longer than foreseen for buses with 10-µm filters, longer still because B5 was used for three months before cutting over to B20. Sporadic incidents caused by the finest (10-µm) filters had no real impact on STM operations and resulted in no significant unforeseen costs. Similarly, no specific complications arose from using biodiesel, despite its cloud point, in very cold weather (overnight temperatures dropping to between -20°C and -30°C). The problem that gave rise to incidents would vanish if producers succeed in developing processes to better control pure biodiesel's cloud point.

Impact of B20 Use by Urban Transit Authorities on Annual CO_2 Emission Reductions

	Units	Frontenac Terminal	STM	Quebec	Canada
Bus Fleet		155	1600	2,850	11,500
Total Distance Travelled	km	6.7 million	70.5 million	195.3 million	800 million
Total Fuel Consumed	litres	4.5 million	47.2 million	90 million	368 million
Estimated CO_2 Reduction Using B20 (B20)	tons	2,100	22,000	42,000	171,500

Sources: *Canadian Transit Fact Book (2002 data)* and ***BIOBUS*** Project

Overall Recommendations

Any infrastructure-related problem has a direct impact on process flow therefore, a consistent multi-step filtering process must be followed to ensure consistent blend quality. It is essential to require that suppliers use filters whose performance has been proven by documented test procedures.

Moreover, when cutting over to biodiesel, it is important to use the desired concentration, e.g., B20, from the outset rather than gradually phasing in biodiesel using weaker blends, in order to avoid prolonging the cleansing period. Lastly, adequate training must be planned for technical workers to make them aware of the importance of identifying the source of a problem in order to achieve a correct diagnosis, particularly during the cleansing period.

Efforts Acknowledged

The project's success is above all due to the unwavering participation of STM employees, particularly those from the Frontenac terminal, who were most closely involved in the great ***BIOBUS*** adventure. Constant support from various partners was also instrumental.

The innovative nature and global scope of the project were indeed acknowledged. At its April 2003 convention, the Association québécoise du transport et des routes (AQTR) honoured the project team with its environmental award for technical achievement. The project was also a finalist for the Phénix award for sustainable development know-how. The name of the winner was announced only after this newsletter went to press.

Ride a BIOBUS...
So simple!
So pure!

To learn more about the BIOBUS project, or to obtain a softcopy of either this newsletter or the project's FINAL REPORT, visit the STM web site at:
www.stm.info
or call Camil Lagacé
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*La version française de ce document est disponible et s'intitule Bulletin **BIOBUS** Numéro 3 – Mai 2003*