Biodiesel in Transit and Municipal Fleets

Organizations
Halifax Regional Municipality, City of Brampton, City of Saskatoon

Status
Brampton and Saskatoon initiated in 2002. Halifax initiated in 2004. All projects still ongoing.

Overview
Biodiesel is an alternative to diesel fuel made from vegetable oils, waste cooking oil, animal and fish fats or tall oil (a waste product from pulp and paper processing). Compared to conventional diesel, biodiesel combusts better and produces fewer GHGs and particulate emissions. From a performance perspective, biodiesel engines deliver similar torque, horsepower and kilometres per litre as petroleum-powered diesels.

Biodiesel is being tested and used by a number of Canadian municipalities in their transit and fleet operations, including Brampton, Saskatoon, Halifax, Montreal, Vancouver and Toronto. Globally, over 100 cities have run biodiesel demonstration projects involving more than 1,000 vehicles.

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Resources
- Canadian Renewable Fuels Association: www.greenfuels.org
- Biodiesel Canada: www.biodiesel-canada.org
- Brampton: www.city.brampton.on.ca
- Saskatoon: www.city.saskatoon.sk.ca/org/transit/
- Halifax: www.halifax.ca/metrotransit/

Overview

Biodiesel is a clean burning alternative fuel produced from domestic, renewable resources, principally vegetable oils and waste oil products. As an alternative fuel, it is often considered one of two main types of biofuels, the other being ethanol. While ethanol is produced primarily from grains such as corn, biodiesel is made primarily from oilseeds, such as soybeans and canola. Biodiesel can also be made from animal and fish fats, waste vegetable cooking oil and tall oil, a waste product from pulp and paper processing. In the Maritimes, biodiesel has been made from fish oil from fish plants and from waste cooking oil from french fry plants in New Brunswick.

While ethanol is generally blended with regular gasoline, biodiesel is blended with diesel gasoline. Both biofuel blends can be used in existing engines without modification. With modifications, diesel engines can run on 100% waste vegetable oils.

Before any of the biodiesel feedstock products can be used as fuel, they must first be processed to make them less viscous. In the process the feedstock is blended with an alcohol and a chemical catalyst. The resulting reaction produces biodiesel as an ester. One bushel of soybeans produces about 1.5 gallons of biodiesel.

Biodiesel itself can be blended with diesel gasoline in any concentration depending upon the desired emissions and driving conditions. Generally, most Canadian municipalities have been using biodiesel concentrations of 20 per cent (B20) and 50 per cent mixtures (B50). Saskatoon's BioBus project is using a B5 mixture. Some additives are required with the higher biodiesel concentrations during colder winter months to address flow issues.

Vegetable oil was used as a diesel fuel as early as 1900, when Rudolf Diesel, the inventor of the diesel engine, demonstrated that his engine could run on peanut oil. However, up until more recently biodiesel has attracted little attention except in during World War II and the energy shortages of the 1970s.

As a fuel alternative, biodiesel emits fewer GHGs, hydrocarbons and particulate matter than conventional

diesel. Biodiesel is also considered readily biodegradable and non-toxic. Testing indicates that biodiesel degrades four times faster than petroleum diesel and that it can help accelerate the degradation of conventional diesel in the environment.

Research and testing has also shown that biodiesel-fuelled vehicles deliver similar torque, horsepower and kilometres per litre as conventionally-powered diesel vehicles. Depending on the feedstock used, some biodiesel blends have also been show to reduce engine friction and wear. Finally, biodiesel does not require new refueling stations or engine modifications.

Policy context

Through the Kyoto Protocol, Canada is committed to reducing greenhouse gas emissions by 6 percent below 1990 levels between 2008 and 2012. A major focus for reduction efforts will be in the transportation sector, which is responsible for 25% of emissions nationally.

On a municipal level, more than 120 Canadian city governments have committed to reducing GHGs and acting on climate change through FCM's Partners for Climate Protection program, a national program that seeks to achieve a 20 per cent GHG emissions reduction in partner municipal operations by 2008. Halifax Regional Municipality, the City of Saskatoon and the City of Brampton are all part of the Partners for Climate Protection network.

Locally, each of the three municipalities is going through planning processes, components of which directly address municipal GHG emissions reductions.

In Saskatoon, the city is undergoing a yearlong system-wide study that will focus on improving transit services in the municipality. To be completed in Spring 2005, the 10-year Strategic Action Plan will support reducing fleet GHG emissions.

Brampton is also in the final stages of developing a new Transportation and Transit Master Plan. The new plan emphasizes increasing and improving the role of transit to help improve municipal air quality and reduce associated GHG emissions.

Halifax Regional Municipality (HRM) is in the midst of creating a long-term, strategic Regional Plan. One of the plan's goals is to "identify and implement opportunities and programs to reduce transportation energy consumption and emissions" to meet Kyoto and FCM targets.

Saskatoon's Bio Bus

Rationale and objectives

Canadian municipalities own and operate a large fleets of vehicles for municipal operations, including light and heavy duty trucks and transit buses. Typically, these fleets are responsible for between 3% and 5% of total municipality-wide GHG emissions and consume a large amount of the 23 billion litres of diesel fuel Canada uses per year.

To reduce the overall environmental impact of fleet operations and help meet the terms of municipal and national GHG reduction strategies, many Canadian fleet operators are exploring the use of alternative fuels like biodiesel, improving operational fleet standards (e.g., reducing idling) and exploring the use of hybrid vehicles. With its low cost of implementation, significant environmental benefits and excellent operational performance, biodiesel in particular is emerging as a major GHG emission reduction tool with Canadian municipalities.

In addition to helping improve air quality and meet the country's Kyoto Protocol commitments, biodiesel production also has the potential to help diversify and improve domestic Canadian energy supplies and assist with the economic development of farming and rural communities which produce and grow the raw materials. Although current commercial production is relatively small, increased use of biodiesel will also help grow the biodiesel refining business.

Actions

The City of Brampton was Canada's first municipality to commit to the ongoing use of biodiesel in both transit and heavy duty fleet vehicles. Beginning in 2002, the municipality began testing the alternative fuel in 16 of its vehicles. The test vehicles were fueled with B20 biodiesel during the colder months and B50 biodiesel during the warm summer months.

Tests conducted during that time indicated that exhaust emissions were reduced by about 27 per cent with the B20 blend and by 50 to 60 per cent with the B50 blend. Vehicle operators also reported back that the biodiesel

fuelled vehicles operated more smoothly and more responsively than conventionally powered vehicles.

The city is currently expanding its use of biodiesel to most of its 415 diesel burning fleet vehicles and up to 130 Brampton Transit buses.

A biodiesel powered works truck in Brampton

"I think [using biodiesel] makes business sense now," says Alex MacMillan, former Commissioner of Works and Transportation for the City of Brampton. "I think it leads to better health and a healthier environment…it's not simply an economic decision."

The City of Saskatoon also began exploring the use of biodiesel around the time Brampton began its work. The purpose of the Saskatoon Transit biodiesel research project is to promote the use of canola biodiesel as an environmentally friendly, renewable fuel and to gather scientific data on canola biodiesel as a fuel for public transit vehicles.

Better know as the BioBus project, the objective of the project is to conduct scientific engineering documentation using 5% biodiesel blends in Saskatoon transit buses to determine the impact on fuel economy, engine wear, engine operation and emission implications.

The scientific study involves four buses from Saskatoon Transit Services. At any one time, two buses are using the biodiesel blend, while the other two act as control vehicles. Throughout testing, each bus is monitored using scientifically rigorous protocols and field testing procedures. The final studies final results will be released in early 2006.

For its part, Halifax Regional Municipality (HRM) began exploring the use of biodiesel in 2004. With so much prior work and experience to build on from other parts of Canada and beyond, HRM moved quickly on the issue and announced in October 2004 that the entire Metro Transit bus fleet and its three marine ferries had switched to biodiesel fuel.

"We are confident of the bio- fuel's performance and that it will deliver substantial benefits in reduction of tailpipe emissions for the Metro Transit bus fleet," says Paul Beauchamp, General Manager Fleet Services "There is a cost increase of less than 1% associated with adopting the use of B20 fuel," he adds, "and the outcomes will ensure that HRM is closer to its goal of providing a leadership role in reducing practices that contribute to global warming-mainly through greenhouse gas emissions".

The biodiesel used in the HRM project is being produced locally by Wilson Fuels, a family run business with a long history in the Maritimes. The company recently signed a $3 million contract to supply HRM's ferries and buses and sells its biodiesel in one of the company's gas stations in Moncton, New Brunswick.

Results

Globally, many municipalities and national governments have conducted extensive tests of biodiesel in both transit and municipal fleet vehicles. According to the Canadian Renewable Fuels Association, all results indicate that biodiesel-powered engines show reduced engine wear with no performance loss.

Many tests have concluded that the best overall results are obtained with a blend of 20 per cent biodiesel and 80 per cent conventional diesel. Tests in Brampton showed that B20 blend reduced emissions on average of 25 per cent and up to 60 per cent when using B50 blend. Total emissions reductions are influenced by vehicle use and operations and weather conditions.

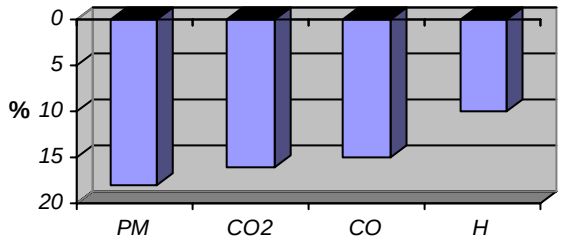
Saskatoon's preliminary project research has shown that the addition of 1 to 2 per cent biodiesel in conventional diesel fuel will reduce engine wear by 40 to 50 per cent and improve fuel economy anywhere from 3 to 10 per cent. Other tests conducted by the University of Saskatchewan have shown that biodiesel reduces particulate matter emissions up to 18 per cent, carbon dioxide by 16 per cent and hydro-carbons by 11 per cent. Their research also found that each ton of biodiesel fuel saves five times its weight in diesel fuel.

Halifax Regional Municipality had their project assessed by Environment Canada's Environmental Technology Centre in 2004. Their study found that NOx emissions reductions were negligible along with improved fuel consumption, but reported a 19 per cent reduction in total hydrocarbon emissions, and 18 to 28 per cent and Carbon Monoxide and a 15% reduction in total particulate matter.

A further cost analysis in Halifax determined that the additional cost of using biodiesel was roughly two-tenths of a cent per litre.

The table below illustrates average emission reductions for B20 blend based on the results of testing in Halifax, Saskatoon and Brampton. Technical information sheets are available through Environment Canada's Environmental Technology Centre and the University of Saskatchewan's Mechanical Engineering department and the Saskatoon Research Centre.

Average Emission Reductions by % (B20 blend)



PM = Particulate Matter
H = Hyrdocarbons

Participants

In addition to the municipalities involved, various government departments, industry associations and businesses are working to expand biodiesel production and use in Canadian municipalities.

The BioBus project in Saskatoon is being coordinated by the Saskatchewan Canola Development Commission with technical research and engineering support provided by the University of Saskatchewan's Mechanical Engineering department and the Saskatoon Research Centre. Private companies have assisted with the project through the provision of technical resources and in-kind support.

Brampton's work has been supported by City Council and involved the city's Fleet Services department and City of Brampton Transit.

In Halifax, the project was first brought to the municipality by a local fuel company, Wilson's Fuels, who approached the municipality about using the fish-based biodiesel product.

Resources

Brampton's original testing work was funded through regular operations budgets. This was possible due to the minimal cost differences between using regular diesel and biodiesel.

Saskatoon's BioBus scientific research project has been costed at $240,000. The project is financed by a variety of partners, including the three orders of government, canola organizations and the private sector who provided technical assistance and in-kind services, including the biodiesel itself. Western Economic Diversification Canada has provided the bulk of project funding. The cost of the project's first phase was $115,000.

In Halifax Regional Municipality, all project costs were borne by the regional municipality through regular operating budgets.

Lessons learned

Some of the lessons learned in developing biodiesel fueling programs include:

- **Find the right blend for climate conditions.** Biodiesel performance is influenced significantly by climatic considerations. Generally, higher concentrations (e.g., B50) should be used only during warmer summer months or additives are required with the higher biodiesel concentrations during colder winter months to address flow issues.
- Both Halifax and Brampton experienced gelling in extended temperatures below -20c using a B20 blend. In Brampton, gelling in the tanks could be eliminated with the use of heaters and agitators but trucks and buses not in use for one or two days this was a concern. Brampton currently uses a B5 blend in the colder winter months and switches to B20 blend in April for summer and early fall use. Halifax Regional Municipality now uses a B10 blend in January and February and switches to a B20 blend for the remainder of the year.
- **Find the right type of biodiesel.** Brampton's municipal fleet switched from biodiesel made from waste animal fats to a vegetable blend after experiencing flow problems during the colder winter months. No formal studies were done on the different flow properties of the two types, but performance observations confirmed that vegetable biodiesel had fewer lower temperature flow issues than the animal fat biodiesel blend.
- Saskatoon uses a canola biodiesel product given its availability in the region, while Halifax Regional

Municipality uses a fish oil-based product for similar local availability reasons.

- **Biodiesel storage is a consideration in colder climates.** Underground fuel storage and indoor fueling stations are an important consideration for colder winter climates. During the cold winter months, Brampton's municipal fleet has experienced some fuel flow problems with its above ground tanks and outside pumping station. The problems were such that the fleet operations temporarily switched back to conventional diesel during one particularly cold snap. On the other hand, Brampton Transit, with an underground biodiesel storage tanks and an indoor fueling station, has never experienced the same fuel flow problems.
- **Clean fuel storage tanks prior to filling with biodiesel.** Prior to using Biodiesel for the first time it is recommended to thoroughly clean all fuel storage tanks.
- **Some minor engine modifications may improve efficiency.** Brampton Transit experience plugging and gelling of fuel filters during the first 3 months of operation using a B20 blend. This was caused by the cleaning effect of Biodiesel. Installation of primary fuel filters were necessary on all vehicles.
- **Minor fuel consumption savings can be expected.** Although both Halifax and Brampton have reported negligible improvements in fuel consumption, scientific research in Saskatchewan has shown that biodiesel blends of 1 to 2 per cent can give a slight improvement in fuel economy by improving fuel lubricity.

Next steps

Phase II of Saskatoon's BioBus project is currently underway, with testing scheduled to be completed by December 2005. At that point a final technical report will be produced. The final results of the Saskatoon BioBus project will be available in early 2006 and provide additional, scientifically quantified information on the benefits of using biodiesel.

Halifax Regional Municipality's transit arm, Metro Transit, runs its entire fleet with biodiesel, including their three ferries.

In Halifax, the municipality is expanding use of biodiesel to its fire fleet, city snow plows and heavy equipment fleet. The municipality is also researching the use of using a B100 biodiesel product for heating municipally-owned buildings.

Biodiesel testing is currently also underway in a number of other municipalities across Canada , including Vancouver and Delta, BC.

The biofuel industry is also working to establish expanded production capabilities and carrying out extensive awareness and marketing programs. Some of this includes a lobbying program with the provinces and the federal government to recognize biofuels as "green fuels" which would result in decreased taxes and costs – something that would help speed municipal and consumer use of the products they argue.