DIESEL PARTICULATE FILTER PILOT PROJECT:
Summary Report by the Clean Air Strategic Alliance
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Introduction

There are several options available to mitigate diesel emissions from heavy duty vehicles in the transportation sector. These options include substituting diesel for a cleaner burning alternative fuel (e.g. biodiesel), improving fuel efficiency through changes in travel/driving behaviour or improved engine design, using "after-burn" technologies, or using hybrid vehicles. One type of an "after-burn" technology is a diesel particulate filter (DPF).

Johnson Matthey Continuously Regenerating Technology (CRT) is one example of a DPF. It typically replaces the muffler from the original engine manufacturer (OEM) and functions with a diesel that is low in sulphur (less than 30 parts per million [ppm]). By September 2006, all diesel fuel offered for sale in Canada will have a sulphur content of 15ppm (referred to as ultra low sulphur diesel, ULSD). Although ULSD does not significantly reduce total vehicle emissions, its use allows other technologies, such as DPFs, to be installed and decrease the emissions of various gases. By 2007 all new diesel engines will require DPFs. The advantage to DPFs is that they can be applied to existing engines without waiting for vehicle turnover, since diesel engines can last up to 30 years. DPFs can reduce emissions more economically than alternative fuels.

There are two stages to the operation of a DPF. In the first stage carbon monoxide (CO) and hydrocarbons (HC) are oxidized to form carbon dioxide (CO_2) and water. In the second stage, soot (particulate matter, PM) is trapped and destroyed.

Although there have been studies of DPFs done in other jurisdictions, the purpose of this project was to determine if the use of DPFs in cold weather is practical. The project also provided the opportunity to test ULSD before the new regulations take effect in 2006. The specific objectives of the study were to:

- demonstrate the effectiveness of diesel emission reduction technology in Albertan winters
- provide Alberta's transportation and transit industries with experience installing and using DPFs, and to become acquainted with performance characteristics
- increase public and industry awareness of available emissions reduction technology
- stimulate interest and adoption of available technology
- increase public awareness of air quality issues
- improve urban air quality.

Project Details

DPF Bus Promotion
There were several methods used to promote this pilot project. For example, there were vinyl wrap advertisements on the exterior of the two buses, and advertising cards and brochures inside the buses. The kick-off event took place at City Hall in March 2003. The project received positive media coverage, and an article was published in the ETS newsletter, ***In Transit***. The

buses were displayed at various transit and transportation events. A website was developed to provide detailed information on the project and the buses (www.cleanbus.ca).

The ETS Fleet

There are 140 regular routes operated by the ETS, adding up to a total of 34 million kilometres annually. The ETS fleet contains:

- 716 diesel buses
- 59 trolley buses
- 25 small diesel buses
- 37 LRT (light rail transit) vehicles.

Peak service in Edmonton requires 590 large buses and 27 LRT vehicles. The majority (54 per cent) of the diesel fleet had modern diesel engines at the time of this report. The older fleet, with two-cycle diesel engines, is replaced at a rate of 35 buses per year. Although the posted speeds on the ETS routes range from 50-100 km/h, the average system operating speed is 20 km/h. Fuel consumption for the fleet averaged at 1.78 l/km in 2004.

The Function of CRT

Continuously Regenerating Technology (CRT) acts as a direct replacement for an OEM muffler. It contains a platinum catalyst and a particulate filter (for details please see: http://ect.jmcatalysts.com/technologies-diesel-crt.htm). Installation takes between four and six hours. Regular maintenance checks are still required; the filter must be cleaned after one year of use (or after 45,000-55,000 kms) and hardened ash is expected. Although this is a rather simple procedure, it adds approximately three hours of maintenance per vehicle. During this project, some problems were encountered with the software, requiring the system to be reset.

Operation of CRT requires the use of diesel that is low in sulphur. During this pilot project ULSD was not readily available. Shell supplied diesel with an average sulphur concentration of 21 ppm. Although this is higher than the 15 ppm which will be required by June 2006, it is still an acceptable level to function with CRT.

Emission testing was done by Environment Canada during two sessions (January 2003 and January 2004). The Dynamic Dilution On/Off-road Emission Sampling System (DOES2) was used and is capable of measuring total hydrocarbons (THC), nitrogen oxides (NO_x), carbon monoxide (CO) and carbon dioxide (CO_2).

Results

Fuel consumption and CO_2 emissions did not change significantly when CRT was used. Although NO_x emissions actually increased in some cases, in general these increases were not significant. Table 1 summarises the emissions that changed significantly.

Table 1. Per cent difference in emissions between the OEM and the CRT configuration

			THC	CO	PM
Bus 1	Per cent reduction due to CRT	Jan. 2003	55.8	79.7	72.51
	Per cent reduction due to loaded* CRT	Jan. 2004	87	89	75
	Per cent reduction due to cleaned CRT		61	84	75
Bus 2	Per cent reduction due to CRT	Jan. 2003	51.1	67.7	60.4
		Jan. 2004	80	83	73

* Loaded refers to a filter which is nearing capacity. The filter to this bus experienced occasional high pressure alarms in December 2003, so testing in January 2004 was done with both a loaded and a cleaned filter.

The tests done in January 2004 show the durability of CRT since emissions reductions were still significant one year after installation, and in fact showed greater reductions than those achieved in January 2003.

Conclusions

Ambient temperatures experienced by the buses during this pilot project ranged from -34^{o}C to +34 ^{o}C, showing that DPFs are capable of functioning in cold weather, with ULSD fuel and a modern engine. The minimum temperature of the filter that is required for CRT to be effective (260 ^{o}C, 40 per cent of the run-time) was maintained even at cold ambient temperatures.

This technology provides the opportunity to improve emissions control without waiting for fleet vehicle turnover. ETS has a relatively low impact on the overall air quality in Edmonton. The overall air quality in Edmonton would only be slightly improved by the use of DPFs in diesel buses. For example, CO emissions from the ETS fleet in 2003 constituted only 0.11 per cent of CO emissions from all transportation sources in Edmonton and the use of DPFs is expected to decrease these emissions to 0.022 per cent. Although the overall impact is low, the impact on air quality inside transit facilities would be high.

All diesel engine buses will probably require exhaust treatment after 2006 to meet the new emission requirements. This pilot project showed that, with an initial capital cost and some added annual maintenance, DPFs are viable emissions control mechanisms in cold weather conditions.

For the full report from CASA for this pilot project, please see:
http://casahome.org/uploads/VET_DPFReport_ApprovedbyBoardSep2004.pdf