BEST
BioEthanol for Sustainable Transport

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Short report on vehicle demonstration tests using low blend of ethanol derivatives in diesel fuel

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Summary

A vehicle demonstration test using low blend of ten percent ethanol derivatives in diesel fuel has been running in Örnsköldsvik since May 2007. Two Scania Omni city buses have been running the normal city routs without any standstill in operation depending on the fuel. The buses have been available 100 percent and followed to the original timetable.

The result, so far, shows no difference in fuel consumption and the bus work just as normal when running on normal diesel fuel.

Background

The diesel engine has taken its position as the leading prime mover for heavy-duty vehicles mainly on the grounds of high fuel efficiency and reliability. In most countries, diesel is in practise the sole fuel for heavy-duty vehicles, buses and trucks. The main drawbacks of the diesel engine are high particle emissions and high emissions of nitrogen oxides.

Fuel modifications, so called low blend, provide an interesting option to emission reductions for the existing vehicle fleets. The main advantages of fuel modifications are that the lead time for implementation is relatively short, and that in the best cases no modifications are needed to the fuel distribution system or the vehicles.

This report is a short summary on vehicle demonstration test made with modified diesel fuel. By using low blend of a renewable ethanol derivative the heavy-duty diesel emissions easily could be reduced without any modification of the vehicle engine. The fuel is generally called ED-diesel.

Preparation for the demonstration test

The first priority for this demonstration test was to find a buss operator close to the area of Örnsköldsvik where SEKAB is located.
After discussions with some alternative companies, we ended up with Veolia Transport AB, (Veolia), which has their office and bus depot not far from the SEKAB site in Örnsköldsvik.
A demonstration test agreement and project plan was signed between SEKAB and Veolia in beginning of 2007. The demonstration test started 22 May 2007 and is still running, December 2008.

Buses

Veolia have two identical standard Scania Omni City diesel buses, which are running seven days per week. Both buses alternate between all city routs in Örnsköldsvik so they have a very various running cycle.
The buses have a Scania DC905 engine, emission class Euro3. The emissions test was made on an identical engine. See delivery D3.08.

Before changing fuel in the two buses, from diesel fuel to low blend fuel, ED-diesel, an oil sample was taken from one of the buses. This sample is a reference sample for evaluation of wear and tear in the engine when using low blend.

Fuel tank

The fuel tank is a 15 cubic meter tank. The tank is made of stain less steel, SS2333, and double mantled, which makes it possible to place the tank almost everywhere, without any diked-in land in case of leaking. The total volume is 22 cubic metres.

The refuelling equipment is composed of a dispenser including a pump and a pistol nozzle. There is also a digital terminal mounted at the dispenser. Every time each of the two buses should refuel, the operator has to feed in the actual mileage of the bus. The terminal is logging the driving distance and

the fuelling volume, which gives exact information of the fuel consumption. The data is read from the terminal via a “digital key” and manually transferred to a computer.

Safety and legal issues

The flash point of ED-diesel using 10 percent ethanol derivative is 32°C. According to the Swedish fire risk classification, ED-diesel therefore belongs to Class 2b. That means it is possible for vehicles to refuel ED-diesel indoors as long as the ambient temperature is below 27°C. If the amount of ethanol derivative should be 13 percent or more, the flash point of the ED-diesel blend will fall below 32°C. Then the fuel has to be handled as petrol. However, the fire risk classifications may differ in different countries. There is no international standard.
In comparison, diesel oil has a quite high flash point, about 55°C. That corresponds to Class 3, which means the risk of fire is relatively low.

Before the tank could be installed, the local authority must give their building permit. According to the National Rescue Services Agency, a fire-extinguisher has to be installed close to the tank and Material Safety Data Sheet, MSDS, for the fuel has to be available. When all safety and legal issues were approved, the tank was filled with the first batch of ED-diesel.

Infrastructure

The infrastructure of preparing and distribution of the fuel has been very easy. For distribution of the fuel, SEKAB has an agreement with the oil company Preem. When the volume of fuel is below 5 cubic meters in the tank at Veolia, SEKAB sends an order to Preem for delivery of fuel, about 10 cubic meters.

When a delivery take place, the Preem tank car arrive at the SEKAB plant, filled with 9 000 litres of diesel. At SEKAB one cubic meter of ethanol derivative is added to the diesel oil. The tank car has two chambers in the tank. The fuel blend is mixed by pumping back and forth the two chambers. After doing so for some minutes, a sample is taken and then the fuel is delivered to the bus depot.

Test planning

The demonstration test was planned to run for twelve month with two buses. The driving mileage for each of the two buses is about 60.000 – 70.000 kilometres per year.

The fuel consumption was estimated to be about 55.000 to 60.000 litres and delivery of fuel to the bus depot tank, was planned to be 10 cubic meters every second month.

The buses are normally checked for service after 45.000 kilometres. The buses follow the normal service scheme except from a sample of the engine oil should be taken.

During the test period some interviews was made with the bus drivers and other personnel at the bus depot. A questionnaire has also been given to the drivers and the result is expected to be summarized in beginning of January 2009.

Measurements during the test

Problem with smell

There have been some complaints from the drivers and some passengers about the smell from the fuel. The fuel has a character of smell that is the same as ether, which can be very irritating. The problem with smell is specially when refuelling and at the bus-stop.

The reason why the ED-diesel fuel composition smells, is because of the ethanol derivative in the blend. ED-diesel has no ethanol or alcohol in the blend but 10 percent ethanol derivative. The derivative chemical product it selves, has a very strong characteristic smell, which could be irritating.

There has been lot of internal discussions how this problem should be handled and if there is some possibility to disguise the smell by adding some other component. Measures have also been made at the buses and the dispenser to minimise the smelling problem.
One measure made at the buses was to close the ventilation valves on top of the fuel tank. Doing so, the problem with smell almost disappeared.
Another measure made was to install a gas recovery system to the dispenser and pistol nozzle. That minimized the problem when refuelling. Instruction was also given to personnel responsible for refuelling to minimize spill or drop of fuel.
In general there has been a more marked smell during the warm summer periods.

Fuel consumption

Every time the buses refuel, the mileage and the volume of ED-diesel are logged in a digital terminal mounted at the dispenser. That gives exact information of the fuel consumption.

After 11 months, running about 60.000 kilometres per bus, the fuel consumption was 41,5 litres per 100 kilometres. The comparative consumption of diesel for the two buses, monitored during 2005 and 2006, was 41,9 litres per 100 kilometres.

Bus	ED-diesel (liter)	Distance (km)	Consumption Maj 07 - April 08	Consumption diesel 2006	Consumption diesel 2005
No. 7316	21.707,34	52.547	41,3	42,0	41,7
Bus	**ED-diesel (liter)**	**Distance (km)**	**Consumption Maj 07 - April 08**	**Consumption diesel 2006**	**Consumption diesel 2005**
No. 7317	25.818,09	61.973	41,7	42,1	40,9
			Average on ED-diesel 41,5 l/100 km	**Average on diesel 41,9 l/100 km**	

Table 1.

That is the same fuel consumption as running on diesel the same period the years before. That was not expected, since the result from the bench test showed increased fuel consumption at about 3 percent.

Driveability and accessibility

The two buses started to run on ED-diesel end of May 2007. The change of fuel was made without any problem and until now, December 2008, there has not been any standstill in operation depending on the fuel. The buses have been available 100 percent and followed to the original timetable.

The result from the bench test showed some loss in engine power, which was expected because of less energy density in ED-diesel. However, some drivers said spontaneously that they could feel the same power and the same response from the engine or even better.

Conclusion

Driving a standard diesel engine on low blend has been demonstrated in Örnsköldsvik since end of May 2007. The test shows that a standard heavy duty diesel engine could run on low blend diesel fuel with 10 percent renewable ethanol derivative. Even though result from emissions test shows reduced maximum power, the driver's subjective comments are that they do not feel any difference in the engine response. Since the energy content in ED-diesel is little lower than standard diesel, higher fuel consumption could be expected. The test has not showed any increased fuel consumption.

Product data sheet
Etamix D3 (ED-diesel)

General fuel characteristics
Etamix D3 consists of diesel and a bioethanol derivative. The ethanol derivative is fully based on renewable raw material. The blended fuel fulfils the criteria for a diesel fuel.

Flammable classification
According to the Swedish flammable classification and the Guidance for classification of flammable liquids ECB/51/05, Etamix D3 can be handled as diesel fuel.

Fuel composition
- 85,5 % diesel Mk1
- 4,5 % FAME (RME)
- 10 % bioethanol derivative

Typical data

		Etamix D3[a]	Diesel Mk1[b]	Swedish Standard SS155435
Cetane number		54.5	52	Min 50
Viscosity, 40°C	mm^2/s	1.6	2,0	1,4-4,0
Density, 15°C	kg/m^3	817.1	815	800-820
Distillation, Initial boiling point[c] 95 % distilled at	°C	 105 308	 193 285	 Min 180 Max 320
Cloud point	°C	< -24	-32	Max -16
Filterability, CFPP	°C	-34	-35	Max -26
Lubricity, HFRR	μm	233	350	Max 460
Corrosion on copper		1A	1A	1A
Heating value	MJ/kg	41.8	43,1	-
Flash point	°C	33[d]	> 60	Min 56
Sulphur content	mg/kg	2	< 2	Max 10
Vapour pressure at 20°C	kPa	3	< 0,5[e]	-

a) Analysis made by Saybolt Sweden AB, 2008-02-06. Data from one analysis.
b) Preem Diesel ProMil Environmental Class 1
c) Initial boiling point is only measured according to Swedish Standard, not European Standard EN590
d) Swedish flammable classification 2b means flash point min. 30°C
e) Measured at 38.7°C

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