Report: FuelGems treated diesel fuel – “on road” testing.

Introduction:

A Mercedes Benz C220 CDI 2003 model year was used as a test vehicle for the evaluation of FuelGems product. The test period included the consumption of 12 approx. full tanks of fuel, comparing the consumption of two tanks of treated fuel with two tanks of standard pump fuel repeated sequentially over 6 cycles. A detectable difference in fuel consumption between the treated fuel and standard fuel was observed over the period of testing, additionally an overall improvement in fuel consumption regardless of fuel treatment was noted. A number of UK Standard smoke emission tests[1] were undertaken prior to and during the fuel evaluation program, showing a small reduction in smoke number over the test duration. ([1]Equivalent to US Smog checks)

Methodology and test preparation:

A 2003 model year Mercedes Benz c220 cdi automatic saloon car showing approx. 145,000 miles on the odometer was chosen as the test platform vehicle. The vehicle was fully serviced, with new tyres fitted and tracking set prior to the test. Subsequently the vehicle was driven over two similar daily commuting routes and operated by a driver unaware of their participation in a fuel evaluation program. A single fuel source – brand and filling location - was used throughout (Shell fuelsave EN590 Diesel)

The embedded vehicle fault diagnosis and reporting system was used to monitor the vehicle condition in terms of excessive temperature, oil level and general sensor reporting parameters. All consumption data was taken from the vehicles’ inbuilt fuel consumption readout, this was recorded when the low fuel level light had been activated and refuelling was required. The fuel capacity of the vehicle is stated as 62 litres with 8 litres of that total being the reserve. Fuel receipts over the test period typically show 53-56 litres of fuel being added at each refill. The dose rate of the FuelGems additive used was 3ml per litre, to aid mixing a fixed dose of 150ml additive was added to the fuel tank prior to filling with the main fuel load; although this procedure compromised the accuracy of dosing slightly it did ensure a high level of mixing and rapid establishment of a homogenous fuel/additive mixture.

Results:

Principal data acquired over the duration of the test program is shown graphically in Figure one, it must be noted that the testing took place over several months due to various national Covid restrictions, starting in mid-June 2020 and completing in December 2020. As an indication of the general efficiency of the vehicle, given the mileage it had already covered, the official consumption figures are extra urban 5.1 litres/100 km (52 mpg) and overall 6.7 l/100km (42 mpg) as per Directive 1999/100/EC. Throughout the test duration no Malfunction Indications (MIL) were activated. Smoke test data relevant to the trial is presented in Table one.

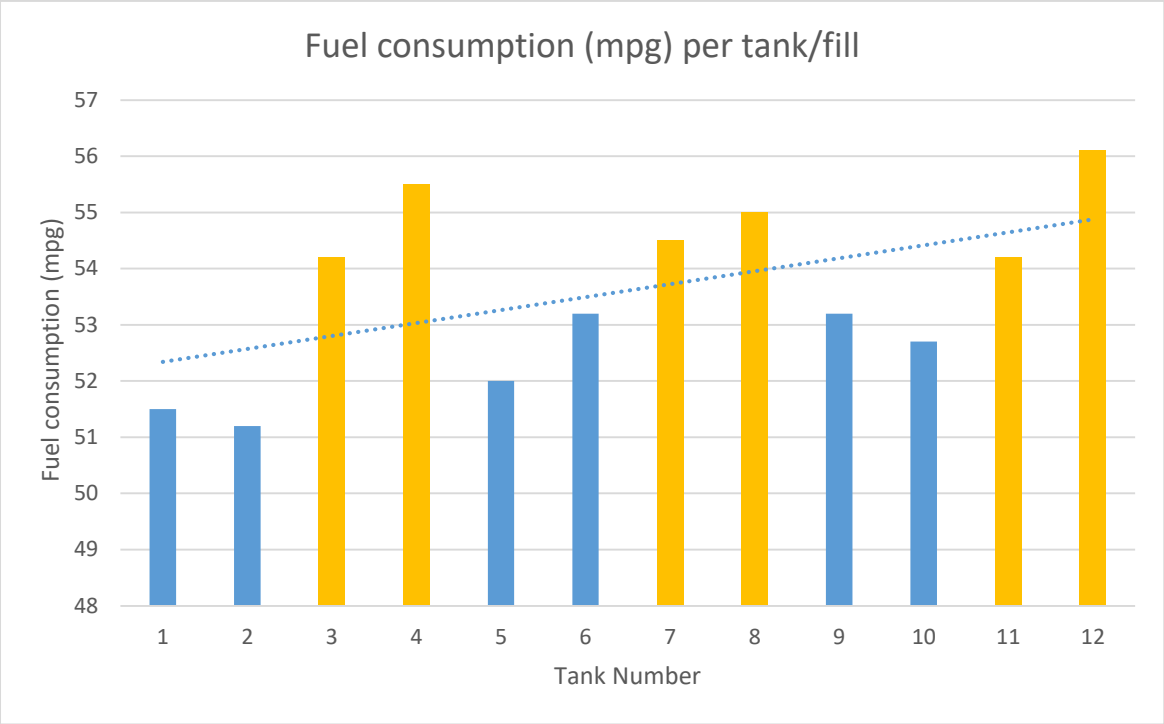


Figure One: Av fuel consumption per tank: Untreated EN590 FuelGems treated EN590 Average trend line

Time	1.Absorption coefficient (l/min)/rpm	2.Absorption coefficient (l/min)/rpm	3.Absorption coefficient. (l/min)/rpm	Mean Absorption coefficient (l/min)
Pre test*	2.23/4238	1.71/3857	1.35/4069	1.76
Tank 4	2.22/4211	1.71/3915	1.33/4112	1.75
Tank 11	2.22/4187	1.69/3807	1.27/4032	1.73

Table one: Smoke test results. *Test undertaken as part of full MoT** Test untreated fuel.

Smoke testing was done in accordance with MoT** procedures for the “Diesel – Free Acceleration Smoke Test”. A SUN DGA 5000 tester was used at the test location Willow Road Garage, Vehicle Test Station Number 1845AP. The maximum smoke absorption coefficient for this class of vehicle is 3.0 l/min; at this point there is clearly visible smoke from the exhaust tailpipe. The test measures the opacity of the hot exhaust gases produced when the engine, at operating temperature, is accelerated to governed speed. Any particulate matter, referred to variously as soot, smog or smoke present in the exhaust reduces the ability of light to be transmitted through a predetermined cross section of flowing exhaust. The more the light is obscured the higher the smoke number and thus the greater amount of particulate material present in the exhaust gases. An engine that combusts more of the fuel completely and therefore has a low smoke number is said to be more efficient as

more of the chemical energy of the fuel is being transferred to motive power, rather than being expelled as waste energy via the exhaust.

Discussion:

It is inevitable that field trials suffer from the influence of external factors outside the control of the experiment and this is recognised in this work. However the long duration of the test and the number of miles covered – approx. 7,500 - go some way to averaging out excessive deviations. It is clear from the consumption data that the use of the FuelGems additive has a measurable effect on the fuel consumption that is observed over the use of the first tank of treated fuel. The data also shows that there is a reduction in fuel consumption when untreated fuel is used after FuelGems treated fuel and that the reduction in consumption increases as the test progresses. It should be noted that the fuel consumption (mpg) figures were taken directly from the display in the vehicle and were not calibrated, however whilst the numerical value may be inaccurate the overall trends and differences can be reported with some confidence.

Interestingly the overall reduction in fuel consumption trend (indicated by the dotted blue trend line in Figure One) continues to improve over the duration of the test, perhaps indicating that the improved combustion efficiency resulting from the use of FuelGems treated fuel enables untreated fuel to be consumed slightly more efficiently. This may be due to carry over of treated fuel in the fuel system as the fuel system was not flushed between fuel changes, or perhaps a cleaning effect, where residual deposits of carbonaceous material are oxidised and burnt away; improving gas flow and eliminating hot spots. An engine inspection would be required to establish if this latter mechanism was in effect.

Exhaust smoke has a number of mechanisms of formation and is defined as solid particles of carbon resulting from otherwise complete combustion, the black or dark grey smoke produced from diesel engines at operating temperature can have a mixture of unburnt hydrocarbons and partly oxidised fuel particles entrained in the exhaust gases, these continue to oxidise and leave the tailpipe as soot or smog. Clearly, the reduction in these species is highly beneficial in reducing emissions and if fully burnt in the combustion process there is an increase in the amount of power extracted from the fuel; an increase in efficiency and consequent reduction in overall fuel consumption.

Conclusions:

Prior to testing the engine and vehicle were operating to a good standard and continued to do so over the duration of the test.

A general improvement or reduction in fuel consumption was observed when FuelGems treated fuel was used.

A residual effect was observed in that the consumption of untreated fuel was marginally reduced following the use of FuelGems treated fuel.

A maximum improvement of approx. 9% in mileage was observed, this equates to a cost saving of approximately £64 at an average fuel cost of £1.18/litre.

An average improvement of 5% in mileage was observed over the test duration where untreated fuel consumption was compared to FuelGems treated fuel, although it must be remembered that an improvement (approx. 3%) in untreated fuel consumption was also noted.

A reduction in smoke number of approx. 6% was noted over the duration of the test, this equates to a useful reduction in the amount of particulate matter found in the exhaust. It is likely that this reduction is more significant in actual vehicle use as the test purposely observes an extreme condition that exacerbates the formation of smoke particles.

The reduction if fuel consumption and reduction in smoke number correlate with the improvement in combustion efficiency due to use of FuelGems additive. This infers that the FuelGems additive is enabling combustion to reach completion throughout more of the fuel charge than would otherwise be the case.

Observations:

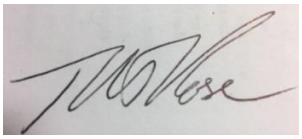
Starting and general engine noise appeared unchanged, although the driver did report that the car drove very well and seemed to be more responsive towards the end of the testing. Also as winter approaches there are several factors which can act to increase overall fuel consumption; the low temperatures mean engine warm up takes longer, electrical loads of heated screens and seats etc increase, and resistance to vehicle movement due to cold dense air and rainfall increases.

Notes:

Mercedes C220 diesel is powered by an inline 4 cylinder, 16 valve direct injection, common rail diesel engine fitted with turbocharger and intercooler. This engine is commonly used throughout Mercedes mid range vehicles with larger 5 and 6 cylinder engines following the same architecture. For this model year there is only an oxidation catalyst fitted for exhaust gas after treatment before discharge to atmosphere.

**MoT = Ministry of Transport – UK Authority for mandatory yearly vehicle assessment and testing.

Report authored by: Dr.T.W.J.Rose. C.Eng (Chartered Engineer), C.Sci (Chartered Scientist), B.Eng (Bachelor of Engineering, Hons).



Dated: 11th January 2021.