MANCHESTER XPAG TESTS

FUEL AND TUNING – PART 2.1 CHOICE OF FUEL AND TUNING CARBURETTORS

By Paul Ireland

Introduction

In the previous article I suggested steps that could be taken to mitigate the problems a number of classic MG owners suffer from: *Weak Running*, where the engine stops in slow-moving traffic, especially on hot days, and the *Hot Restart* problem where a hot engine cannot be restarted after stopping for 5-10 minutes. The Manchester XPAG tests identified a further problem with modern petrol: *Slow Combustion*. Particularly at normal road driving speeds and with high throttle settings, modern fuel appears to burn too slowly, overheating the valves, cylinder head and exhaust system. This in turn increases under-bonnet temperature, making the *Weak Running* problem worse.

In this article I will discuss the effect of different grades and blends of petrol on the severity of the *Slow Combustion* problem and the importance of choosing a fuel best suited to your car.

The implication of these results is that the normal additives used to enhance the octane rating are possibly to blame for *Slow Combustion* and fuels that use ethanol or other chemicals as an octane enhancer perform better.

A number of articles have been published on the dangers of ethanol blended fuel. There is one other potentially serious corrosion problem I have discovered and I will cover this in a later article.

Remember that our cars are all different and the severity of the problems experienced by owners varies immensely, even between the same models of car. The suggestions in these articles should be taken just as that, suggestions for people to try; they are not intended as solutions to be blindly adopted.

Slow Combustion

Previous articles described how poor mixing of the air and petrol in the carburettor can lead to a problem called *Cyclic Variability*. This is a condition where, in every cylinder, the timing of each combustion cycle can vary significantly cycle by cycle leading to some cycles firing too early, or pinking, and others firing too late, resulting in very hot gases and unburned fuel leaving the cylinder. It is as though something is making huge adjustments to the ignition timing every time the engine fires.

Carbon monoxide (CO) in the exhaust gases is an indication of poor combustion. CO is produced when there is insufficient oxygen present to burn the carbon to carbon dioxide (CO_2). In an engine that is running rich, insufficient oxygen is inducted with the fuel and this will lead to high levels of CO in the exhaust gases. However, at Manchester both the mixture and timing of the engine were set to the optimum for each test. Therefore the high levels of CO are a direct indicator of poor combustion caused by imperfect mixing of the air and fuel in the cylinder – one cause of *Cyclic Variability*.

The measurements of the SU suction piston heights at Manchester provided an indication of the scale of this problem particularly when using full throttle settings below 3,000 rpm. In addition, there was a strong correlation between the degree of enrichment seen » below 3,000 rpm on full throttle and the levels of CO in the exhaust gases for the different fuels, confirming the link between the *Slow Combustion* problem and poor combustion.

Choice of Petrol

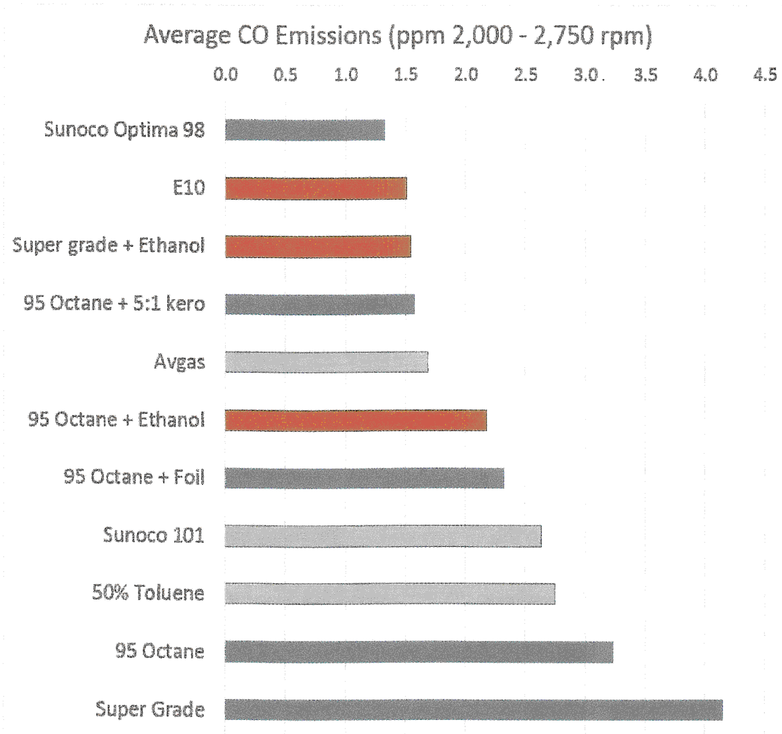
At Manchester nine different fuels were tested, along with a 20% kerosene mix and the use of a nebulizer to improve petrol atomisation and mixing. Each of these combinations produced different levels of CO. As the *Slow Combustion* problem appeared at its worst on full throttle between 2,000 and 3,000 rpm, the diagram below shows the average CO levels in the exhaust gas for each fuel or combination for these tests. The lower the levels of CO, the better that sample of fuel is burning. The grey bars show the special fuels we tested and the orange bars the ones containing ethanol.

These results show significant differences in the levels of CO between the different fuels. The top performing fuel is the Sunoco Optima 98 that was also rated highly as not suffering from the weak running problem.

Of the top six best-performing fuels, three were ethanol blended, one an ethanol blended Super grade, came in third. Remember Cleveland Discol that was introduced in 1928 and mentioned in the first article? This fuel contained alcohol (ethanol) and these findings support the manufacturer's claim that it "contributed to a brilliant performance and better mileage because it keeps the engines cooler and cleaner".

The diagram on the right shows shows the average relationship between unburned hydrocarbons in the exhaust gas against exhaust temperature for the 2,000 to 2,750 rpm range. As the engine was fully tuned for each test, high levels of unburned hydrocarbons reflect poor combustion. As might be expected, the less of the fuel that has burned the lower the gas temperatures and the less efficiently the engine is running.

It is interesting to note at the bottom right hand of the graph, the 95 Octane + foil and 95 Octane + 5:1 kero both burn better than the 95 Octane on its own. Adding kerosene certainly improves the combustion, suggesting any fears it will not burn are unfounded.

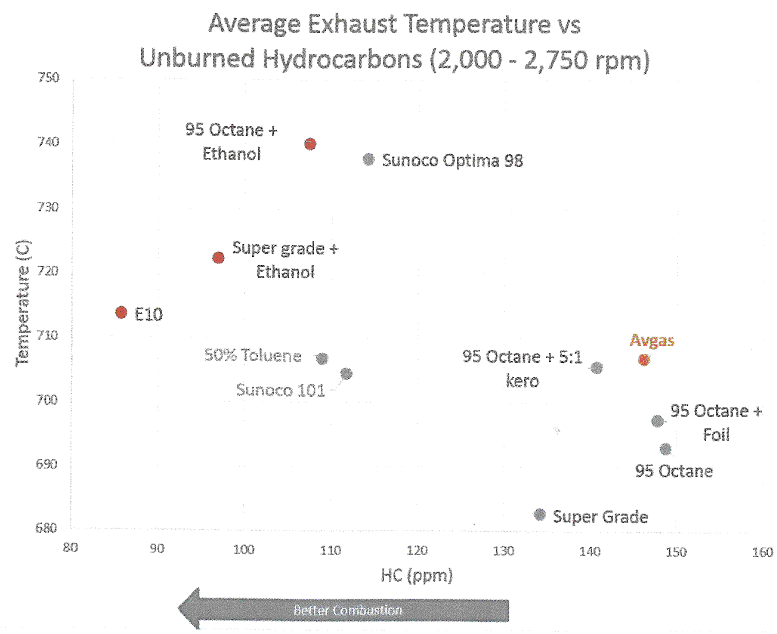


The three red tests at the top right of the graph show that increasing the volume of ethanol in the petrol both improves combustion and reduces exhaust temperatures as more hydrocarbons are replaced by oxygen molecules. However, before filling up your car with an ethanol blended fuel, read the warning later in this article.

Unfortunately, these findings show that not all Super grade fuels performed as well. The Super grade **with** ethanol produced 1.55 ppm CO while a different brand of Super grade **without** ethanol produced 4.16 ppm CO – more than double.

One question most people will ask is: "Did you see any difference in power output between the different brands?" The answer is yes. The average full throttle power output of the test XPAG between 2,000 and 2,750 rpm was 25.2 BHP, The difference in power output between the worse performing petrol and best was one BHP. While measureable, this difference is small and would not be noticed during normal road driving. However, this measurement was obtained for an engine that was fully retuned for each fuel and rev setting. Different fuels showed different levels of enrichment due to the *Slow Combustion* problem. When an engine is running rich, it produces less power. Hence when used on the road and where the engine is not being continually re-tuned, as in the tests, these fuels will produce less power than the tests predict.

The fuels that gave the maximum average power output were Sunoco Optima 98 and the Branded 95 Octane (Batch two) with nebulizer. One surprising result is that adding 20% kerosene to the 95 Octane (Batch two) reduced the CO emissions by nearly 50%. However, it also gives the lowest power output. It is not clear why adding kerosene should significantly improve burning and reduce the effect of *Slow Combustion* while, at the same time, reducing power output. The power



reduction is not caused by the kerosene failing to burn properly; the level of unburned hydrocarbons in the exhaust (141 ppm) was slightly less than that of petrol on its own (149 ppm), suggesting people's worries about the kerosene not burning are unfounded.

This test was run with a very high concentration of kerosene (one part kerosene to five parts petrol or 20%). Adding kerosene to standard fuel is perhaps something worth trying. Best to start with lower concentrations, eg 5% kerosene (one part kerosene in 20 parts petrol) and increase it if it appears to improve matters. Owners of high compression engines need to take care as adding kerosene also reduces the octane rating and could cause pinking. This is discussed more fully in the next article.

These results demonstrated differences in the performance of different brands and grades of petrol in the XPAG engine. High ethanol content fuels appear to perform best, but they bring with them another set of problems. Trying different fuels to find one that best suits your car, is not easy. Look at the difference between the two batches of the same brand of 95 Octane petrol, both bought within days of each other in Manchester at a filling station close to the University. The one without ethanol burned worse, producing 50% more CO but with an exhaust gas temperature 50°C lower than the ethanol blended batch. Also remember the composition of the same brand and grade of petrol will vary across the country.

However, for normal driving, remember the advice that was given in the last article: To avoid the *Slow Combustion* problem, do not open the throttle fully below 3,000 rpm. If you wish to accelerate, select a lower gear first. Conversely, if you are cruising in third or second gear and your revs are above 3,000 rpm you should change UP to a higher gear.

Conclusion

The Manchester tests showed there were significant differences in the way the engine ran on different brands and grades of petrol. They showed that with the exception of the specialist Sunoco Optima 98 petrol, the best performing, commercially available fuels are ones that used ethanol to boost the octane rating. But these come with a warning.

The advice for classic car owners is try different brands and grades until you find a fuel that works best in your car. As *Cyclic Variability* causes an engine to run slightly rough, owners should choose the fuel on which the engine runs most smoothly, particularly on full throttle below 3,000 rpm.

Although Sunoco Optima 98 is around twice the price of pump fuel, its low volatility below 50°C, improved running characteristics, guarantee it does not contain ethanol and long storage lifetime make it a fuel of choice for low-mileage vehicles.

Sunoco Optima can be ordered direct from the Anglo American Oil Company via their web shop (www.aaoil.co.uk) or by telephone on 01929 551557. Be aware: the law limits the amount of petrol that can be stored in a garage, or anywhere within six metres of a dwelling to 30 litres.

Adding around 5%-10% kerosene to pump fuel reduces its volatility below 50°C, also reducing the degree of the *Slow Burning* problem. Owners of high compression engines who try adding kerosene must watch out for pinking as it reduces octane rating.

If you live in the UK remember, you can legally add kerosene to petrol for cars produced before 1956, but you will need to apply to HM Customs and Excise for a Concession. Write to:

Mr John Loughney, Excise, Stamps and Money Businesses, HM Revenue & Customs, 3rd Floor West, Ralli Quays, 3 Stanley Street, Salford, M60 9LA

Requesting a "General Licence to mix hydrocarbon oils under Regulation 43 of the Hydrocarbon Oil Regulations 1973 (SI 1973/1311)" giving your name, address, model and dates of production of the model of your vehicle.