Manchester XPAG Tests

Part 12 - Conclusion

Over the past series of articles my aim has been to help readers understand the issues caused by modern petrol when used in classic cars. This, the final article of the series, summarises the common problems, the reasons why modern petrol causes them and suggests some solutions. Please note: the suggestions should be taken as just that, suggestions to try; they are not intended as solutions to be blindly adopted. Far better to employ solutions specific to particular vehicles based on an understanding of the causes of the problems.

Problems

The most common issue people suffer from is called the "*Hot Restart problem*". Drive a car any further than 10 miles or so, stop for 10 minutes, for example to fill up with petrol, and the car will not re-start. A related problem occurs in slow traffic, especially on a warm day, the engine coughs and splutters to a stop as though it has run out of fuel.

Annoying when you cannot start your car in a petrol station and potentially dangerous if it stops in busy traffic.

If you cannot restart your engine, for example in a petrol station, sometimes pulling out the choke will help to get it started although it will run rough until cooler petrol from the tank gets to the carburettors. If the engine starts to misfire in slow moving traffic, the only solution is to pull to the side of the road as quickly as possible, stop the engine, open the bonnet and wait about 15 minutes until it has cooled.

Causes

The primary cause of these problem is the high volatility of modern petrol below 50^{o}C, a typical under-bonnet temperature. At 50^{o}C, only 8% of 1960's petrol would have evaporated (or boiled away) compared to 25% of modern petrol, nearly 3 times that volume! In addition the higher volatility of modern petrol is the reason it "goes off" when stored in a vehicle's petrol tank.

When the car is stopped or moving slowly in traffic, the temperature under the bonnet starts to rise. With little or no petrol flowing through the fuel pump, petrol lines and carburettors, it has more time to get hot and boil. Carburettors will not deliver the correct mixture when there are bubbles of vapour in the petrol and it is this weakening of the mixture that causes the engine to stop or prevents it from restarting.

There is a second, less obvious problem. Modern petrol **appears** to burn more **slowly** and **hotter** than classic petrol. These symptoms are caused by the "*Slow Combustion problem*" which has the same effect as running with a retarded ignition. This increases the temperature of the exhaust gases which, in turn, heat up the cylinder head, cooling water and exhaust manifold, further raising under-bonnet temperatures and making the *Hot Restart problem* still worse!

The "sting in the tail" is that the tests at Manchester found the *Slow Combustion Problem* is worse at engine speeds and loads typical of driving on the public highway.

In practice, modern petrol does not actually burn more slowly or hotter than classic petrol, the apparent effects are due to a phenomenon suffered by all petrol engines called Cyclic Variability. The time it takes for the air / petrol mixture in a cylinder to burn depends on a number of different factors. Random variations in these factors cause some of the combustion cycles to take longer to burn than the ideal. Unfortunately, modern petrol appears to make Cyclic Variability worse, increasing the number of slow burning cycles and effectively slowing the average burn rate. Even with the correct ignition timing, this has the apparent effect of retarding the ignition.

Possible Solutions

Unfortunately, there is no magic fix to the problems of running classic cars on modern petrol. However, there are a number of steps that can be taken which, together, will reduce the severity of the problems:

1) Use a less volatile petrol
2) Stop the temperature under the bonnet getting too high
3) Stop the heat getting to the fuel system components
4) Tune the engine to reduce the effect of the *Slow Combustion Problem*

1) Use a less volatile petrol

The only practical way is to achieve this is to use a specialist petrol such as Sunoco Optima 98 sold by Anglo American Oil. While this is expensive, its volatility matches that of 1960's petrol, it is ethanol free and it can be stored without degrading. Probably worth considering for low mileage vehicles.

The only other guaranteed way to reduce volatility is by adding kerosene to the petrol, legal for cars built before 1956. Kerosene also reduces the *Slow Combustion Problem.* It works by diluting the "bad" components of modern petrol, suggesting the greater percentage you add the better. However, the down side is that at concentrations above 10% it appears to reduce the power output. It also reduces the petrol's octane rating so you need to be careful if you plan to try this with a high compression engine.

If you choose to use standard pump fuel, the volatility changes over the year - more volatile in the winter (to make it easier to start the engine) and less volatile in the summer. Try to avoid winter, spring and autumn petrol and only fill up in the summer. Unfortunately, finding a summer petrol is easier said than done as even petrol bought at the same filling station can vary between deliveries.

Of the fuels tested at Manchester, super grades appeared to be less volatile than the same brand of 95 octane petrol, they also reduced the magnitude of the *Slow Combustion Problem* so are probably the best choice.

Interestingly, the addition of ethanol does not appear make petrol more volatile.

2) Stop the temperature under the bonnet getting too high

A petrol engine is only around 30% efficient. Around 35% heat energy produced when the petrol burns is lost in the exhaust gasses, around 25% goes into heating the cooling water and the remaining heat is lost to the oil or from the engine block.

The under-bonnet temperature is increased by the hot exhaust system, air heated as it passes through the radiator and the heat lost from the engine block. When driving, the airflow through the front of the car dissipates this heat. It is important to keep the under-bonnet and particularly the fuel system temperatures as low as possible. The most effective ways are to ensure the cooling system is working efficiently and cold air can flow freely around the engine, particularly around the fuel system components.

Take steps such as flushing out the radiator, removing flies and other debris from the radiator fins and checking the thermostat is working properly. On the older cars it is possible to fit the cooling fan the wrong way around which reduces its efficiency. It may be worth replacing an old pressed steel fan with a 7-bladed plastic fan like that fitted to an MGB. A wetting agent in the cooling system may also help. Consider re-running fuel hoses, especially if they are near the hot exhaust manifold or downpipe and repositioning ancillary equipment such as the horn, badges or additional lamps to ensure they are not blocking the airflow through the front of the car.

Air that has passed through the radiator is hot. In slow moving traffic, electric cooling fans may make matters worse. These will switch on as the radiator heats up, blowing hot air under the bonnet. If your car has an electric fan fitted, it may be better to position the fan at, or slightly below the bottom of the radiator where it can suck in cooler air.

It is also worth fitting a timer or equivalent circuit to keep the fan running for around 5-10 minutes after the engine has stopped as this will help disperse the hot air from under the bonnet. Another possibility would be to add a switch or circuit to reverse the polarity to the fan when the engine is stopped, allowing it to draw cool air from under the car and vent the hot air through the front of the radiator.

On hot days, think about where you park your car. If parked in direct sunlight, the slab petrol tanks on the back of the older MGs can get quite hot. Even more modern cars with internal petrol tanks can get very hot in the sun.

3) Stop the heat getting to the fuel system components

Insulating fuel system components and fitting heat shields may help. However, these will only slow the transfer of heat, not stop it. Any insulation will need to prevent heat getting to the petrol until the under-bonnet temperature has had time to drop below 40^{o}C.

The tests at Manchester showed that, when the engine was stopped, the petrol in the carburettors was heated through the inlet manifold by heat conduction and hot gases from an open inlet valve on one of the cylinders. Some owners have fitted 10mm insulating blocks between the carburettors and inlet manifold and suggest these have helped prevent the *Hot Restart Problem.* The thermal images also showed the choke levers underneath the carburettor were hot. Most surprising was the float bowls, positioned only a few centimetres above the 400^{o}C exhaust manifold, did not get hot.

An alternative approach is to insulate the hot parts of the engine such as the exhaust manifold and down pipe. These run very hot and, after the engine has stopped, cool down quickly. This may provide a more effective solution than insulating the fuel system components.

Before fitting any insulation or heat shields it is worth investigating which parts of the fuel system are getting hot using an infrared thermometer or electrical test meter with a thermocouple. As was shown at Manchester, it is not always obvious where the problems lie.

4) Reduce the Effect of the *Slow Combustion problem*

The *Slow Combustion Problem* causes the cylinder head and exhaust system in particular to become overly hot. During normal driving, this does not pose a problem because of the air flowing through the engine bay and the high flow of petrol through the carburettors. However, when the engine is stopped this heat “soaks” out, increasing under-bonnet temperatures and causing the petrol to boil.

Reducing the magnitude of this problem both helps to protect the engine from damage and reduces the severity of the *Hot Restart Problem.*

There are basically three ways to achieve this:

1) Choice of petrol
2) Advancing the ignition timing
3) Tuning the carburettor

Other than Sunoco Optima 98 (which is ideal), super grade petrol or petrol containing ethanol appear to be the best fuels to use, adding kerosene also helps. Although very specialist equipment is needed to accurately measure the degree of Cyclic Variability, the good news is that it is something that can be detected during normal driving. Cyclic Variability makes an engine sound and run rough. Comparing the sound and smoothness of an engine when using different brands or grades of fuel, can give an indication of which is the best to use. Choose the one where the engine runs most sweetly.

In addition, a thermocouple fitted to the top of the radiator gives some indication of the waste heat generated by the engine. It provides the means to compare different fuels when driving in in the same way in similar ambient temperatures. The lower the temperature reading the better the fuel is performing.

Advancing the ignition timing is the most effective way of reducing exhaust temperatures. Make sure the centrifugal advance works using a timing light with the means to measure the engine advance. Check the shape of the advance curve against that recommended for your model of car. If your car is fitted with a vacuum advance check it is working properly using the timing light. If your car does not have a vacuum advance, consider fitting one. Advancing the ignition timing a few degrees (e.g. 5^o - 10^o) beyond that normally recommended also helps.

However, **DO NOT** over advance the engine to the point where it starts to pink!

If you are considering gas flowing your inlet manifold and cylinder head think about what you want to achieve. For normal road use, this could reduce the turbulence and mixing of the air and petrol in the inlet manifold and make the *Slow Combustion Problem* problems worse.

With an SU carburettor, check the fuel level in the jet is set correctly. Modern floats or "stay up" floats may be too light causing the fuel level in the carburettor jet to be too low. If they are fitted, check that the springs in the suction chambers are the correct colour for your car. Most MGs should have red springs, but the TF uses light blue and the V8 uses yellow.

Finally, consider a session on a rolling road to ensure that your engine is optimally tuned and running as efficiently as possible.

Storage problems

When stored in a car's petrol tank, modern petrol "goes off". After not being used for a few weeks, some people have found their cars difficult to start and when they do, they run rough until filled with a new tank of petrol. The reason for this is that even at normal ambient temperatures, the low boiling point components of modern petrol evaporate changing its characteristics. Data from BP Australia Ltd produced in 2005 shows this effect:

Time	1 Week	2 Weeks	3 Weeks	4 Weeks	5 Weeks
% volume or petrol lost	3%	5%	8%	10%	15%
Density (gm/cc)	0.75	0.76	0.765	0.78	0.79

With fewer low volatility components, the petrol does not evaporate as easily to help start the engine. When it does start, the increased density will cause the engine to run rich making it run rough.

This creates a dilemma. Some people recommend storing cars with a full tank of petrol to stop condensation. Should you follow these recommendations, you will lose a greater volume of petrol and have more "bad" petrol in your tank when you come to use your car.

Suggestions include:

1) Only keep your tank ½ full when you store your car
2) Add some fresh petrol before you try to start or use it after storage
3) Use a fuel that contains anti-oxidants, metal deactivators and corrosion inhibitors (possibly super grade petrol) or use an additive.

Ethanol Blended Petrol

I believe ethanol blended petrol is here to stay and over time, concentrations of ethanol will rise. While there are issues, it appears that ethanol blended petrol is not the "baddie" that some people fear.

As far as I am aware, there are two practical problems owners need to be aware of, rotting petrol hoses and seals and, more serious, the severe corrosive effects of any water that may get into the petrol. On the positive side, the tests at Manchester showed the engine ran better on ethanol blended petrol.

As part of the regular service routine, owners should check for petrol leaks. Start the car to pressurise the fuel system and feel around the rubber hoses, carburettors and fuel pump. A dry kitchen towel is a good way to detect leaks.

Be very careful when filling the car, especially on wet days. You do not want to get ANY water into your fuel system. Consider slosh coating your petrol tank and periodically draining it and letting it dry out. Annually clean out the carburettor float bowls and replace any filters.

Conclusion

Modern petrol and classic cars don't really go together. The Manchester XPAG test have helped to understand the cause of these problems and suggest ways they can be avoided. Hopefully, implementing such suggestions, will enable owners to better enjoy their classic motoring.

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