

Manchester XPAG Tests

Part 11 - Ethanol blended Petrol.

Introduction

A great deal has been written about petrol that contains ethanol (alcohol) by experts such as Barrie Jones of the TF register, some authors suggesting it may cause serious problems in older cars.

In the UK, 95 octane and some premium brand fuels can contain up to 5% ethanol blended into the petrol. This is referred to as E5. In Europe and other parts of the world, petrol with 10% ethanol (E10) and greater concentrations are sold. These are often marked on the pump as E10, E15, etc.

Unfortunately, in the UK, it is virtually impossible to tell if the petrol you are putting into your tank contains ethanol and, if so, at what concentration.

Adding ethanol to petrol is not new. Cleveland Discol was introduced in 1928 and was sold until 1968 claiming to “contribute to a brilliant performance and better mileage because it keeps the engines cooler and cleaner”, “the perfect cold-weather fuel”. However, it is not known what percentage ethanol Cleveland Discol contained making it difficult to compare with modern fuels. The good news, however, is that 40 years of use in what are now today’s classic cars did not appear to cause major failures of their fuel systems.

While this article is not a definitive description of the issues of using ethanol blended petrol, it provides practical observations on the severity of some of the problems to allay some fears, but also to raise others.

Why add Ethanol to Petrol?

It has been suggested that the initiative to add ethanol to petrol was driven by Governments trying to reduce a country’s dependence on imported fuel. This may or may not be true. One fact is true, adding ethanol does reduce carbon emissions and pollution. Firstly, the carbon in the ethanol comes from renewable sources, it is a by-product of the sugar industry and, as the tests at Manchester showed, it burns better than non-blended petrol producing less pollution. There is also a financial benefit for petrol companies, as the cost of producing ethanol is around 13% lower than petrol and it is not subject to UK fuel duty (which is currently 57.95p per litre plus VAT).

Ethanol is also an octane booster, reducing the need for other octane boosters such as methyl tertiary-butyl ether (MTBE) and ferrocene that are now being added petrol. These, in turn, replaced tetraethyl lead (TEL) that was used in leaded petrol before it was banned. Some brands of super grade fuels sold in the UK use ethanol to boost their octane rating.

If you are using an ethanol blended fuel, it is important NOT to try to remove the ethanol as this will reduce its octane rating.

Why is Octane rating Important?

During the engine’s compression stroke the air / petrol vapour mixture is heated and, especially if there are incandescent carbon deposits in the cylinder, the mixture can auto-ignite before the spark plug has fired. This causes a phenomenon called pinking or knocking when the engine makes a sound like a pebble being shaken about in an empty tin. Pinking can cause serious damage to an engine.

A fuel’s octane rating is a measure of how resistant the petrol is to auto ignition. The higher the octane number the less likely it is to auto ignite and cause pinking.

The only problem is there are two similar measures. Research Octane Number (RON) and Motor Octane Number (MON). RON is determined by running the fuel in a test engine with a variable compression ratio and is the measure widely used in Europe. MON is determined at 900 rpm engine speed instead of the 600 rpm for RON. Usually, MON numbers are around 6 – 10 points lower than RON which means 89 MON is approximately the same as 95 RON. (MON is commonly used in America and Canada).

How can you check if a Petrol contains Ethanol?

It is relatively easy to determine if a fuel contains ethanol, BUT you must be **VERY CAREFUL**. Petrol vapour is highly flammable so care should be taken to ensure there are no naked flames, sources of sparks or similar anywhere near to where you test the fuel.

The test is based on one of the problems with ethanol blended petrol, the fact that when water is present, the ethanol will be sucked out of the petrol and into the water, increasing the volume of the water.

To perform the test, add some food colourant to a small quantity of water and pour it into a small bottle, such as a drinking water bottle. Place the bottle on a flat surface and put a mark at the top of the water. Fill the bottle to the top with the petrol you want to test. Put the lid on and shake. After the mixture has settled and the coloured water has dropped to the bottom, look at where the level of the water is. If it is above the line, the volume of the water has increased, proving that the petrol did contain ethanol.



The two bottles in the picture were filled to the same level with red / brown dyed water, the petrol on the left does not contain ethanol and the one on the right does. The difference in height of the water is easy to see. (Note there is nothing at the bottom of the bottle, this is just an effect of the light on the indentation).

When you have finished the test, remember to dispose of the petrol and water responsibly – do not just pour it down the drain!

What are the Problems with Ethanol?

There are four potential problems with ethanol blended petrol:

- 1) It rots non-metallic components such rubber hoses, seals, diaphragms and plastic floats.
- 2) It contains oxygen which weakens the mixture.
- 3) It is corrosive to metallic components such as the steel petrol tank and aluminium float chambers.
- 4) It absorbs water and can create a separate acidic layer underneath the petrol.

The effect and seriousness of these problems are discussed in the following sections.

[Rots Rubber hoses, Seals, Diaphragms, etc.](#)

Ethanol blended petrol removes the plasticisers from the rubber and plastic components used in fuel systems, causing them to become brittle and crack. Old braided fuel hoses which have lasted for many years have been known to fail within weeks of being subjected to ethanol blended fuel.

Most MG owners are fortunate to have an electric fuel pump which makes it very easy to detect most leaks in the fuel system. When you come to start the car from cold, switch on the ignition and before

you start the engine, just listen to the petrol pump. Normally an electric pump will click for up to 15 seconds or so as it replaces fuel lost by vaporisation from the carburettors and pressurises the system. This clicking should gradually slow and stop. If it doesn't, you may have a leak in the fuel system or a problem with the petrol pump, leaking needle valves in the float chambers or a faulty float. In any case, this should be investigated.

Note that, if you are trying to restart a hot engine, then a continued clicking may be due to petrol vapour in the fuel pump or hoses.

Is this tendency to rot hoses, seals, etc. a real problem? Probably not. These components are relative cheap and easy to replace with ethanol tolerant parts and in the older cars they would probably need to be replaced anyway due to their age.

However, it is important that owners are aware of this problem and keep a regular watch for any petrol leaks, especially if the fuel hoses are hidden inside a metal braiding. If your car is fitted with an electric fuel pump, make a habit of listening to the clicking.

Enleanment

Pure petrol is a mixture of Hydrocarbons - it contains only carbon and hydrogen atoms. Hence, 1 litre (1000 ml) of petrol contains 1000 ml of hydrogen and carbon atoms. However, ethanol contains 35% oxygen atoms by weight, so 1 litre of E10 (with 10% ethanol) will only contain 965 ml of hydrogen and carbon atoms.

In effect, we are being "short changed". All else being equal, a car that returns 30 mpg will only give 28.9 mpg when running on E10. However, as we found at Manchester, the XPAG engine ran more efficiently on ethanol blended fuels and it is quite possible E10 will give a better mpg despite containing less hydrocarbons.

The replacement of hydrocarbons by oxygen has a second effect called enleanment. Carburettors deliver a precisely measured volume of fuel to a given volume of air. The ideal is called the Stoichiometric ratio with 14.7 parts of air to 1 part of petrol. With this ratio there are exactly the correct number of oxygen atoms to combine with the hydrogen and carbon atoms when they burn to produce water and carbon dioxide. Adding ethanol to the petrol has a double effect. Not only does E10 reduce the number of hydrocarbons by 3.5%, it also increases the amount of oxygen in the mixture by a similar amount. This has the effect of weakening the mixture.

Most carburettors are set slightly rich as standard, and the tests at Manchester showed they will cope with E5 without any adjustment. If E10 is used, they should be adjusted to make the mixture slightly richer. With the older SU carburettors this corresponds to screwing the adjusting nut DOWN by $\frac{1}{2}$ to 1 flat on the adjusting nut. On the HIF type the adjusting screw should be turned $\frac{1}{8}$ to $\frac{1}{4}$ of a turn clockwise.

At higher concentrations of ethanol, SU carburettors will require slightly richer metering needles. Weber carburettors and mechanical fuel injection systems will need larger jets and possibly different emulsion tubes. Modern computerised fuel injection systems should adjust the mixture automatically.

Enleanment does not appear to cause any practical problems with 10% or less ethanol added to the petrol.

Corrosive to Metallic Components

Corrosion of metals is a complex process however, it can be caused by two different processes:

- Oxidation - where oxygen combines with the molecules on the surface of the metal to create a metal oxide. This is most common when an acid comes into contact with a metal.

- Galvanic corrosion – occurs when two dissimilar, electrically connected metals are immersed in a liquid which is able to conduct electricity. This acts like a battery and as current flows, the positive anode corrodes. Galvanic corrosion is often the cause of electrical problems in classic cars where dissimilar metals in the connectors build up an insulating layer of metal oxide.

Ethanol blended petrol causes both oxidation and galvanic corrosion to metals.

Additives are available on the market that have been tested by the Federation of British Historic Vehicle Clubs (FBHVC) who found their recommended additives reduced the severity of oxidation. However, some grades of petrol claim they already contain such additives.

Fuel systems are made from a range of different, electrically connected metals such as, brass, copper, steel and aluminium. As a result you get galvanic corrosion when using ethanol blended petrol.

The test I ran over one winter clearly demonstrate this.

The picture shows the same piece of abraded aluminium sheet before the tests (left hand picture) and after spending 3 months immersed in E10 while electrically connected to a similar sized sheet of mild steel (right hand picture).



The black dots on the right hand picture are galvanic corrosion pits.

Although I did not test the combination of stainless steel / aluminium, electrical test suggest this combination will cause a higher level of galvanic corrosion than mild steel / aluminium shown above. Other metal combinations such as brass / aluminium or brass / steel, appear to be far less affected.

I have not tested the effectiveness of the additives in protecting against galvanic corrosion. However, voltage measurements across a mild steel / aluminium cell containing E10 treated with additives showed an increase in voltage suggesting the use of additives may make the galvanic corrosion worse.

While ethanol blended petrol does cause galvanic corrosion, its effects appear to be relative minor compared to the effect of water absorption. It will probably not create any practical problems.

[Water Absorption](#)

Ethanol blended fuel absorbs water vapour from the atmosphere. If the critical concentration of water is reached, the ethanol / water mix will separate from the petrol and form a layer underneath the petrol, just as shown in the test bottles shown above. In practice it is unlikely you will experience this problem unless the fuel you used was nearly saturated or your car has been stored in a damp environment for a long time.

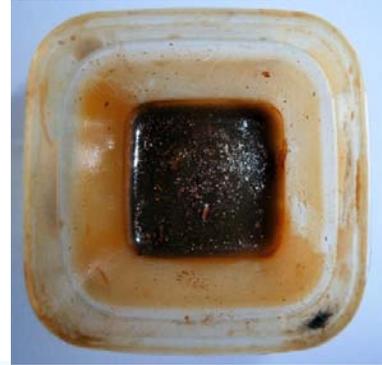
What is a more serious threat is the ingress of water in liquid form. The fuel systems of classic MG's are far from waterproof. The filler cap is located where rain can easily get in and the float chambers have ticklers on them that can also allow water in.

It only requires one droplet of rain to enter a tank of ethanol blended petrol to cause a far greater problem. The droplet will not mix with the petrol. It will fall to the bottom of the tank where it will absorb ethanol. This droplet could also get pumped into float chamber. Water containing ethanol is highly corrosive and, if the car is not being used, it will sit in the same place, corroding the base of the fuel tank or float chamber.

This is something I have tested by mixing ethanol blended petrol with water then storing a piece of mild steel and a section of aluminium float chamber in that water.

I am sure you can imagine how shocked I was when I opened the storage container used to hold the test samples for 6 months. Yes, they are still in there hidden by the rusty water!

The before and after pictures below show the piece of mild steel (left of the picture) and a section of a float chamber (right of the picture) used for this test. The degree of corrosion of both the steel and aluminium is extreme and it is hard to believe these are the same pieces of metal taken only 6 months apart.



The problem also shows itself in real life. This picture shows similar corrosion inside one of my float chambers, probably caused by water getting in through the tickler pin when driving in the wet. You can see the dark line about 12 o'clock on the bottom of the chamber caused by the corrosion. When I first looked into the float chamber, there was what looked like a worm, sitting underneath the petrol at that point. This was almost certainly a small quantity of water.

Once the water settles at the bottom of the petrol tank or float chambers, it will sit there absorbing ethanol from the petrol and corroding the metal. Not only is the degree of corrosion seen in this case far greater than the galvanic corrosion reported above, the problem will occur regardless of the concentration of ethanol. In other words, while the degree of galvanic corrosion increases with ethanol concentration, corrosion from water which has absorbed ethanol will be just as bad with E5 or petrol with lower ethanol concentrations.

Unfortunately, the additives sold to protect fuel systems against ethanol give no benefit. While they will mix with the petrol, they will not mix with the ethanol / water mixture.

The problems caused by water getting into the petrol system are not new. Even with petrol that does not contain ethanol, any water that gets into the fuel system will sink to the bottom of the tank or float chambers and cause corrosion, particularly to steel petrol tanks. Ethanol blended petrol just makes the water more corrosive.

I believe this is poses the greatest threat of using ethanol blended petrol.

Hot restart problem

It is worth mentioning what is known as the Hot Restart Problem. This describes the problem where, once stopped, a hot engine will not restart and is caused by the petrol boiling in the carburettor.

As ethanol has a relatively low boiling point of 78.4 °C and some people have suggested it may make the Hot Restart Problem worse. The tests at Manchester showed this definitely NOT the case. By 75°C, 43% of a branded 95 octane petrol without ethanol had evaporated, while only 35% of a super grade petrol with ethanol had evaporated. The petrol with the ethanol was LESS volatile than the un-blended 95 octane petrol. However, the reduction in volatility may be due to the fact the less volatile petrol was a super grade blend rather than the effects of ethanol. Certainly many classic car owners have reported their cars run better on super grade petrol than normal 95 octane.

The tests also showed that ethanol blended petrol burned more efficiently than non-blended petrol. For a given load, the exhaust gas temperatures will be lower when using ethanol blended petrol, creating less heat under the bonnet, reducing temperatures and the effects of petrol vaporisation.

Ethanol blended petrol appears to reduce the severity of the hot restart problem not make it worse.

Solutions

The only practical solution to avoid the problems caused by ethanol blended petrol is to use a fuel **known** to be ethanol free, such as Sunoco Optima 98 a specialist storage petrol. While this cannot be bought at a filling station, it 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. Sunoco Optima 98 is approximately twice the price of pump fuel, however, its long shelf lifetime and excellent combustion properties, make it an option worth considering for low mileage vehicles.

If you are using pump fuels, you do not know if they are ethanol blended or not. The composition of a particular brand or grade may change day on day. For example, two samples of branded 95 octane petrol bought in Manchester at the same filling station within days of each other were different. One sample contained ethanol, the other did not.

Great care should be taken to avoid getting water (e.g. rain water) into either the petrol tank or carburettor float chambers. Perhaps it is worth draining the petrol tank and float chambers once a year and allow them to dry to ensure no water / ethanol mix remains.

Possibly the most satisfactory solution is demonstrated by modern practice. For the tests at Manchester, I was sent drums of petrol and replacement parts for modern carburettors. In both cases they were coated to prevent corrosive damage. Coatings protect against both oxidation and galvanic corrosion.

Perhaps the most satisfactory solution is to slosh coat the inside of the petrol tank with an ethanol proof paint. Unfortunately, I have not found any similar products that can be used to coat the inside of the float chambers. Suggestions would be most welcome.

Conclusion

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, the tests at Manchester showed the engine ran better on ethanol blended petrol.

The first problem is something that can occur in older vehicles as age as well as ethanol causes degradation of fuel hoses, etc. The second, water in the petrol, can be avoided with care. Slosh coating fuel tanks will significantly reduce this risk.

Be aware, stainless tanks may not be the answer. Stainless steel can be attacked by acid such as the water ethanol mix and it may cause more severe galvanic corrosion to any aluminium parts such as the tank petrol level sender. It may be worth getting replacement stainless tanks slosh coated as well.

I believe ethanol blended petrol is here to stay and over time, concentrations of ethanol will rise. I hope this article will reduce owner's worries and help them be better prepared for this when this happens.