Leaded - Unleaded

The leaded-unleaded petrol debate seems to run on and on, with occasional scare stories appearing, particularly to frighten off the old vehicle movement. So what is the truth, what's been happening with our petrol, can we live with it, what representations should we make to legislators, and is the historic vehicle movement doomed?

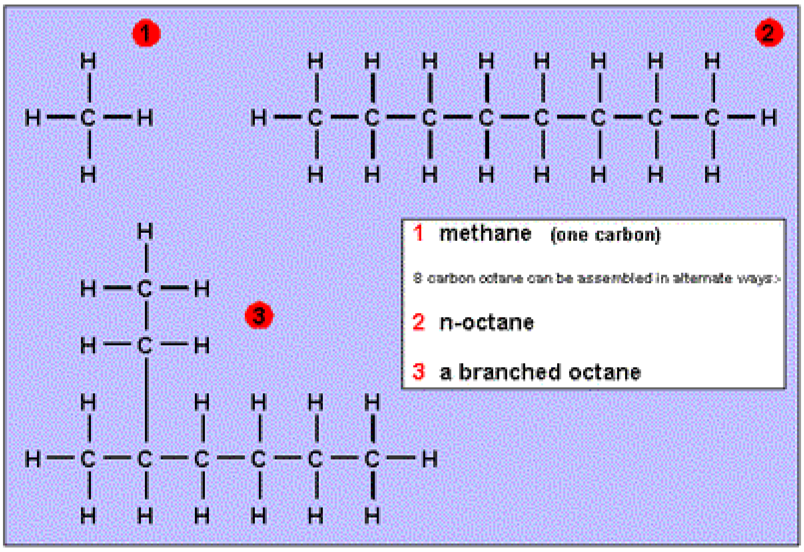
Short outbursts cannot cover all this ground, so bear with us for a longer, but more depth, treatment of the subject. If you have a short attention span you might try reading the 'what you should do' ending first, and come back to the explanations later.

Chemistry

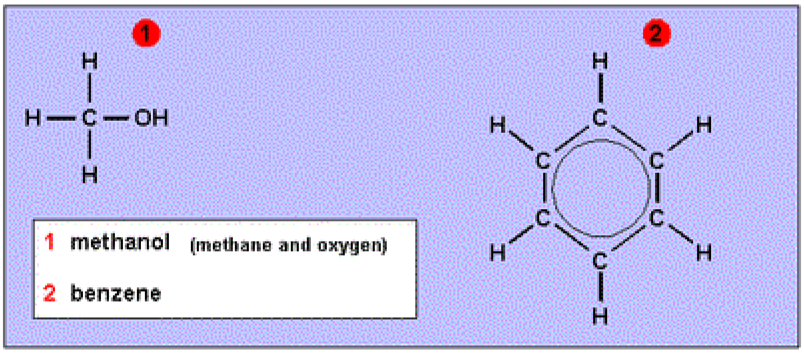
Back to school for a quick chemistry lesson, but don't panic - we aren't going in very deep and there isn't too much which you need learn.

Petrol, as most of us have heard at sometime or another, is a hydrocarbon. That means it is chemically made up of hydrogen and carbon atoms. These, however, can be arranged in surprisingly many ways due to the versatile bonding ability of the carbon atom - the same property which allows carbon based life-forms to develop such complex forms including us people.

Simplest of these hydrocarbons are the 'paraffins', which are a major constituent of petrol (here 'paraffin' is being used in the chemical sense, not the ironmongers sense where you buy paraffin for stoves). The easiest way to picture these is as a string of carbon atoms, each holding hands with the one in front and the one behind. However carbon has four 'hands' so it has some left unattached. This is where one-handed hydrogen comes in, one holding each unoccupied carbon hand. Thus the paraffins, as shown in the diagrams, have a chemical formula of C_nH_{2n+2} and start at the lightest, methane, with just one carbon atom, through gases such as the propane and butane of gas stoves. Heavier molecules, such as the liquids heptane and octane, can be more complex as indeed is the iso-octane of octane ratings.



Two other hydrocarbon forms are worth mentioning as examples of much more complex molecules involved in the story, these being alcohol, and the benzene ring. Alcohols incorporate an extra oxygen atom which has two 'hands' and can insert itself between a carbon and hydrogen bond, so that, for example, adding an oxygen to methane gives us methanol. Alcohols therefore carry oxygen into your engine, in addition to that of the air it breathes, which can be good for getting extra power (but you need more of it). The benzene ring is different. Here the carbon atoms arrange themselves somewhat differently, using alternately two and one 'hands', so there are less to hold hydrogens. This chemical structure gives the benzenes different properties.



Crude oil is a mixture of all sorts of variants of these ingredients, from the lightest liquids to heavy tars. Once upon a time refineries primarily distilled off the various weights, of which at one time the light fractions which we call petrol went to waste for a lack of use. Later the tables turned, and the chemists learned to 'crack' the crude oil big molecules into smaller ones using heat and pressure, and thus increased the most wanted ones (petrol). Even so what we buy is not a single chemical, but a complex mixture, characterised by such things as its specific gravity (weight), volatility (ability to vapourise), and calorific value (energy released when burned). Furthermore it isn't completely stable, which is why old, unused, petrol goes 'stale', smells foul, and rots tanks: the lightest fractions can evaporate whilst the remains gradually join their molecules back into heavier stuff like that they were once cracked from.

Enough, you say, and it probably is.

Leaded, unleaded, and a bit of history

Once upon a time all petrol was unleaded - surprised? The early pioneers had to buy spirit from paint shops or the like, and some veterans still demand a specially volatile 'Motor Spirit' to suit their primitive surface carburettors (basically a biscuit tin in which the spirit sloshes around, and from which the engine draws its air/vapour mixture). Next time you watch such a pioneer machine, marvel at it and be glad that there are still people willing to show them to you running, for they can't stop and refuel at a garage like you can, but must buy in stocks the way their forefathers did. With the coming of horseless carriages, petroleum spirit supply gradually became formalised, and spray carburettors appeared which have continued up to modern times. The petrol itself was characterised as much by where it came from as by its chemistry.

One of the pioneers who unravelled the latter was Ricardo (founder of Ricardo Consulting Engineers) who studied combustion in the piston engine for his Ph.D. He learned some of the secrets of different formulations, instituting a form of the octane rating for the purpose, and indeed supplied the special fuel which played a part in giving Alcock and Brown enough power to make their Vimy biplane first across the Atlantic in 1919. The search for higher octane fuels, to permit higher compression ratios, was on.

For the racing men various forms of 'dope' have been used, based on the alcohols (ethanol and methanol), which can be distilled from plant matter. Extra power comes from the oxygen carried into the engine by the fuel, but if one thinks of alcohol as being somewhat ‘preburnt’ (burning being the chemical reaction with oxygen) then it is easy to see that more of it is needed. A lot more as sprinters will know. For the road, however, oil-based petrol remained king, undergoing continuous development in its chemistry. Pre-war a number of octane improving methods were used, including the addition of benzole (a by-product of coke and gas works, lending its name to 'National Benzole'), and of alcohol (the Discol in 'Cleveland Discol' being shorthand for Distillers Co. alcohol).

Esso introduced something different - tetra-ethyl lead (TEL). Unlike benzole or alcohol TEL is not itself a fuel, but an additive; nevertheless it improved the octane rating of Esso fuel from its introduction in 1927 (although *The Motor Cycle* had been conducting tests back in 1924). TEL was not commonplace in most petrols until at least 1935 so that vintage and veteran machines originally ran on 'unleaded'. Indeed one of the problems which the motor and motorcycle industry discovered in the late thirties was that older valve steels didn't all stand up to the new leaded chemical environment!

Excluding the commercial grades, octanes in those days varied from 67/68 (ROP - Russian Oil Products and Essolene), through to 81/82 (Cleveland Discol and Esso Ethyl), with most ordinary grades being around 74. Post-war the notorious 'pool' petrol had an octane rating only in the 70s, but this was gradually upped over the years into the heady days of the 60s and 5-star 101 octane. I shall gloss over the intricacies of RON (research octane number) and MON (motor octane number) but readers should be aware that this does make an uncertainty of a point or two if not specified.

And then the war against lead began.

Firstly the lead content was reduced, to reduce lead pollution. In Britain as a whole, lead in our water pipes contributes more than lead in cars, but for those living or working in urban environments, alongside busy routes, serious concerns about lead in the atmosphere are valid. Lead content came down more than tenfold, with current leaded fuels having something like 0.1 g/litre TEL. The reason for going completely unleaded is different - it is to reduce other pollutants, the unburned hydrocarbons and nitrogen oxides. To achieve this, catalytic exhausts have been adopted, and they cannot stand even the residual lead. Exit TEL.

But already, octanes had dropped from those heady days, from 101 back to 90/95, and yet manufacturers are pressed for ever more efficient and economical cars, for which high compressions and high octanes are desirable. So the chemists got to work again. They turned to benzene and aromatics, to 'oxygenates' like the alcohols, just as their 1930s predecessors in fact, but with a lot more industrial chemistry at their fingertips. Petrol is not what it was! 'Saturates' (such as the paraffins) now make up typically only 60%, with 30% 'aromatics' and the remainder 'oxygenates' and benzene. Exact figures are hard to find, and variable as different countries gradually wake up to the hazards of some of these constituents (benzene, for example, being reckoned carcinogenic) and regulate them. Incidentally petrol is also variable with country and season, because fuel in summer or tropics must not vapourise too easily, but in winter and Arctic conditions the reverse is required.

And lastly, leaded is generally no different from regular unleaded (92 octane), except for the little bit of TEL left which raises it to 95 octane, something which super-unleaded needs even more aromatics to achieve. You thought 'leaded' was the same stuff you used to buy in the seventies? But how would they have maintained its octane with the gradually reducing lead, and why would the refineries maintain two, different, processes? No, it's ALL different stuff now, and there is no going back.

The old-vehicle problem

The introduction of unleaded petrol onto the market has exposed the fact that some engines do not take kindly to it, and suffer severe valve problems when deprived of the 'lubricating effect' of TEL.

The graph of *Figure 1* shows the result of a road trial on one 4-cylinder engine, firstly on unleaded, then temporarily on leaded, and returning to unleaded. Over 5000 miles the exhaust valve seat wear was horrific. The 30-70 thou. wear measured would exceed normal valve clearances, and once a valve is propped open it rapidly overheats and burns, leading to catastrophic failure.

Note that leaded petrol stopped the wear, and continued to do so for 2 of the cylinders after the return to unleaded, but the other 2 quickly started wearing.

This demonstrates the difficulties of getting definitive results, the variability of the phenomenon with very minor variations in the installation, and the ongoing protection which can occur for a time after using leaded fuel.

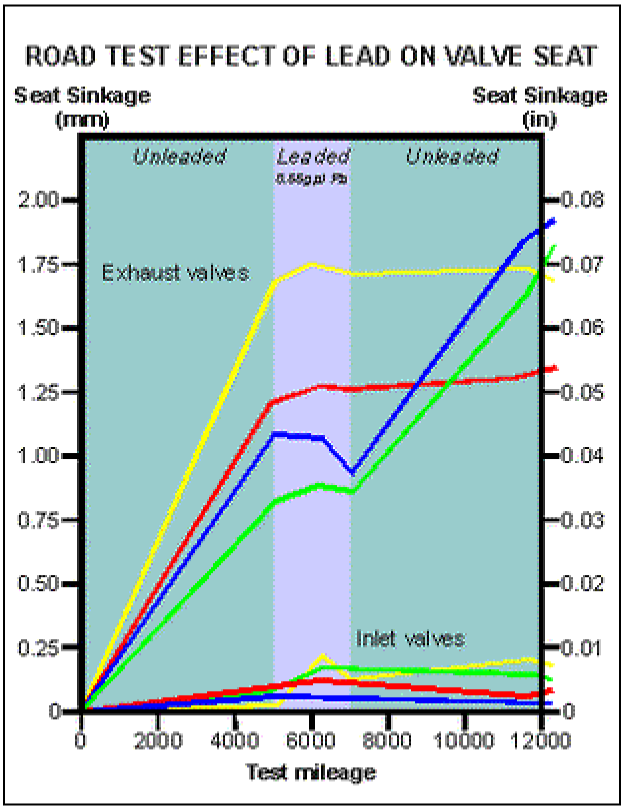


Figure 1

The wear is caused by iron-oxide particles, formed by the friction and heat at the exhaust valve, grinding between the valve and seat. Wear rates then become a function of valve loading, relative motion on opening and closing, hardness, and speed. In general the phenomenon has not afflicted low speed engines (e.g. 2500-3000 r.p.m.) even at high load and throttle settings, but at 3500-4000 r.p.m., engine speed seat wear rates start to increase dramaticallv, almost irrespective of throttle and load. Considerable study of the problem, and a variety of possible solutions. has been made over the years, although not always widely publicised, and were intensified around 1970 by the industry in order to cope with the unleaded fuels being demanded by the environmental lobby.

Octane rating is a minor issue in the debate. In recent years the highest octane ratings have disappeared completely as the expense, and high TEL loading required, have become insupportable, High performance engines thus have to face this problem whichever pump they may be filled from. The 'regular' grade of unleaded it is true, is slightly lower than that of the leaded fuels but the petrol companies have overcome this problem with a higher rated ‘super-unleaded’ grade. The lobby to reduce lead emissions may be to blame, but whether you run on leaded or unleaded you will have to detune those sports machines made in the heady days of 5-star 100 octane. If your vehicle dates back to the 50s, or earlier, then all modern grades exceed the octane it was made for and you have no octane problem at all.

Hot running

There have been a number of reports that old engines run hot on unleaded fuels, and when these come from respected sources such as Titch Allen of the VMCC then they must be taken seriously. One 'cure' being used is to use a small dose of domestic paraffin in each gallon, and the UK authorities have even given a blessing to the practice on genuine old vehicles. Rumour is that the problem is due to modern petrol 'burning hotter' than the old stuff. This seems a bit unlikely, but if it were true it would be rather a good thing. Our engines are 'heat engines', they burn petrol to make heat, to expand the gas, to push down the piston. If petrol 'burned hotter', your engine would become more powerful and more economical - just the job.

In actual fact, alcohols and oxygenates tend to have significantly lower calorific values, in other words they release less heat (aromatics are more complicated, releasing more heat by weight, but less by volume). However, another significant difference is the air-fuel ratio required by different constituents - typically 15:1 for paraffins but only 9:1 for alcohol - competition users will be familiar with the much bigger jets needed for 'dope' fuel. So it seems more likely that the primary problem with a lot of old engines is just that the composition of petrol has changed since they were 'tuned', and since their manuals were written. Carburettor and timing settings may need revising, probably with richer jets and perhaps a touch more retard? At any rate try that first, before resorting to 'brewing your own'.

Valves and valve geometry

Two parameters of valve geometry in particular have received attention: seat angles and valve rotation. Most commonly valve seats are cut at 45 degrees, although 30 degree angles are also widely used. Tests indicate that 30 degree seats wear significantly less than 45 by a factor of up to 3. Valve spring rate also markedly affects seat wear, with a 20% increase in spring pressure doubling the wear rate. However seat width (which also increases the surface pressure) has not been found to be a major factor, and neither has valve temperature (which is slightly raised by 30 degree seat angles).

Most motorcycle engines retain their valves with split collets, clamping the valve stem with a one piece cap. It might thus be supposed that valves do not, and should not, rotate upon their seats. The truth is otherwise, and there are a number of variations of valve retention which reflect this. Firstly why?

A valve which is very positively locked gets no chance to spread wear, and once a bit of uneven wear takes place then the temperatures and pressures become uneven, accelerating the differences. Split collets which butt before clamping the valve, and two-piece caps recognise this fact and permit freer rotation to spread wear, and there are even versions incorporating bearings for positive rotation. Unleaded tests with these various systems has indicated that completely pegged valves are indeed undesirable, but that after some small amount of rotation then wear, accelerates with the rate of rotation (more grinding action, as one might expect). Thus valves should turn slowly (e.g. 1 r.p.m.), preferably whilst open, but not spin rapidly.

Exactly what is going on inside your own engine is very difficult to be sure of. Ordinary helical springs 'wind up' to some extent and result in some rotation as the valve seats, even if there is no net rotation over time. Such are the reasons why wear is extremely difficult to predict for an engine without actual trials. Valve surface finish is of some significance, but interestingly the finest finish proved inferior to the standard ground surface which is assumed to retain deposits or oil better.

If you find, or run, a vintage bike with original exhaust valves then they may be a simple nickel steel. As well as having limited hot-strength, and therefore reliability, such steels are susceptible to corrosion by lead by-products when running at exhaust valve temperatures. So if you don't use leaded petrol the seats wear away, and if you do then the valves corrode away! Valve life in those days was distinctly limited, and frequent attention required. Pre-war and aero-engine development brought silicon-chrome steels which were widely adopted in post-war engines. These materials have better hot strength, but still were not very good from the corrosion point of view. The modern 21-4N steel (21% chromium, 4% nickel) is better in both regards. Note that although the much vaunted Nimonic 80 has excellent hot-strength (good for racing), it corrodes very badly and is not a good material for production machines running on leaded fuels.

Experiments to improve the lead-free problems by facing the valves with different materials have produced mixed results. An 80-20 nickel-chrome facing, produced a marked improvement (as it does to a lesser extent even when running with leaded fuel), but a 70-30 alloy actually made things worse. Note also that the 'lead memory' effect noted here was observed back in the days of relatively heavy TEL loading in petrol. It is much lower now, and so reliance on 'lead memory' to justify using just the occasional tankful of leaded is not at all advised.

Solutions - fuel and oil additives

Since the seat recession problem has only become serious with the withdrawal of a petrol additive it naturally raises the question of looking for an alternative additive to achieve the same result without altering engines. Such research has not been without success. Phosphorus based additives tested by Associated Octel succeeded in reducing wear back to leaded fuel levels, but not without side effects. Deposits and plug fouling were serious, and it was also recognised that the phosphorus based emissions can be as noxious as the leaded ones being replaced, and are unlikely to be adopted. Other, metal based, additives studied have been found to be beneficial, some may even find their way into our petrol supplies, but current environmental pressure does not favour heavy loadings with materials destined to become exhaust emissions.

However for the user of an old vehicle the research does confirm that beneficial treatments to be added to pump petrol are possible. More recently sulphur based additives have been marketed, on which I have not yet seen any test results. An additive must be possible, if only because if you could buy petrol loaded with 2mg/litre of tetra-ethyl lead (rather nasty stuff on its own, but this is only what we used to buy as high octane petrol), then mixing it at roughly the same ratio as two-stroke owners mix their oil, would produce current leaded fuel! The old vehicle movement needs more, thorough, tests, and to publicise them when done - it is certainly not safe to assume that because an additive is marketed then it must be effective - caveat emptor!

Even in modern engines with their low oil consumption some oil does get burned in the combustion chamber. This could also be a vehicle for carrying protective material to the valve seat. Indeed it is so, and again metal based additives were found to be useful, although only to a small extent. Modern oils feature a number of additives, for keeping combustion products in suspension, anti-wear, anti-oxidant etc., mostly based on metal salts. Thus the use of a modern additive oil is likely positively beneficial.

Falling more into the 'quack' treatment category are the insoluble metal pellets recommended for insertion into petrol tanks, or lines, and the use of magnets etc. As far as current research can ascertain the protection of exhaust valve seats is provided by surface coatings, or possibly impregnation, although the exact chemistry may not be fully understood. Insoluble treatments (those which do not dissolve, and last forever) seem unlikely to be able to produce a sufficient chemical loading to achieve useful protection and are judged to be ineffective. In the case of the much advertised tin-based treatment this was confirmed by a test carried out by *Practical Classics (Dec 1989/Jan 1990)*, although there are users who swear by the treatments.

Solutions - valve seat materials

The use of separate material for the valve seats has a long history, and is particularly associated with light alloy heads which do not provide a suitable base material and therefore leave little alternative. However the benefits of alternative seat materials for reducing serious wear problems has been long known. As hinted earlier in this article valve seat problems were not unknown in the vintage era, especially in the USA where the roads were opening up and there was less practical or legal inhibition to running engines fairly fast and long.

Papers by Getzoff (*Prevention of valve seat erosion, Transactions of the S.A.E., Vol.25*) and by Colwell (*Recent developments in poppet valves, Transactions of the S.A.E., Vol.26*) in 1930 both outlined the classic symptoms, and similar conclusions to those arrived at by the 1970 researchers. Colwell far-sightedly stated that the use of TEL would prove to be a solution by providing lubrication, whilst Getzoff recommended the use of alternative seat materials such as aluminium bronze or Mackalloy (a hard tungsten steel).

A number of American manufacturers of heavy-duty engines adopted the practice of using seat inserts for long life and hard wearing properties, as did Rolls-Royce in the UK. One problem at the time was the method of retention of the seats, and pre-war motorcycle manufacturers seeking to make light alloy heads tried cast-in individual seats, cast-in 'spectacles' (single bronze inserts encompassing two valve seats and spark-plug hole), screw-threaded retention, and simple parallel shrink-fitting. The simple shrink-fit proved to be the best (as recorded by the late Phil Irving in *Motorcycle Engineering*).

Laboratory and road test experiments have confirmed that hard valve-seats can provide a high degree of protection against valve seat recession when running on unleaded fuel. The properties required are hardness and corrosion resistance, and the recommended modern materials are sintered chromium-iron alloys. BRICO materials XW23 and XW35 include an additional copper content, believed to both provide some intrinsic 'lubrication' effect, and improving the heat conductivity which helps offset the additional heat barrier which an insert shrink-fit joint presents to the escape of exhaust heat.

Manufacturers of course are not enthusiastic about the increased cost of machining and stocking required by separate exhaust valve seat inserts. Researchers have therefore also studied other alternative ways of enhancing seat performance. A very similar result is in fact possible, by localised treatment of an iron head casting by induction hardening - a sort of case hardening treatment where the heat is provided electrically from an induction coil. It is thus not safe to look at a modern engine, see no apparent seat insert provisions, and conclude that because they manage then your old iron head will have no problem. A modern one-piece casting, can in fact have properties as complex as a fabrication of selected materials! The majority of research has been directed to car and truck engines fitted with iron heads. Belcher and Forrester, however, included aluminium heads in their tests (*Some factors affecting exhaust valve seat sinkage in gasoline engines, Associated Octel report OP73/2 1973*). Noting that such heads automatically demand inserts of some 'hard' material, they found seat sinkage to be low even with unleaded fuels.

Recommendations resulting from the above research should be directly applicable to iron-headed motorcycles, but application to air-cooled alloy head machines should be a little more cautious. The poorer temperature control makes the exhaust valve operating conditions more arduous and variable than in the water cooled engine, and the wear rates will depend critically on the original choice of seat material adopted by the manufacturer. This choice will have been taken with the usual regard for cost cutting, but also with regard to the need to match the expansion rate of aluminium in order to adequately retain the seat at temperature. Normal cast iron head insert materials do not always stay tight in air-cooled light alloy heads, and manufacturers had a more limited choice of materials such as high expansion cast iron or wrought aluminium-bronze. The same care is required when choosing from the new hard seat materials - a dropped valve seat ring is likely to make a serious mess.

If an engine can be converted to modern valve seats this is the most effective treatment.

Coping with the future (directed at motorcyclists, but mostly relevant to 4-wheels)

Enough of the technicalities - what should you do!

<u>Learn to live with it</u>

You should have learned enough from the above to know that the situation is irreversible. Petrol has already changed its content, and the refineries aren't going to change it back. New cars have all been made to run on unleaded petrol for many years now, so the requirement for leaded is only going to fall. Even if governments don't ban it, the garages will not stock it once demand falls. They have only a limited number of underground tanks and wish to put them to good commercial use.

Indeed in the U.S.A. I have come across many with but two tanks, so in addition to Regular unleaded they have to choose between storing Super unleaded and leaded - those on main drags picked the Super whilst out in the sticks leaded was often stocked (lots of old cars one assumes). Even if they did have the tanks, the stuff doesn't keep, so when turnover drops too far they are bound to discontinue stocking it.

Can you survive, or are the harbingers of doom right to predict the end of old vehicles? Forget the panics. In many areas of the U.S.A., as mentioned above, leaded is long gone, but classic bikes still thrive. Many years ago, on a through trip, I discovered that Austria was a lead-free zone, but the enthusiasts have survived there too.

This doesn't mean we have to take it all lying down though. The EU Commission has passed its rules with statements that 'adequate additives are available'. This isn't true, and they should be called to task for being 'selective with the truth'. It won't make a difference to this problem but this isn't the last problem!

Veteran and vintage bikes (to 1930)

It is unlikely that anyone can be definitive about the best practice. These were built in the pre-TEL era, so they are just 'returning to their roots'. Those, rare, models still running original valves in pre-lead steels might even benefit more on the valves than they lose on the seats. Run moderately, as is normal in vintage rallies, they will probably continue on leaded or unleaded. On a day to day basis one need not fear using the occasional fill of unleaded, although the recommendation to stay with leaded is probably safest, because the current lead loading is light, and "better the devil you know than the devil you don't". When you can't get it any more just fill up with regular unleaded (you certainly don't need Super) and carry on.

Ridden long and hard, vintage bikes always did require valve grinds, and even replacements - a spare valve was a standard item to carry in the toolbox. The original valves in such circumstances would corrode, so replacements in modern materials are always a good thing. If you haven't set the carburettor or timing since 1960-sometime then it really is time you experimented again and ran some plug checks.

Post-vintage/early post-war

Most machines of this era feature iron heads, but higher performance and higher engine speeds than vintage bikes. They were built in the leaded era, and will generally suffer badly if run hard on unleaded. An occasional tankful is unlikely to be disastrous, and if extended use is forced upon one (such as when touring abroad) then keeping the revs down a bit, and checking the tappets more frequently than usual will avert serious problems. Looking at your tappet clearances is of primary importance - start doing it now, so that you have a reference for when you have to run on unleaded. Provided that valve clearances are readjusted before disappearing then valve failure should not occur, so you need not fear breakdowns. When the evil day comes that you can only get unloaded, keep monitoring those tappets. If you are a gentle rider you may see little difference, in which case you have no worries. If they do start to close up you will know that recession is a problem, but in the short term just keep adjusting them. Treatment with additives may prove to be adequate, but you should be discerning about the choice of 'potion', and keep taking those frequent tappet clearance checks to judge its efficacy on your own engine.

For a permanent unleaded solution for the future then machining for, and fitting of, hard sintered alloy seats should he undertaken - this is available from a number of specialists (such as The Cylinder Head Shop). Note that you will not be able to cut such seats with old fashioned cutters, because they need grinding, and so the whole conversion is a job for competent engineers. Modern valve materials will be beneficial whichever path you choose to tread, being more resistant to lead corrosion and longer lived than the originals, and compatible with the hard seat materials recommended for use with unleaded. As with the vintage bikes, if you haven't set the carburettor or timing since 1960-sometime then it really is time you experimented again and ran some plug checks.

Late post-war

Most of the late British bikes had adopted light alloy heads with valve seat inserts as standard. Where cast-iron was used then seat recession may occur with unleaded petrol when used hard and fast. Again the occasional tankful is nothing to be too fearful of, and the concerned can keep engine speeds down a bit, and check the tappets frequently to compensate. Indeed checking the tappets is something you should be doing now - it is going to be your guide as to whether you have a problem or not. Bronze seats, especially when cut at 30 degrees may fare better. The reported research alone would lead to a more optimistic forecast, but it is also noted that the German and Italian bike manufacturers were very slow to recommend lead free petrol in their similar engines, and not even then retrospectively in their older models. Once again, frequent tappet cheeks will tell the owner how the engine is coping - if they get looser or stay the same then all is well, if they tighten be concerned, and if they tighten quickly then return to leaded fuel pronto.

The issue of octane rating does require considering in the case of the sporting machines, especially those manufactured in the 60s, the Goldies, Thruxton Venoms, CSRs, running 9:1 or even higher ratios. These will suffer serious 'pinking' when ridden anything other than carefully on current lower octane fuels. Around 8.5:1 is enough for big cylinders, and either lower compression pistons, or compression plates, should to used to keep down to this figure. Even so the recommendation has to be to stay with leaded fuel whilst running original valve gear. However the change for unleaded fuel should present no problems, since all that is required is to rebuild the head with exhaust valve seat inserts of a modern hard sintered alloy material. Remember that ordinary car material inserts will likely loosen in an air-cooled alloy head, so it is important to get the work done by a specialist who understands bikes and the higher expansion rate required of the insert materials. Original valves are likely to be of similar material to modern ones and quite compatible - so no need to change there, although your supplier may recommend something new. However throw away those high performance or aftermarket heavy valve springs, whose added pressures will aggravate seat recession. When you have finished you must consider what sort of model you are riding, to decide whether 92 octane Regular unleaded will do, or whether you have a sporty model which is going to need expensive 96 octane Super unleaded.

Maybe you have set the carburettor or timing since 1960-sometime, since these are newer bikes, but if you have done it 'by the book' then it really is time you experimented again. A plug check is easy (open it up for a while, then kill the engine quickly and coast to a halt) but unlike the owners of earlier machines, who may simply be able to waggle their ignition levers to experiment with the timing, you may have to do it properly. But first you could try opening and closing the points gap a few thou. which might be enough to show whether you have got it right without actually disturbing the main timing.

The difficult and obscure

Some engines may be rare, or of such unusual design that fitting of inserts may not be practical - for example light alloy heads with cast in 'spectacles' forming the valve seats, or 4-valve heads with insufficient material. First advice of course is to stick with leaded fuels as long as you can. When the day comes that the option no longer remains, then seek out the additives with the best reputation. It is unlikely that a port with insufficient material for an insert can be recut for a different valve, but if a build up with weld should be needed then adopting a 30 degree seating from then on will be beneficial as regards longevity.

Valves themselves can be faced with Nimonic, but be sure to find a competent firm who will ensure that the correct 80-20% nickel-chrome is used and not just a 'hardfacing' which could prove detrimental. Check and adjust those tappets, and you can still go on riding it. You may have to decide whether you want a long life (ride it gently) or an exciting one, but there is no need to give up entirely. And if you think you have problems consider the plight of the Bentley Speed Six owner: whose 6 ohc 4-valve heads are all non-detachable and whose valve seats are, therefore, only accessible from the wrong end of the 140mm bores!

Health and handling

Petrol never was particularly nice stuff, being volatile and a fire hazard, but lots of people - including myself - have done little more than acknowledge the fire risk for years. "Wash it in petrol" used to be the norm and we splashed it about with gay abandon. It probably wasn't a good idea then, but its a worse idea now! Leaded or unleaded makes little difference, modern petrol is a complex cocktail of paraffins, aromatics, and oxygenates. Out of the back of a catalyst-equipped car they result in low emissions - generally good for health. But if you work or play with the neat stuff it is not so good for health and I am not alone in noting that modern petrol seems to have joined the various 'trigger factors' associated with migraines. Authorities, too, are concerned about the makeup of modern petrols, for example setting limits on benzene content (a carcinogen). Treat it as a hazardous substance, don't slosh it around unnecessarily, and repair any leaks (especially if your house has an integral garage).

Something to worry about

I hope that this article will have dispelled your worries about unleaded petrol and you can ignore the various panics you may read elsewhere. Old vehicles can be kept running, most of them without very much trouble. So can we all rest easy, and forget about Whitehall, Brussels, and the lobby groups? Absolutely no.

Legislation is continually tightening up on vehicle design and maintenance. For ease of legislation the powers-that-be would be quite happy to have us all off the road anyway. A number of issues could be involved, daytime light, electronic boxes and tolls, but more relevant to this particular article - emissions.

The whole point about unleaded petrol is that it has been a prerequisite of getting vehicle emissions down. According to the 'Urban Cycle' tests, a modern car emits only about 1% of the rubbish that an old one did, and the rules haven't stopped tightening yet. That's dramatic. Indeed, so dramatic that in California the situation has been reached where the fumes released during filling-up are now significant, and gas-station hoses are fitted with rubber bellows to seal against the car and stop this form of emission. Other eyes, not surprisingly, are turned toward 'old cars' - not least the new car. Manufacturers of course. Just think on the surface of the argument, if just one in a hundred vehicles is old, then someone could argue that they are the problem and should be banned. The old vehicle movement needs on one hand to be better informed than to be taken in by this spurious argument, and also must look realistically at itself and see just what they should be doing or accepting as part of the global concern about pollution.

Just to make you feel a bit better, and less hopeless, I should point out that the 'Urban Cycle' doesn't replicate real driving, to and from work, traffic light Grand Prix, and cold starts. Taking those into account the old vehicle doesn't fare, in practice, so badly, plus of course the annual mileage is generally much lower and doesn't take place in the urban rush-hours. Old motorcycles especially tend to have far lower fuel consumptions, and carbon dioxide ($C0_2$) is directly related to the fuel burned. $C0_2$, is of course, the latest 'greenhouse gas' problem, but isn't classed as a 'pollutant' in car exhausts. So we need to be on the ball, we need to understand the issues, and we need good people representing us with governments and legislators in order to hold our own. There are such people working for the old vehicle movement, but they need your continued support and that of your club.

[Further information and leaflets T/INF/476 and T/INF/477 are available from the DETR Free Literature Service on 0870 1226 236 (in the UK). Web site www.detr.gov.uk

NOC Members - more information on Unleaded Petrol, Lead Replacement Additives, and Recommended Additives