BIKE OIL QUESTIONS & ANSWERS

How is an oil manufactured; transformed from the black sludge that comes out of the ground, into the nectar-like substance we pour into our bikes?

Crude oil, which is usually very thin, (contrary to popular belief!) is distilled into light and heavy fractions, with several intermediate ones. (The evil left-overs are used to fuel the 15 million cc/40RPM diesels in the giant oil tankers that bring the crude to the refinery.) The lighter fractions, usually more than 90% of the original crude, are converted into petrol and diesel. Some of the heavier oils, (still dark and smelly!) go through several processes to clean them up and remove wax. Out of about a dozen oily products 4 clear, bright amber oils are commonly used to blend modern engine and gear oils. These are roughly equivalent to SAE 10, 20, and 30 engine rating and 140 gear rating. Oil refineries also produce all sorts of gases and chemical compounds which can be used to build up 'tailor made' lubricants: synthetics! Read on.

What are the most important substances added to the refined base oils? What do they do?

In the Dark Ages bikes used blends of refined mineral oils 'straight', with nothing added. The trouble was, even in the slow-revving engines of 80 years ago the oil didn't last very long, and the engines didn't either. Black sludge and corrosion were the killers, and both were tackled in the 1950s with detergent and antioxidant chemicals. (When I was a lad, I used to visit a mate of me Dad's who rebuilt the very popular side-valve Ford engines. The thick crap inside these things was unbelievable! The valve tappets were moving in holes in solid blocks of carbon!) The detergents washed the carbon from fuel combustion off the bores and out of the ring grooves, and at the same time reduced bore and piston ring corrosion. The antioxidants stopped the oil reacting with oxygen in the air, which cut acid sludge formation which in turn reduced corrosion and oilway blockages. Some antioxidants had the useful side-effect of reducing wear as well. This added up to longer oil and engine life, both improving about three times. (Straight oil had to be changed every 1000miles, and even lightly-stressed engines running on it were ready for a full overhaul at 15-20,000.) OK, I admit there were design and metallurgical improvements, but they needed that vital 'liquid component' to be fully effective. Later came dispersant compounds which held the carbon as tiny particles in the oil which didn't settle out anywhere, and slipped through the oil filter as if it wasn't there.(Solid bits in well-used modern oil are about 1/1000mm across; the pores in an oil filter are at least 15 times bigger.)

The other big problem with oil used to be cold starting. It was

usual to have SAE 20 Winter or 'W' grades, and SAE 30 or 40 Summer grades, and even the so-called Winter types would defeat the starter in serious cold weather. Unfortunately, oil is very thick when it's cold, and very thin when it's hot. To have an oil thick enough to look after a hard working engine, you had to use a grade which was too thick when it was cold. The answer was (and is) multigrade! What was needed was an oil that behaved like a 20 'W' grade in the cold, but only thinned down to a SAE 40 or 50 when really hot; yes, 20W/50! This can be done by mixing thin oil with thick polymers based on plastics and synthetic rubbers; these don't do much in the cold, but as the oil warms up they unwind and thicken it up to some extent. The oil still thins down, but not as quickly as a polymer-free or monograde type. Multigrades started to catch on around 1960, but these pioneer types were easily ruined by mechanical shear effects, more so in gearboxes than engines. These days the better quality polymers resist shear even in combined engine/transmissions, so it is essential to use good quality shear-resistant types in a motorcycle, which gives its oil a hard time in both engine and gearbox.

Incidentally, there are large amounts of these additives and polymers in there, it's not just 'a little bit of this, a little bit of that'! A good quality mineral 10W/40 can be 80% base 20% additive chemistry, and guess which is the expensive ingredient!

What are the differences, in layman's terms, between mineral, semi-synthetic and fully-synthetic engine oil ? (In terms of structure and performance.)

Before we get into details, the first thing to realise that there is no chalk and cheese difference between mineral and synthetic based oils. After all, the chemical compounds which make mineral engine oils so much better are themselves synthetic. Synthetic lubricant bases are stepwise improvements on mineral oil, with more desirable properties and fewer undesirable ones. The second important point is that there's no one thing called 'synthetic'! There are several different types of synthetic lubricant, and to say something like: 'the Supergrunt XXR must have a full synthetic' is meaningless unless the 'expert' explains what sort of synthetic he means. Equally, to imply that dreadful things will happen if the 1970 Hardley-Ableson Bluegrass is run on anything other than Pennsylvania mineral is ridiculous. It may not need a 2007 synthetic, but it isn't going to come to any harm if the owner uses a 2007 synthetic.

The most basic type of synthetic is really a special mineral oil. Known as 'hydrocracked' bases, these are made in oil refineries by putting certain types of mineral fraction through special processing, so they cost more than the usual mineral types but not much more. They are useful because they resist evaporation at high temperatures. Although

used for years for genuine technical reasons, they are now popular with marketing men because the magic sexy word 'synthetic' can legitimately be printed on the label without spending much on the oil inside the can! Yes, all low-cost 'synthetics' contain anything from a few percent to 20 percent (i.e. 'semi-synthetic') of special mineral oil.

Using fairly simple chemical compounds or gases from oil refineries or other sources, it is possible to 'synthesise' or build up tailor-made lubricant molecules which have very desirable characteristics, such as great resistance to cold, heat, evaporation losses or excessive thinning as they get hot. These are the true synthetics, and the two that are used in engine oils are PAOs (poly alpha olefins) and esters. Neither is cheap! PAOs are related to mineral oils, and are the ideal carriers for all the chemical compounds used in mineral oils. Because they do not gel at very low temperatures, all genuine 0W-something oils have to be based on PAOs to pass the 0W test at a sub-arctic -35C. Esters were originally made for jet engine lubricants, and to this day all jet oils are ester-based. Although similar in performance to PAOs, they have a valuable extra trick: they are good lubricants and help to protect metal surfaces.

As 0W- and 5W- grades are not usually recommended for motorcycles, perhaps the best all-round oil is a 10W/40 shear-stable semi-synthetic with some ester content. Esters help with transmission and valve train lubrication. 100% fully-synthetic oils are actually quite rare, probably because they are very expensive to make, and even more expensive to buy. Even so, an ester/PAO with a very shear stable multigrade polymer is the ultimate oil for high output engines that are worked hard, which means racing.

How does oil work? What gives it its lubricating properties? How does it 'cling on' to surfaces?

A plain bearing such as a main or big end, when spinning fast is 'floating' on a relatively thick film of oil. The metal surfaces literally do not touch. The high velocity drives a wedge of oil between the two surfaces, and the oil film supports the load, just like a water skier skimming over that very thin lubricant, water. But, when the engine slows down and stops the bearing shells drop through the film and touch the crankpins, just as the skier sinks in up to his neck when he lets go of the rope. It is where there is metal to metal contact that lubrication, that is, something to reduce wear and seizure, is needed. On gear teeth, valve components, and piston rings at top or bottom dead centre, there is no high speed rotation to generate 'wedge' support, so the oil films are very thin, and some metal contact is inevitable. Some fluids, even if they look thick and oily, are completely hopeless! Very pure mineral oils, and some synthetics fall into this group. They depend entirely on chemical load-carrying compounds which react with metal at

high pressures and temperatures to provide very thin protective films which prevent micro-welds where metal surfaces come into contact. Detergent and antioxidant chemicals often double up as anti-wear agents. The odd ones out are esters. These are attracted to metal by electrostatic forces and cling on when surfaces are forced into contact.

What are (or can be) the main differences between oils of the same type, i.e. what's the difference between a 'good' and a 'bad' oil?

It all comes down to honesty really.....so beware! A good oil is what it claims to be on the can. 10W/40? Does it really pass the cold test at -25C? Quite a few I've tested do not. There is usually an API spec quoted, such as API SH or SL. These are car-based, but a good basic quality guide. If absent, leave it on the shelf, and avoid lawyer-speak: 'meets the requirements of....' or 'recommended (by whom?) for use in....'. The JASO MA or MA2 spec is a good sign, because this Honda/Kawa/Yamaha/Suzuki-sponsored series of tests is entirely motorcycle-orientated, and includes a clutch slip test, a shear-stability test, and a high-temperature/high shear viscosity minimum permitted level. The 'big four' were pushed into introducing this series of tests back in the late 90s by the poor quality of USA-produced oils.

Then there is the 'synthetic' minefield! Provided the price hasn't been pushed up by shipping an average oil 5000miles from the West coast of the USA, you get what you pay for. The best motorcycle oils are made in the more developed European countries, but low price buys the cheap 'modified mineral' synthetic and not much of it, with a poor multigrade polymer. As is so often the case, quality follows cost.

What are the likely consequences of using poor-quality oil?

Usually, these are fairly long term, except in racing. Think of the oil as a liquid component, and poor oil as a cheap pattern spare. In a touring bike, long-term reliability and performance retention (i.e. acceleration figures below new spec., fuel and oil consumption above) are the casualties. Particularly in a high performance or racing bike, the effects can be more immediate and catastrophic. I recently saw a Honda CBR 600 crankcase/block from a racing sidecar. All 4 bores were scored from top to bottom on the thrust sides, and all 4 pistons ruined, needless to say. The whole casting had to be scrapped. After spending a lot of cash on race preparation, the owner had saved a few quid by using a cheap 10W/40'workshop' oil, probably API SG or lower, no JASO spec, and the used oil had sheared down to SAE 30.
Now this is the really crazy part: it was the second engine he'd ruined on the same oil!

Some oil companies have run advertising campaigns that imply their products have special, unique qualities. Can these adverts be taken seriously?

Yes and no! Generally adverts in motorcycle magazines* are honest, with marketing-speak terms such as 'Magnatec' and 'Electrosyntec' really being code words for esters, which are particularly beneficial in motorcycle-orientated oils. No manufacturer has any unique 'secret', so it's all down to providing the best possible blend for the job at the right price, and making it clear that you get what you pay for. I personally think that the importance of shear stability or 'stay in grade' is not stressed enough.
What is dodgy is claiming that a mineral based oil with a few percent of modified mineral ('hydrocracked') synthetic is the D.Bs and suitable for racing, etc. when it clearly isn't. Also, there is endless semantic manoeuvring and lawyer-speak around The Magic Word…. 'synthetic'. For instance, a 'synthetic' oil is invariably semi-synthetic ('Ah!....we didn't say it was all synthetic did we?), and, if low priced, invariably the modified mineral type synthetic. It is a sad fact that you get what you pay for, but even so, stick to the reputable UK/European brands, and remember that shipping an oil half way around the world doesn't automatically make it better than one made in your home town.
(*As for TV advertising…well, does anybody believe it? Due to its huge cost, a TV advertising campaign can significantly raise the cost of specialist items such as oil. Everybody assumes it's just a few pence per gallon, but it can be pounds per gallon.)

Please can you explain the grading system? What is meant by the weight of an oil? What does 10W/40 mean for example?

Weight means viscosity, or resistance to flow. Water and paraffin flow very easily, so they are low or light viscosity. Golden syrup or 140 gear oil do not come out of the can so easily, so they are high or heavy viscosity. Especially with oils, temperature is very, very important. An oil which looks 'heavy' at 20C will be very 'light' at 100C. People sometimes say, 'I drained the oil when the engine was hot and it ran out like water…' so I say, 'Good! It's supposed to be like that!'
The American Society of Automotive Engineers (SAE) ratings cover cold starts and 'up and running' viscosities. There are two sets of standards, the 'Winter' (W) ratings, and the 100C standard ratings. ('W' does not, repeat not, mean 'weight'!) So a 10W/40 oil has to pass a 10W cold viscosity test at -25C, and a SAE 40 test at 100C. In an oil lab there will be a refrigerated viscosity measuring device for the 'W' tests and another at 100C for the standard SAE tests. There are 6 'W' ratings from the difficult 0W at -35C to the dead easy 25W at -10C, occasionally used in India for example! The whole point of these Winter ratings is to assist cold starts, to get the oil circulating quickly, and to avoid power and fuel wasting drag as the engine warms up. Once it is warmed up, the 100C ratings count.

There are 5 of these, 20, 30, 40, 50, and 60 although why anybody bothers with 60 in the 21st Century is a mystery to me!

Sorry folks, but I've got to get technical. Viscosity is measured in standard units called 'Centistokes', names after a Victorian engineer, Sir George Stokes, who used to time ball bearings as they sank through oil. SAE 30 for example is from 9.3 to 12.5 Centistokes, and SAE 40 follows on at 12.5 to 16.3, although most SAE 40 oils are in the middle at about 14. Now this is something most don't realise: engines do not know what grade of oil they're running on. They're not clever enough! So an engine filled with 10W/40 will be running on a viscosity of 14 at 100C, but with a sump temperature of 90C its seeing a viscosity of 18, so as far as the engine is concerned it's running on SAE 50. Likewise, at 110C, it's down to 11 Centistokes so it 'thinks' it's on a SAE 30! (Which is preferable.) The lesson is, do not use power and fuel-wasting thick oils in cool climates. A decent 10W/40 or even thinner is perfectly OK unless you're riding an air-cooled classic with wide clearances and a slow oil pump.
Radical race cars use 1300 Suzuki Hyabusas and work them very hard. (Didn't one take the old Nurburgring absolute record recently?). They use our high-ester 15W/50, but that's OK because they see oil temps around 130C! (No problem for the oil or the engine, but they do fit special oil seals.) At 130C the true viscosity is 10cSt, so the engine thinks its on a thin SAE 30, which keeps it happy.

What is the best type of oil to use in a road bike for general riding? Is fully synthetic a waste of money?

Personally I'd go for a shear-stable ester semi-synthetic, SAE 10W/40 or 10W/30. The 'shear-stable' bit (ie, a decent quality multigrade polymer) is actually more important than the 'synthetic' part! If strapped, I'd go for a shear-stable mineral based oil rather than a 'synthetic' of dubious stability that's probably based on modified mineral oil anyway. Unless you're covering a huge annual mileage, genuine 100% synthetics are probably an extravagance. High mileage long-distance fans can use a light full synthetic and save on fuel and oil changes, and cut overhaul costs if things get to that stage, but more later…..

What are the main differences between 2 and 4-stroke oil? Why does 2-stroke oil have to be mixed with fuel?

2-stroke oil has a very short working life, straight in and out, and it gets burnt. The 2-stroke engine doesn't have a sump full of oil and the bearings are all rollers, so there's hardly any oil drag, hence no need for multigrades. Long term stability is obviously not a problem! But, 2-stroke must burn off without leaving any plug-fouling or detonation-initiating deposits. The detergent and anti-wear additives used in 4-stroke oil leave hard white ash behind when they burn, just what you do not need in a 2-stroke. So 2-stroke oils use low-ash detergents and dispersants, and the better types use ester synthetics to act as anti-wear compounds. With current environmental concerns, smoke is a sensitive issue, so

most ‘road’ 2-stroke oils are now low smoke, which requires yet another type of synthetic base designed to burn off invisibly. For some rather basic but very high-revving air-cooled racing 2-strokes there’s still some sense in using blends with that marvellous anti-seize liquid, castor oil!

Due to crankcase induction and compression, the classical 2-stroke obviously cannot have an oil-filled sump, so the only way to keep an oil film on anything was to add oil to the fuel, or inject oil into the crankcase space where it could mix with the fuel vapour. There are now some engines where the fuel and oil are injected separately, but the oil is still burnt.

How important is it to change oil regularly? What are the implications of failing to do so?

It is only really important to change oil regularly if the bike covers a low annual mileage made up of slow, short runs. This is being cruel to the oil and the engine! The oil, regardless of its quality, gets full of fuel and water vapour, and never gets the chance to evaporate it all off with a long fast run. The consequences are corrosion, ring and bore wear, and gear tooth pitting. It is essential to do a change at least once a year, even if the recommended mileage hasn’t been covered. On the other hand, if you eat up the miles on long blasts the engine and its oil will love it, so with a top-quality oil it is OK to cheat a little on oil drain periods.

Do some types of oil (i.e. fully-synthetic) ‘wear out’ quicker than others? How important are timely oil changes? Can you rely on the frequency suggested by your bike’s User Manual?

(Your enquirer has got it arse about face!)
The type of oil that is likely to give trouble after low mileage is a light viscosity non-JASO MA type with poor shear stability, either mineral or modified mineral based. (Such as one of the USA ‘fuel economy’ oils for lazy car engines that pushed the Japanese OEMs to bring in their own oil spec.) The important thing is the shear stability; the much hyped ‘synthetic or mineral’ nonsense is a red herring. The oils that will last the longest are the relatively rare 100% genuine synthetic shear stable types, which will easily stand twice the recommended drain period in a high-mileage high performance bike. (So in the long run they aren’t really so expensive.) Just the thing for those touring fiends who pack the panniers and set of for the Transylvanian Alps as soon as the clocks go forward! (Fancy an oil change in L’Viv?) Of course, User Manual drain recommendations are based on a back-covering ‘worst case’ scenario of low annual mileage on poor quality oil, so they can be regarded as a very safe minimum mileage.
In the past, there used to be trouble with heavy carbon deposits and sludge around the engine with early low-detergent oils, but these days almost any oil with a good API specification will keep everything clean for 10 to 15,000 miles, so that’s the least of your worries.

Does oil have to be warm to do its job properly? Is it important to warm up your bike before riding at speed?

Yes, it does have to be at least warm, and preferably hot. Most people except vertical twin riders with white finger syndrome find metal at 60C too hot to touch, yet 60C is too cold for oil in an engine that's going flat-out. The best approach is to use a good 10W/40 or even a 5W/40, and take it easy for the first couple of miles, especially in very cold weather. For racing, a really good warm-up is essential, except perhaps with special 0W/20 low-drag race oils. The trouble is, oil pumps are very good at pushing oil out at 60PSI, but unfortunately there is only 14PSI (atmospheric pressure) pushing it in! (Even less in Katmandhu.) So it's easy for an oil pump to pull voids or pockets of vacuum in the oil if it doesn't flow fast enough into to uptake. This 'cavitation' obviously reduces the amount of oil the pump can deliver. Also, in high-speed bearings the oil can be too thick to keep up with the high rubbing speeds reached in modern engines so the 'wedge' or hydrodynamic' effect breaks down. I know it goes against common sense (whatever that is) but the faster a bearing is turning the thinner the oil should be. (A 4cm. diameter main bearing is rubbing its shells at 56 MPH at 12,000RPM! To avoid cavitation the oil need to be less 10cSt or less, which is SAE 30 if the oil happens to be at 100C, or SAE 40 if its at 110C.))

What is the difference between road and racing oils?

The days of incense-like 'R' oils for racing only are past, except for classics. At least as far as 4-strokes are concerned, the best synthetic types are ideal for both race and road use. (Well, that's our policy. All of our race oils are on the retail price list!) With ultra-precise components, high-pressure pumps and high engine RPM there has been a move to special synthetic low cavitation/low drag oils to release more power with no reliability loss. These can be (and are!) used in road bikes, but 0W/20 is not mentioned in the user handbooks, so there is always some warranty risk.

How does a high-performance oil allow the motor to produce more power?

An engine wastes fuel energy in several ways, and most of them are due to the laws of thermodynamics, which is another way of saying you can't do much about it. But up to 6% of engine output is lost due to oil drag, made up of pumping losses and viscous drag between moving components. The transmission is included in this in most motorcycles. Provided wear and friction are kept down, there are real gains to be made by using a 'tough' but low viscosity oil. Surprisingly, frictional losses are low, down at 3% or less even with conventional oils, so there are few gains to be made here.

I have actually seen this extra power output on the dyno! A very experienced operator in Peterboro who does a lot of test work for Lord Emap used his own year-old Honda Blackbird, with the first run on his favourite 15W/50 high-ester synthetic. 128BHP. Then we changed to a 5W40 high ester synthetic. (So it

wasn't an unfair comparison with B & Q 15W/50!) This time we saw 131.6BHP with a corresponding torque increase. Finally we went to a new (at that time) 0W/20 special synthetic and 134.4BHP appeared! Even the boss was impressed! Later trials in different race and road bikes showed this level of improvement was no fluke, so it really does work; and, with the right chemistry to look after the engine and transmission internals, there's no down side of increased wear.

Why do some engines consume oil? Is this a problem?

Large air-cooled engines with wide piston clearances, or very highly stressed liquid-cooled engines which flex under load, or which use ultra-light pistons with the minimum number of rings are likely to be oil users. There is little that can be done about it. Unfortunately, burnt oil tends to leave hard deposits in the combustion chambers which can initiate pre-ignition, so more frequent top overhauls are usually necessary.

Occasionally, touring engines will use oil for no apparent reason. This is often due to the oil level rising in the crankcase due to air retention, leading to oil loss through the breather. The answer is to move to a lighter grade of oil to improve air release.

If you need to top up your engine oil, how important is it to use exactly the same brand and type?

Not very important at all. Unfortunately, due to 'arse covering' reasons we cannot print this advice on the can! Although officially all manufacturers advise against mixing different makes and grades, in fact there is very little chance of any harm being done, even if one is a mineral 20W/50 and the other is a 5W/30 synthetic. Obviously, avoid this if you can, but do not panic if there's no other alternative. Just don't mix 2 stroke and 4-stroke oil!

There are all sorts of additives available which are supposed to improve ordinary oil and reduce friction, improve power output etc. Are they worth a try?

Oil is already a very advanced and deeply researched fluid which does not need any 'enhancement'. There is no secret formula out in the backwoods that the mainstream lubricant chemists do not know about; but there are plenty of half-baked ideas and gullible people out there! These wonder additives are usually 1930s chlorinated paraffins, long obsolete gear oil additives which should have disappeared in the 1950s, but they keep turning up as 'Xxtrasuperlube ZX3' with a mark-up of several thousand percent. They actually corrode engine and transmission internals, so they do far more harm than good. Others depend upon the total myth that PTFE powder coats engine internals and reduces friction. It doesn't do anything or the sort. It just blocks the oil filter. The AA tested one of these overpriced PTFE concoctions ('Quick 60' or something) very thoroughly back in the 80s. They stated: 'This is an expensive way of coating your oil filter'.

Au revoir, JR