

# OIL – AH! THERE’S THE RUB

Trevor G. White

Member \*

Gold Wing Owners Club of Great Britain

Gold Wing Owners Club of Ireland

CBX Riders Club (UK)

Honda Owners Club (UK)

Vintage Japanese Motorcycle Club (UK)

American Motorcyclist Association

Classic Wing Club (USA)

\* The information, interpretations, views and opinions expressed herein are entirely those of the author. In no way does the acknowledgement of these affiliations make those Clubs, their Managements or their Members responsible for them. They are given solely as a record of the author’s own experience and researches and for informational purposes. Anyone acting upon any aspect whatsoever of them assumes full, personal responsibility for any consequences resulting from that action.

© 2002 T.G. White, CH-3173 Oberwangen. No part of this work, either in its original or any translated form, may be reproduced, stored in any retrieval system and/or transmitted in any form or by any means, electronic, mechanical, photo-copying, recording or otherwise, without the express prior, written permission of the author except, with all due acknowledgement, only in the official club journals or publications of the current Member Clubs of the Gold Wing European Federation

7<sup>th</sup> March 2002

## CONTENTS

<u>Chapter</u>	<u>Page</u>
INDEX OF CONTENTS	2
1. INTRODUCTION	3
2. MORE IS LESS	4
3. WHAT, WHERE, WHEN, WHO & HOW?	5
4. OILY JOBS	6
4.1 Job 1 - Lubrication	6
4.2 Job 2 – Cooling	6
4.3 Job 3 – Cleaning	6
4.4 Job 4 – Sealing	7
4.5 Job 5 – Protecting	7
4.6 Job 6 – Surviving	7
5. BASE OILS & LUBRICATION	8
6. VISCOSITY & VISCOSITY INDEX	8
7. SAE RATING	9
8. BASE OILS	10
8.1 First Base – Vegetable Oil	10
8.2 Second Base – Mineral Oil	10
8.3 Third Base – Synthetic Oil	10
8.4 Fourth Base – Semi-Synthetic Oil	11
9. API PERFORMANCE RATING	11
TABLE 1: API Service Performance Classifications For Engine Oils	11
10. ADDITIVES	12
10.1 Additive 1 – Viscosity Index Improvers	12
10.2 Additive 2 – Anti-Wear Agents	12
10.3 Additive 3 – Antioxidants	13
10.4 Additive 4 – Detergents	13
10.5 Additive 5 – Dispersing Agents	13
10.6 Additive 6 – Alkalinity Agents	13
10.7 Additive 7 – Corrosion Inhibitors	13
10.8 Additive 8 – Pour-Point Depressants	14
10.9 Additive 9 – Antifoaming Agents	14
10.10 Additive 10 – Friction Modifiers (Friction Coefficient Reducers)	14
11. GETTING IT RIGHT	14
12. SAUCE FOR THE GOOSE AND GANDER	15
TABLE 2: Some Engine Specifications	15
12.1 Engine Specifications	15
12.2 But Motorcycle and Car Drive Units – They are Different!	16
12.3 Evidence? Some of it's here!	17
TABLE 3: Oil Viscosity After Motorcycle Use	17
12.4 Exception 1 – Wear	18
12.5 Exception 2 – Performance	19
TABLE 4: Motorcycle Peak Dynamometer Horsepower with Different Engine Oils	19
12.6 Exception 3 - Clutch Design	19
12.7 But here is THE evidence	21
TABLE 5: Motorcycle Oil Quality & Engine Performance Before and After 6'150 km Road Use	22
13. OIL SUPPLEMENTS	24
13.1 Supplement 1	25
13.2 Supplement 2	25
13.3 Supplement 3	26
14. FACTORS I HAVE DISCOVERED THAT COULD INFLUENCE MY OIL CHOICE	27
15. IN FOR A PENNY, IN FOR A POUND? - or – PENNY WISE, POUND FOOLISH?	29
16. OUR MOTORCYCLES AND OUR OILS	30
TABLE 6: Honda Official Workshop Manual Recommendations for Oil	31
17. MOTORCYCLE OIL STANDARDS	33
18. MY CONCLUSIONS AT THE BEGINNING OF 2002	34
19. EPILOGUE	36
Literature Sources	36

## 1. INTRODUCTION

The 20<sup>th</sup> century was punctuated by innumerable Oil Wars. The 21<sup>st</sup> century doesn’t look like being any different. No, I’m not predicting that all sorts of nastiness will break out again in the Near or Middle East. I reckon that the frequent Oil Wars will continue more on the Home Front – not risking your own life and limb but that of your loved one – your motor-cycle (m/c). The belligerents want to capture our credibility and our credit. We refugee riders are caught between the lines, being coerced into choosing the right side, knowing that the wrong side – the wrong oil, that is – could lead to two casualties – our bank balance and our m/c.

Oil companies barrage us with the heavy artillery of their propaganda – claiming that only their weapons safeguard against the blood, sweat and tears associated with poor performance and clapped out mechanics. They try to entice us into their castles in the air with promises of eternal life – for our m/cs – fortified by *NASA-juz* or *Elixir XQ73*. It is no more than propaganda – because no oil company provides independent data that support those claims. They feed on some of our basic needs, such as performance, eternal life, safety and protection – for our m/cs, that is. They also promise this with a not-to-be believed economy.

Also having a need for social support, we may seek refuge and succour in the pubs where riders gather – only to be sniped at by our own kind! Barricaded behind their jugs of Newkie Brown or Bud’, they want to lead us into a no-man’s land of this or that special brew concocted by a little old lady whose garden path they were led up. In her marzipan and ginger-bread cottage she promised our gullible mates all sorts of delicacies. Her oil-additive special for m/cs, extracted from Thai buffalo-crap chili peppers, was sure to give any m/c the hots, and a squirry performance to go with it. She guarantees that no user will get roasted. Her seductions are backed only by testimonials from a Mr. Hansel and a Miss Gretel whose m/cs match any of the best to be found in any bar-room – having done a zillion miles “*wiffawt a spanner on ‘er, guv, an’ no oil change neiver!*”

So, what *is* the best? There’s the rub! It *can’t* be what Valentino Rossi uses – because he rides a slightly different machine in a slightly different way to me. It can’t be what Ted Simon uses because he rides around the world in all sorts of rough conditions, deserts and places singularly devoid of clinically arranged service depots. What about the path followed by our mates? Do we have to believe in Santa Claus *and* free lunches? No, we don’t. Nor do we have to believe the advertisements because each one says that *its* product is the best. What we have to do is to sit down and make a list. That list should note what sort of bike we ride – and how, where and when. Then we have to ask ourselves what our priorities are. Is saving money the most important aspect of our choice of oil? Or do we want every decimal point of performance from our engines? Maybe we want to provide our engines with the best possible protection against wear and tear. That would, to a certain extent include the two previous aims – because less wear and tear also means more performance and less repair costs. Only when armed with that list can we begin to ask what oil recipe best suits our needs.

With no engineering background at all, I am singularly ill equipped to address this problem. Still, I have one or two things going for me. First, thanks to the British education system of the 1950s, I can read. Second, my Mum managed to let me loose on the world with a portion on common sense. True, not as much as she hoped, but I owe it to her to use the bit I’ve got to the full. Then, my thick ear shows that my Mum was also adept at recognizing bullshit. Hopefully I inherited that ability to see it as well as give it – to separate fact and fairy story. Also in bygone years, that ability to read was a key to the portals of Higher Education. Once inside, when not playing cards, I learned a bit of chemistry – and oil is about chemistry, isn’t it? The card-playing taught me to think halfway logically. So, prodded by an old riding mate, I had an idea – or, as the Swiss quaintly say, a ‘*brain-fart*’. I would survey the issues involved in the choice of m/c engine oil and hope to arrive at the most important aspect of finding the answer. *That* aspect is establishing the relevant question(s).

## 2. MORE IS LESS

Without presupposing the outcome of my survey, one issue can be clarified immediately because it applies generally and not just to oil. *If* it should prove necessary to use an oil specially formulated for m/cs, then it *has* to be more expensive than an automobile oil. Period! Many people can’t address the market realities, always thinking that factors governing the automobile world also apply to m/cs. They reckon that cars have oil, tyres, batteries, spare parts, etc. – and they should be priced equivalently for m/cs. Sorry, mate! Life ain’t like that. Let’s look at one basis for that difference.

In 1997, there were 4’525’062 motor vehicles registered in Switzerland. 3’323’421 were private cars, with Opel (GM/Vauxhall) having the lion’s share with 439’287 units (13.3% of all cars registered). From that grand total of registered vehicles (of all ages), 409’493 (9% of the total) were classed as powered two-wheelers (PTWs) – one for every ten cars. In other words, alone there were more Opels than all m/cs put together. Of those PTWs, Honda was King, having 104’042 (25%) of all PTWs on the road. It will probably sell another 16’000 or so this year – from a range of 53 different models! So, for 2001 alone, Honda has to manufacture, store, distribute and sell spares for, on average, just 300 examples of each model. Wholesalers and retailers also have to invest capital in providing us with our bits – not just for these current models but also for those that are no longer produced. Is it any wonder that *anything* connected to a m/c is more expensive than its equivalent in a car?

Riders of a particular model may say, “*Hey, hang on a moment! There are thousands of my make of bike around. Surely, that’s mass-production - with correspondingly cheap bits.*” Well, let’s take the number of Gold Wings around. Honda (Europe) recently supplied the German GW Club with U.S production figures. Production started in 1980 with the 1981 GL 1100 model. (No figures are available for the GL 1000 series and 1980 GL 1100 that were produced in Hamamatsu, Japan.) In the 7 years leading up to 1987, Honda (USA) produced (in round figures) 210’300 4-cylinder GWs of the 1100 and 1200 series. That averages out at just over 30’000 annually. In the 13 years from the 1988 to 2000, only (surprise!) 137’500 6-cylinder GL 1500s were built – an annual average of about 10’600

spread *worldwide*. (About 6’000 of those 137’500 GL 1500s are on the roads of Germany.) So, whatever you think from your point of view, in the Grand Scheme of Things, this m/c model does indeed look like a one-off and worthy of all the inattention oil companies and after-market parts manufacturers can give it – unless the owners are a soft touch, that is. (It’s even worse with the CBX1000. Only 25’000 were ever made. Exclusivity has its price!)

So, for your service materials maybe you do not use Honda but, say, M & P’s mail-order in the UK. M & P’s catalogue lists about 120 different types of m/c battery for the handful of British bikes. Further, nine of the world’s m/c tyre manufacturers are listed. Take Metzeler. It offers about 57 different types of m/c tyre – and those in anything up to a dozen different sizes! This amounts to *hundreds* of different combinations – just from *one* maker for the relatively small m/c market. Whereas a production run of car spares, tyres, batteries or oils will run into the tens of thousands of units, those for m/cs will be peanuts – nigh on one-offs. In the Grand Scheme of Western Transportation, m/cs occupy a minor niche that borders on luxury, so it is certain that a *m/c-specific* oil will cost more than common-or-garden types used for millions of automobiles.

### 3. WHAT, WHERE, WHEN, WHO & HOW?

Oil products have many applications; each surrounded by propaganda and confusion. I considered only the runny stuff, excluding greases and waxes. Also, I stayed close to matters of the heart by only looking at automotive applications. There, various oils are used in engines, manual gearboxes, automatic gearboxes, primary transmissions, final drives, suspension units, etc. My interest centred on engine oil – for petrol rather than diesel engines. Petrol-driven m/cs have either a 2- or 4-stroke engine (though the former has become less common because of emission problems in our eco-friendly environment). Although an air-cooled engine was typical in the past, liquid-cooled engines are now more common. This is both for mechanical efficiency and noise reduction, again because of our highly regulated world. (Even Harley Davidson has gone that way now with its new 2001 V-Rod model.)

By now I have mentioned 5 x 2 x 2 x 2 x 2 factors relating to a single lubrication application – 80 in all! These applications may, as in early days, use a vegetable oil – such as castor oil. More commonly, mineral oils are used. More recently, oils synthesized from small components are becoming widely available. Then, blends of mineral and synthetic oils can be bought. So, there we have four types of engine oil. Then, the way a machine is used can influence the choice of lubricant. A rider who never goes above 3’000 rpm when pottering for about 1’000 miles over 8 months of the year before laying the bike up for winter may require a different specification than a m/c courier or a sports rider who rides 20’000 hard miles through all seasons. Finally, there are budgets. Just to mention three possibilities, one rider may have to watch every penny. Another wants the best cost-benefit, whereas money is no object for a third rider. So, by adding those 4 x 3 x 3 arbitrary factors we end up with a matrix or network of 2880 various combinations of automotive oil use. You and I are caught in that net somewhere. No! Don’t worry. I’m not going to give you nearly three thousand chapters on all these factors. I am just going to try to inform myself – an average

rider who wants to pay a fair price for an engine oil that does all the jobs it should according to my average demands – and none that neither I nor my m/c find necessary. That means I have to find out what job(s) an oil really does.

#### 4. OILY JOBS

Before I got into this subject I had simple answers to questions about what oil is and what it does. It reduces friction between moving parts and to stop surfaces coming into contact and wearing out, doesn’t it? And oil is oil, isn’t it – whether it comes from my Mum’s frying pan or from NASA’s research labs? So simple are those jobs not!

##### 4.1 Job 1 – Lubrication

This is the job most people recognise. Oil forms a thin film on moving surfaces, stops metal-metal contact and aids movement by reducing friction. These actions reduce wear and increase power output by reducing friction losses. However, those surfaces move in different ways. Some parts slide against each other (cam lobes against rockers, piston rings against cylinder walls), others have a rolling motion (ball, roller, needle bearings). These may expose the oil to different stresses because the parts are subject to different loads varying from a few ounces per sq.in. to many thousand lb/sq.in.. Then there are different thermal stresses. Just take the extreme - cylinder-wall lubrication. Against all the fiery stresses of combustion every few milliseconds, a film of oil – maybe only *5 millionths of a millimetre* thick – is the only protection against *instant* destruction of your engine. Mmmm! That sounds like one good reason for getting the right oil in there.

##### 4.2 Job 2 – Cooling

Although some m/cs rely heavily on oil for engine cooling, *all* engines are cooled to a greater or lesser extent by the circulating oil. They don’t necessarily need radiator-like external coolers for this. Oil is sprayed or thrown up on the parts it has to lubricate. From them it picks up heat. It then drains down into the sump where it loses some of that heat before it is re-circulated. Not everyone realises why the underside of their engines are moulded like waffle plates. These don’t look like the cooling fins found typically on cylinders, but sump cooling fins they are. I wonder whether everyone keeps these as clean as they would the cylinder fins that show. If not, they risk overheating the oil. Nonetheless, however much you hate getting under the bike to remove the crud, it may be ill advised to fit an auxiliary oil cooler on a m/c that wasn’t designed for it. The properties of oils are designed to be best at the engine’s normal operating temperature. Keeping the oil too cool could be damaging to health – your m/c’s.

##### 4.3 Job 3 – Cleaning

No matter how well an oil functions, inevitably there is some internal wear. Fine bits of different metals, fibres, maybe plastics, get rubbed away. Further, no matter how efficient-ly the combustion is set up, there will be solid or semi-solid waste products formed – soot, waxes, sludge, etc.. Oil holds these in suspension until they are carried to the oil filter to be sieved out or they sink down to form sludge in the sump.

#### 4.4 Job 4 – Sealing

Returning to the example of the piston, one function of oil is to complete the seal between the piston rings and the cylinder wall. This it does in a pretty alien environment. It gets squirted up the walls – just to encounter temperatures that run at the many hundreds of degrees level. Then there is this great circular thing thrashing up and down every few milliseconds at speeds approaching a maximum of 25 metres/sec. If anything is left at the end of the day – well, after those milliseconds – it does the whole thing again because that thrashing thingy scrapes off the rest. In other places it doesn’t have such a tough job – just backing up plastic seals as it lubricates spinning shafts. Sounds easy enough – until the wrong oil additives attack the plastic seals or gums up the piston ring.

#### 4.5 Job 5 – Protecting

We are familiar with the use of greases and oils for protecting things against corrosion. On laying up a bike we coat external surfaces against the ravages of the damp British climate. Yet the climate *inside* a m/c engine can be pretty ravaging as well – especially if it is used for short runs in cold weather. One of the main products of combustion is water. If the engine does not get up to operating temperature, this condenses out and can corrode (rust) the motor from the inside out. Oil films offer some protection against this. (This is also the purpose of tipping a thimble-full of oil into each spark-plug hole of that laid-up m/c.) Further, combustion can produce acidic side-products, particularly if there is any sulphur around. These are even more aggressive than water. Any decent oil should protect the engine internals against the attack of these. (That’s the reason for changing used oil and the filter for winter lay-ups. However, one thing engine oil can’t do very well is to protect parts outside the engine, like exhausts. Take that case of a m/c used just for short runs. By not getting up to operating temperatures - mainly in the exhaust system - the water formed is not driven off. With the bike in a cosy central-heated, humid garage, you can almost hear the damp, acid wastes eating away the internals.)

#### 4.6 Job 6 – Surviving

Although it is not usually included in the jobs oil does, an oil must be able to survive its environment without losing its properties in next to no time. This is not so important for Valentino Rossi’s oil because he only occasionally pops down the track for a 120 km GP race - and anyway, his engines are rebuilt from scratch after each ‘trip’. Motorcycling would not be very popular if *we* had to do that! Indeed, today we are fortunate that m/cycling itself survived the bi-annual de-coke and valve-grinding that our early British twins needed to keep them on form. Yet again, though, we seem to have impossible expectations. We fill up a cylinder with a mixture of hydrocarbon fuel and air. The cylinder has been smeared with a film of hydrocarbon oil. That mixture is then ignited. A scorchingly hot flame flashes through the cylinder and against the walls. We expect the fuel to be combusted completely and with the greatest efficiency. At the same time, we want the oil to be totally impervious to these insults – coming 200-250 times a second, day in, day out – and remain untouched and unchanged throughout.

All of this adds up to quite a job description for something as basic as oil. We want oil to be a jack-of-all-trades *and* to be a master of all at the same time. So, what recipes can be brewed to achieve this seemingly impossible task? Although some high expectations have been expressed so far, it would be too extreme to expect that all of the hoped-for properties of engine oil could be met by one single oily component. Indeed, of the stuff called oil you put into your engine, only 75-85% is the so-called *base oil*. Job 1 – lubricating – falls mostly on the shoulders of the base oil. It gets support, as do the other jobs from the 15-25% of additives in the recipe. This pot-pourri extends or introduces various required properties that are not sufficiently available in the base oil. For the moment, though, let us stay with Job 1 – and explore what a good lubrication is.

## 5. BASE OILS & LUBRICATION

I already mentioned that the base oils are made up of hydrocarbons – chemical compounds of carbon and hydrogen atoms. These molecules exist as chains – some short, some long. The very shortest are gases, then come light oils – and so on until you get into the long-chain heavy oils. A feature of these hydrocarbon chains is that there is very little electronic interaction between the molecules. At this level they do not stick together very much. Although the stuff is quite thick, the molecules slip over each other quite easily. Next time you cook spaghetti, drain off the water. The mass of pasta is pretty solid, isn’t it? Yet grab hold of one long strand and pull. Although it is entwined in many other strands, it just slips out – because there is no ‘stickiness’ between those ‘molecular’ strands.

If your spouse is not looking, tip the mass of spaghetti on to a metal tray and gradually tilt it up. This is a different situation to pulling a strand out. The mass is sitting on the metal. The contact surface between the spaghetti and the tray may be ‘stickier’ than between spaghetti and spaghetti. The individual strands are being pulled only by the force of gravity. Only slowly does this unwind the strands from each other so that their weight can pull on the strands ‘sticking’ to the tray. The mass of pasta slides only slowly down the tray. The individual ‘molecules’ may be slippery but the mass is *viscous* – it doesn’t flow so readily. In spite of this evidence, other research must have shown that spaghetti has some hidden limitations as an engine lubricant, because most people prefer to use base oils. These have that property of molecular slipperiness but mass viscosity.

## 6. VISCOSITY & VISCOSITY INDEX

Obviously, oil being squirted on engine parts would not be very effective if it ran off as easily as water off your polished motorcycle. A thin, low-viscosity oil would drain off rapidly and fail to fulfil its functions. Making the oil as thick as possible is not the answer either. First of all it would be very difficult to pump around, particularly when cold. Even if the starter didn’t fail from stress, there would be marked power losses. It would not flow through the oil galleries very well. If it did get where it should, it would slow down the movement of the moving parts due to its thickness. Finally, it might not get in all the little

nooks and crannies that it should reach. An example here is getting into the piston-ring grooves. Failure there means capital damage.

It has also been shown that too thick oil can stick where it shouldn’t. Thrown up in the crank-case, it can cling to the crankshaft, the con-rods and the underside of the piston. It has been said this can amount to pounds of oil! Carrying this weight around leads to power losses, excessive strains on the bearings and a deficiency of oil in other places. (The risks are worsened if the crankcase is not properly vented to the atmosphere. In a semi- or fully closed crankcase the movement creates positive and negative waves of air pressure. Even if the oil wants to drain away, those waves suck or push it back on to the rotating parts and the build-up continues.)

We seem to be dealing with a Goldilocks syndrome. If you remember, she found Daddy Bear’s chair and bed too hard. Mummy Bear’s chair and bed were too soft. His porridge was too hot, hers was too sweet. However, everything of Baby Bear’s was *just* right! The oil in our engines has to be *just* right, too. Yet, Baby Bear’s chair was only just right for a while – only until Goldilock’s prolonged use of it stressed it to breaking point. Yes, oil has to be just right not for the moment but during extended use.

This is not so easy when we realise that in one respect oil does not differ from other liquids. It gets runnier when it gets hot – differently for each product. That’s a bummer, isn’t it? On a winter morning, the oil is thick. Knowing this – and also the fact nearly *all* internal wear of the engine occurs on starting a cold engine - we might be tempted to err on the thin side with our oil. However, 20 minutes down the road the oil is hot – and very thin! So much so that it fails to lubricate and protect – and we get terminal damage. To get an idea about this risk, viscosity values are determined when the oil is at 100°C (212°F) and at 0°C (32°F). The ratio of these two gives the *Viscosity Index*, with higher VI values indicating the least degree of thinning when heated.

## 7. SAE RATING

Oil companies provide measures of viscosity. Under very controlled, standard conditions they assess viscosity by measuring how much oil drips through a small hole in a given time. The greater the flow, the less viscous is the oil. These standards were set by the American Society of Automotive Engineers, and the standardized value of engine oil viscosity is known as the SAE rating, with higher values for more viscous oils.

Some oils lead a double life. They behave like thin oils when cold and like thicker oils when hot. We know this property as *multi-grade* – and it is usually summarized in an SAE rating that gives the actual viscosity measure and not the VI. Such a rating might be SAE 5W-40. (The ‘W’ signifies that the oil is suitable for winter use.) To understand this rating, consider two *mono-grade* oils that have viscosities of SAE 5 and SAE 40 at 0°C. Both of these get thinner at 100°C. However, an SAE 5W-40 does not thin as much as a mono-grade SAE 5 oil. It only thins as much as that SAE 40 oil would. (You could put this the

other way round. A hot SAE 5W-40 oil doesn’t get any thicker than a SAE 5 oil when cold.). Multi-grades are not made from mixing two mono-grade oils – which would result in an oil that was halfway too thin at one time and halfway too thick at others. It is made by adding quite different substances to a mono-grade base oil – of which there are several.

## 8. BASE OILS

### 8.1 First Base - Vegetable Oil

The first automotive lubricants originated from vegetable sources. The main one was the ricinus bean, grown in India and S. America, that provides *castor oil*. Although this finds few uses now, it is forever enshrined in the name of a major manufacturer, cast(o)r o(i)l – Castrol. It is also imprinted in the memories of older riders, with the smell of racing Castrol conjuring up legends of the past. Although venerable, castor oil is quite a good engine lubricant – in the short term. Its limitation is that it doesn’t have much staying power in Job 6 – surviving the stresses and strains of prolonged high-performance use. You only have to look at other uses of castor oil to get an idea of its limitations. Given the right chemical and heat treatment, castor oil can produce varnishes and plastics. Pushed beyond its performance limits it can produce these in an engine, causing pistons to stick, fine oil-channels to block and sludge to build up. If that happens, you may be reminded of another property of castor oil – its laxative action – as parts of your m/c innards drop out of the back! In the earliest machines this wasn’t such a problem because they had total-loss lubrication systems. From a reservoir it went into the engine once and then it was the oil that was excreted.

### 8.2 Second Base - Mineral Oil

Mineral oils have formed the basis of lubricants since the early years of the 20<sup>th</sup> century. A careful distillation and separation process refines crude oil pumped out of the ground. The first distillates give us our petroleum/gasoline fuel. Then come slightly heavier products, but they are still classed as light oils. Progressively, then come heavier and heavier oils and then waxes. In spite of careful distillation the various fractions still contain a mixture of hydrocarbons. Positively, it could be said that this gives an oil a broad range of properties. On the down side, though, something is only as strong as the weakest link in the chain – or the weakest hydrocarbon chain in an oil.

### 8.3 Third Base – Synthetic Oil

I suppose that more exact distillation processes could produce purer mineral oils, at a price. However, other ways were found. The necessities of the Second World War drove German researchers to seeking alternatives to the inaccessible mineral oils. They found ways of taking all sorts of heavy oils, crude oil wastes, animal and vegetable fats and ‘cracking’ them down almost to their bare hydrocarbon bones – usually to ethylene that is only two carbon atoms long. They could then join these building bricks back together, synthesizing oils to a tailor-made specification. It is even possible to make slight modifications to the molecular structure to improve some of the lubricating properties and the thermal stability. Although still not a cheap process today, it has been found to be the best. It results in oils that

have a more exact chemical makeup, much more defined properties and greater stability - and higher price.

#### 8.4 Fourth Base – Semi-synthetic Oil

These are no more than blends of mineral oils with synthetic components. I haven’t found any information about the advantages of these. I can imagine, though, that certain properties of mineral oils are improved to a certain extent with this ‘additive’, without going to the full expense of 100% synthetic oil.

### 9. API PERFORMANCE RATING

The SAE technical tests for viscosity are one thing. However, an oil usually gets a second designation – the performance rating according to the American Petroleum Institute (API). Viscosity is just but a physical characteristic of an oil. Whether an oil actually meets its *overall* design specification when run in an engine is another matter. So, co-operatively with engine makers, the oil industry, API establishes these performance parameters, tests products against them and gives licenses to manufacturers to use these labels. Table 1, for gasoline-powered engines, is from API’s current (January 2002) website information service.

TABLE 1:		
API SERVICE PERFORMANCE CLASSIFICATIONS FOR ENGINE OILS		
CATEGORY	STATUS	SERVICE*
SA	Obsolete	For older engines. No performance requirement. Only use when specifically recommended
SB	Obsolete	For older engines. Only use when specifically recommended
SC	Obsolete	For 1967 and older engines
SD	Obsolete	For 1971 and older engines
SE	Obsolete	For 1979 and older engines
SF	Obsolete	For 1988 and older engines
SG	Obsolete	For 1993 and older engines
SH	Obsolete	For 1996 and older engines
SJ	Current	For <i>all</i> automotive engines after 1996*
* Later engine oil service categories include the performance properties of each earlier category. If, for example, an owner’s manual calls for API SF oil, then API SG oil will provide full engine protection. The italic emphasis added.		

As technology – in oils and engines – advances, these performance standards are periodically upgraded. The rating consists of two letters. The first denotes whether the oil can be used in gasoline/petrol (‘S’ for ‘Service’) or diesel (‘C’ for ‘Commercial’) engines. The second letter – the first was ‘A’ – denotes the time when the standard was set. We are now up to ‘J’. There is one thing about that note in Table 1. Although a later category includes the earlier performance ratings – so that an ‘SH’ could be used when an ‘SG’ is recommended – this does not mean that the ‘SH’ is a *better* oil for *your* purpose. A later cate-

gory meets additional test-criteria for lubrication and protection of an engine without losing the previous ones. For instance, future oils may contain different additives - such as the friction modifiers to be mentioned later. The certification of these oils will confirm their engine properties – not whether they are good for cooking french-fries or as bath for m/c clutches.

That is the seductively dangerous aspect of using just API standards as a guide for selecting and oil. It defines them as applying to “all” automotive engines - and in this case it is an exact definition. It is suitable for engines – not for gearboxes, transmissions and clutches – just engines. The standard does not examine anything except engine performance. Just take the latest Honda recommendation, valid up to the year 2000. By recommending API SG (a standard established in 1993), Honda is saying that in spite of having wet clutches m/c engines *and* transmissions up to 2000 models are served by API SG oil. However, API saying that later SH and SJ specifications are good for all automotive applications is not the same as saying they will be alright for m/cs with wet clutches. We have seen that formulations are changing often. Since 1993 new demands, new technologies, new additives have changed the nature of lubricating oils. They, too, are fulfilling new market ‘niche’. The dates in Table 1 reflect the dynamism of these changes, particularly in the 1990s. The SE standard was in force for 8 model years, from 1972-1979. SF lasted for 9 years. However the 1989-1993 SG standard was upgraded after only 5 years and the SH already after 3 years. Perhaps ‘progress’ has slowed down in that the current SJ standard has been in force for 6 years.

## 10. ADDITIVES

Although it is the base oil that does the lubricating and cooling, the 15-20% of additives determine its performance in long-term use, as listed in the earlier job description and covered by the API ratings. So now we can ask what those additives are and what they do. If you remember, these either extend the available properties of the base oil, or introduce new ones to help it fulfil the six parts of its job description. They do not lubricate or cool.

### 10.1 Additive 1 - Viscosity Index Improvers

These additives are amongst the most important in modern engine oils. VI improvers are responsible for turning a mono-grade into a multi-grade oil. They are very long-chain polymers such as polystyrenes, polymethacrylates and/or olefin-copolymers, etc.. Cold, they are curled up in molecular balls. As the oil warms up, these start to gradually unravel and get tangled up with each other. So, although the base oil itself is thinning and the viscosity of the mix goes down, it does not get as thin as it would otherwise. These long-chain polymers can suffer the same fate as the base oil hydrocarbon chains – being cut up by the heat and mechanical mincing action of the engine. So, what starts off as a golden syrup of SAE 5W-40 will ‘fall out of grade’ to an SAE 0W-30 or even lower if it stays in the engine long enough.

### 10.2 Additive 2 - Anti-wear agents

During extreme conditions –at start-up or during high performance conditions – momentarily there might not be enough oil film around to do its job. There is a slight risk of

metal-metal contact – and excessive wear. Adding organic compounds containing inorganic zinc, sulphur and phosphate helps combat this. The additive binds strongly to metal surfaces and gives an extra few molecules of protection. If those extreme conditions are reached, it is the additive that is ground up and worn rather than the engine metal. Excess amounts of them do not give more protection – they just protect for a longer time before they are used up. When the additive breaks down and loses its protective action, it releases those inorganics into the oil. Sulphur can produce slight amounts of corrosive acids. Zinc and phosphorus do not poison catalytic converters anywhere near as badly as lead but they do not do them any good. They also form solids – seen as ash if the oil is incinerated in the test laboratory – which have to be sieved out by the oil filter. As you will see, many other additives also contain inorganic (sodium, calcium, magnesium) elements. These, as well as carbon, can also deposit on spark-plugs, valves, etc. to degrade performance.

Larger proportions of these or similar compounds are added as so-called extreme-pressure additives. Cam lobes with very aggressive ramps and meshing gear teeth exert enormous pressures and can cause rapid wear in high-performance applications. They may have marginal benefits in racing engines which, because of their frequent re-builds, are not affected by the residues formed.

### 10.3 Additive 3 - Antioxidants

In a hot atmosphere full of oxygen, hydrocarbons obviously can be oxidized. One effect is a loss of function and a break-up of the chains. Another is that the molecules join up with each other, cross-linking to form gums and sludges. Those sulphur-phosphate compounds also work as antioxidants, as well as some organic compounds.

### 10.4 Additive 4 - Detergents

If your engine does not sound like an old washing machine, it might be because your oils contain detergents. These additives, organic calcium or magnesium salts, stop gums, varnishes and carbon residues sticking to the insides. This is especially important around the hottest parts of the engine, like the piston-ring grooves. Again, the eventual breakdown of these additives produces inorganic, solid residues that have to be filtered out of the oil.

### 10.5 Additive 5 - Dispersing Agents

Already several waste and wear products have been mentioned. Some additives slow down their formation, others stop them sticking where they shouldn't. So they are swimming around in the oil, ready to settle where they shouldn't. To prevent this happening, dispersing agents made of organic salts keep them suspended in the oil until they can be filtered out.

### 10.6 Additive 6 - Alkalinity Agents

It was remarked above that some of the breakdown products are acidic – not good for metals. To neutralize these, various alkaline organic and basic salts are added.

### 10.7 Additive 7 - Corrosion Inhibitors

Those warm acidic side-products, oxygen and water vapour can corrode. By forming a protective film on metal surfaces or by lowering the chemical reactivity of metal surfaces

with inorganic (sodium, calcium, magnesium) and organic salts, internal corrosion can be reduced. Again the breakdown of these additives can produce solid residues.

#### 10.8 Additive 8 - Pour-point Depressants

In extreme winter conditions even thin oils can get too thick to flow properly. Some of the heavier components can even ‘wax out’ as semi-solids. Here, it wouldn’t be helpful to take a very low SAE-rated oil because this would be much too thin when the engine warmed up a bit. So, having almost the opposite effect of VI improvers that stop oil getting too thin when hot, pour-point depressants stop it getting too thick when extremely cold. Here too, organic polymers are used.

#### 10.9 Additive 9 - Antifoaming Agents

Detergents were mentioned above. These act a little like soap and can cause the oil to foam – an action that reduces the efficiency of film formation and lubrication. Also, the thrashing, whisking movements of the engine parts can produce foamy bubbles that do not form good oil films. Adding small amounts of silicon or acrylate oils can reduce this.

#### 10.10 Additive 10 - Friction Modifiers (Friction-coefficient reducers)

Certain organic fatty acids and molybdenum compounds have even less friction than oil. Due to their electronic structure they can stick to metal surfaces such as cylinder walls and add to the friction-reducing properties of the oil. These seem to be a relatively new development and are a part of so-called ‘Energy Conserving’ oils being promoted in the USA. Here it must be noted that most additives mentioned before are not concerned with changing the lubrication properties of an oil. They affect its physical properties at different temperatures, add to thermal stability or protect the engine from secondary damage. These are extra benefits above and beyond the lubricating effect of the oil in the engine design specification. Friction modifiers may shift the oil performance outside these specifications – as in wet clutches. An additional aspect of ‘energy conserving’, eco-friendly oils is that they may also have lower zinc- and phosphorus-containing additives than current oils. This could affect the anti-wear properties in high-performance engines.

### 11. GETTING IT RIGHT

There is one attitude that gives me problems. Quite a few people reckon they know more about m/cs than, say, Honda. They also think they are a tad smarter than Castrol, BP or Esso. Yes, they are ready to admit that these companies have mega-\$ research and test facilities and that they are not ready to commit corporate suicide by selling something duff. But ... but! They are taken to be less smart than that fellow beavering away in his Scunthorpe garden-shed. He has found that an extract from rabbit testicles *really* makes a bike potent. Codswallop!

No! I’m not 100% gullible. These companies do make mistakes. In the test facility, you can simulate the daily use of a product – in all climates, over all road conditions, with all sorts of riders – only so far. (One reason might be that their test-riders are *too* good. They

don’t make a cock-up of every second gear change. They don’t start a bike on a winter morning and ten seconds later wheelying it down the road with the engine on the red-line. They don’t leave the bike standing in all weathers for a couple of months and expect it to function perfectly at a turn of the key. They don’t cut corners on standard maintenance schedules ... and so on.) The guidelines that Honda gives to Valentino Rossi are based on the state-of-art knowledge of the time – for running a 500 cc GP bike. This principle is no different than the recommendations you get – even though it is for a street bike designed with a more general, less focussed purpose in mind.

Looking at another aspect, if you want to buy a GL1800 or Fireblade just for going to the newsagent once a week for your bike magazine, Honda will sell you one. Oil companies are the same. Yes, they are also in it for profit – and if you want to pay a premium price for something you don’t need, then they will sell it. Fortnum & Mason will sell you a boring caviar sarnie for your snack-lunch just like Eddie’s Eatery will sell a tasty cheddar roll. With those ingredients – the additive ‘spices’ and ‘herbs’ listed above - the oil-company ‘cooks’ can prepare dishes to suit any taste. Faced with an enormous menu, your problem is choosing a dish to suit – *first and foremost* - your m/c and then your pocket. You want to get it right, but is a sauce for the goose also suitable for the gander?

## 12. SAUCE FOR THE GOOSE AND GANDER

<b>TABLE 2:</b>			
<b>SOME ENGINE SPECIFICATIONS</b>			
	<b>VEHICLE A</b>	<b>VEHICLE B</b>	<b>VEHICLE C</b>
Engine Layout	4-cylinder DOHC Liquid cooled	6-cylinder SOHC Liquid cooled	6-cylinder DOHC Air-cooled
Engine capacity (cc)	1796	1520	1047
Compression Ratio	10.8	9.8	9.3
Power (kW @ rpm)	92 @ 5'600	74 @ 5'200	78 @ 9'000
Torque (Nm @ rpm)	168 @ 4'800	150 @ 4'000	87 @ 7'500
Redline rpm	6'600	5'500	10'500
Engine oil Change schedule (km) Quality Viscosity Recommended base Mineral/synthetic	15'000 API SF or higher SAE 10W-40 None	12'000 API SF or higher SAE 10W-40 None	6'000 API SE or higher SAE 10W-40 None

### 12.1 Engine specifications

To illustrate one of the big discussion points about the choice of engine oil, just consider these three engine specifications shown in Table 2. The most frequent reason we are given for using a m/c-specific oil is that m/cs – not ‘some m/cs’, just ‘m/cs’ - are high-performance, high-revving, hot-running engines. This looks to be the case with Vehicle C – and that does happen to be my 23 year old CBX1000Z. The issue of hot-running should not be an issue with the Vehicles A and B above. Both are liquid-cooled with their thermostats

opening just above 80° C. As to the other issues, with the DOHC design and the performance figures at those engine speeds, I could say that Vehicle A is a sportier engine than B. Vehicle A just happens to be our 1995 Opel/Vauxhall Astra 1.8 car. Vehicle B is a modern GL1500!

So, can you use the same sauce for the goose and gander? Does *that* reason for using a m/c-specific oil still hold up for *your* m/c? (If your trousers are long enough, you may remember the 1976 British *Bike* magazine road-test of the first Gold Wing – carried out by an asphalt-scratching rider of the old school. The magazine fell out of favour with Honda because the GL1000 was not reckoned to be a m/c – more a two-wheeled car. Well, the author was perceptive about the engine. However, he shows his restricted vision by expressing a dislike for ‘the way Honda was going’. It wasn’t the way Honda was going with m/c engines – the whole world was going that way!)

Because of environmental restraints on noise and the search for efficiency, most modern m/cs are now liquid-cooled, so no special ‘heat-resistant’ oil would be needed for those engines. Nonetheless, there are still ‘some m/cs’ that generate enormous power and red-line in the 10-12’000 rpm range. However, who red-lines their engine? HP peaks are used to attain maximum straight-line speeds. Where, in a civilized country, can a Fireblade or Hayabusa be red-lined. Oh, it’s acceleration you want, is it? Well, only a poor rider would take the engine far beyond the torque peak that delivers maximum acceleration – and that’s way below the red-line! Still, let’s be open-minded. Some modern machines may be special and could profit from special treatment.

## 12.2 But motorcycle and car drive units – they are different!

Although it is not always mentioned, there is a major difference between m/c and car drive units. Virtually all cars (with a manual gearbox) have a dry sump, a dry clutch and gear-oil separate from the engine – a few m/cs as well. Here, after serving the engine, the oil drains into the sump and is then pumped up into a reservoir. From here a second pump drives it into the engine again. Most m/cs now have a unit construction, with wet sump (except, for example, Harley Davidsons and the Honda CB 750), wet clutch and a gearbox lubricated by engine oil. The engine oil collects in the sump from where a single pump lifts it into the engine, gearbox and clutch housing. (Have you noticed? The Gold Wing oil dipstick sits more in the gearbox than the engine.) It is gravity that gets it back into the sump ‘reservoir’. (A wet sump needs volume to catch the oil. This increases engine height. This is too much for the new Honda VTX with its OHC and enormous 112 mm stroke. So, it has a hybrid design – a dry sump but with the primary transmission serving as oil reservoir.)

If anything, exposing oil to the machinations of the transmission could be the major reason for special treatment. Whatever dish of yummys the oil-chefs have prepared, when it comes out of their kitchens into our engines, it drops straight into that mincer of a gearbox. Alright! All engine oils are exposed to the stresses of valve-trains, crankshafts and pistons. Not all of them get drawn into the gnashing teeth of the gearbox. Also, not all clutches have to bind without slip when bathed in an oil that should be slippery everywhere else. Therefore the question boils down to what do gearboxes do to oil and what does oil do to clutches.

From the very early days it was recognised that engines chop up those long molecules, be it the very long VI Improvers that give us the multi-grades or the long hydrocarbon chains in the base oil itself. The SAE viscosity rating inevitably drops. The relevant information is how quickly this happens. Strangely enough, there is little information about this – with the oil companies being notably silent. They publish chemical and physical data about their products. They make claims about performance in this or that application. However, they publish no information to support these claims – not from the laboratory and certainly not from real-life use on the road.

But hold on a minute! It is the base oils and VI-improving polymers that get chopped up. Certainly there seems to be no evidence whatsoever that the base oils used in car applications are essentially different from those in m/c oils. A m/c gearbox should chop up these ingredients in a car oil no more than when they are in a so-called m/c-specific oil. After all, in that list of additives none of them claims to prevent the mincing action. Indeed, I can’t see how any additive could. Once a lump of beef gets into a meat grinder you still get hamburger whether it is rump or filet prime steak. So, what evidence is there on this point?

### 12.3 Evidence? Some of it is here!

A few years ago (1994) John Woolum, a U.S. professor of physics with access to test equipment, published his private research in the American *Motorcycle Consumer News*. In a Honda V65 Sabre he tested three *automobile* oils (the mineral-oil Castrol GTX 10W-40, the synthetic Castrol Syntec 10W-40 and the synthetic Mobil 1 15W-50. He also tested two *specific m/c* oils – the mineral oil Spectro 4 10W-40 and the semi-synthetic blend Honda HP4 10W-40. He measured the baseline viscosity (100% at 0 miles) and then after running the bike normally for 800 and 1500 miles. At these points he measured the loss of viscosity compared to that 100% zero-point. (Additionally, he ran just the Mobil 1 for 2’500 miles in the bike.) He obtained the results shown in Table 3.

<b>TABLE 3:</b>					
<b>OIL VISCOSITY AFTER MOTORCYCLE USE (as % viscosity when new)</b>					
Brand and Base-Oil Type		% Relative viscosity after motorcycle use (miles)			
		0 mi.	800 mi.	1500 mi.	2500 mi.
Motorcycle designated oil					
Spectro 4	Mineral 10W-40	100	68.0	63.9	-
Honda HP 4	Mineral/synthetic 10W-40	100	69.2	65.6	-
Automobile designated oil					
Castrol GTX	Mineral 10W-40	100	72.2	68.0	-
Castrol SYNTEC	Synthetic 10W-40	100	78.1	74.5	-
Mobil 1	Synthetic 15W-40	100	86.6	83.0	79.1
Note 1: Castrol GTX mineral automobile oil was also run in a Honda Accord car for 3’600 miles. Viscosity fell to 91.8% of fresh.					
Note 2: A sample of the Castrol GTX used in the m/c was analysed by an independent laboratory. The results showed signs of engine wear to be within normal limits					
Note 3: The relative 1994 US prices of synthetic based multi-grade m/c oils were 185% of similar auto-oils. For mineral oils, the relationship was 319%!					

These data indicate that the m/c was harder on the GTX automobile oil than the Accord car (Note 1). As to that m/c effect, it is striking that the relative loss in viscosity was most marked after the first 800 miles. Doubling that distance did in no way double the viscosity loss. Also worthy of note is the fact that the m/c oils lost about 45% of their viscosity over 1’500 miles (2’400 km). This is dramatically shorter than the usual recommendation for m/c oil changes. I interpret this as m/c manufacturers accepting that a viscosity loss of at least 45% is no reason for changing the oil.

If the design of typical m/c engines does indeed cause the oil to lose its viscosity (and, supposedly, its lubricating properties) by shearing and tearing the long-chain molecules then, in a m/c, oils designed for automobiles are actually superior to those specially promoted for m/cs. The viscosity loss after 1’500 miles (2’400 km) was only 32% for the automobile mineral oil and 17-26% for the car oils with synthetic bases. Indeed, one of them had only a 21% loss after 2’500 miles (4’000 km). A moment earlier I mused that car oils should not be chopped more than m/c oils. Yet here is Woolum saying they are chopped up *less!*

The claim that m/cs - because they are designed to run hot, are high-revving and have the gearbox lubricated by the engine oil - damage oil more than cars does not hold up against this evidence. Indeed, Table 2 shows that not all modern m/cs fit that design stereotype. One American writer has observed that the move towards smaller yet high performing cars and, except for top sports bikes, the move towards softly tuned m/cs for touring and cruising means that differences in engine performance are disappearing. Certainly the Table 2 specifications for the Opel Astra car and Honda GL1500 – and John Woolum’s data - do not suggest that they need different oils ... except!

#### 12.4 Exception 1 – Wear

One of the additives helps protect against wear of moving parts, particularly the highly stressed ones such as cam lobes, plain bearings and gearboxes. Because of the difference in engine and lubrication function, could m/c oils offer better anti-wear protection than car oils? Well, in the engine itself, I don’t see any differences. Both automobile and m/c engines have bearings, cam lobes, etc.. So, if an oil does its anti-wear job in a car *engine*, then it should do it in a m/c engine. Are the anti-wear properties of a car oil sufficient to protect a m/c’s gear box? (Actually the question is not that simple. When the anti-wear additives are called into play they are used up. If a m/c gearbox uses up more of them, in time there may not be enough around to protect those other parts.) Admittedly, the only evidence on this – John Woolum’s – is thin, but that oil analysis mentioned in Table 3 (Note 2) suggests that it *is* enough. Wear after using a Castrol car oil in his m/c was normal.

There is one way to get your own evidence on this. In your riding group, a couple of you may have similar machines (model, mileage, ridden in the same style, etc.) but one already uses a car oil while the other stays with a m/c oil. The group should chip in to make a small fund. The two bikes each get a fresh oil change and new filter. When the next change comes around (or at the end of the season) a sample of each oil is sent to an independent analysis lab – paid for by the group fund. This will give you your own reference data – which

you *must* publish for the benefit of others. (There again, if you are in a big m/c club, maybe your club will finance this study – for the peace of mind of everyone.)

### 12.5 Exception 2 - Performance

John Woolum makes no comment about whether the choice of this or that oil affected the performance of his vehicles. There again, he didn’t suggest that peak power, roll-on times or standing- $\frac{1}{4}$ s should be improved with the right choice. There he differs from the oil companies who repeatedly claim that *their* oil does improve performance. Again, these claims are made totally without any evidence. Last year, though, the largest m/c magazine in Europe, the German *Das Motorrad* reported the first of a series of investigations on oil.

*Das Motorrad* took a bread-and-butter bike, the single-cylinder BMW F650 GS, and the multi-cylinder hyper-sports Suzuki GSX 1300R Hayabusa. They were filled in turn with either the fully synthetic Castrol RS 4T (10W-50) costing around 24 DM per litre; with the mineral Castrol GO! 4T (20W-40) at around 18 DM per litre and the supermarket mineral Power Oil HD (15W-40) that cost 13 DM for a 5 litre can. They were then run on the dynamometer to obtain the power curves over the whole rpm range. The result? It was impossible to show any curves because they were virtually identical throughout. The article did note the peak horsepowers obtained, as in Table 4.

<b>TABLE 4:</b>			
<b>MOTORCYCLE PEAK DYNAMOMETER HORSEPOWER WITH DIFFERENT ENGINE OILS</b>			
Motorcycle Model	Castrol RS 4T (synthetic)	Castrol GO! 4T (mineral)	Power Oil HD (mineral)
BMW F650 GS	47.0	46.9	47.0
Suzuki Hayabusa	164.7	164.6	164.5

So, using an oil that cost nearly 10 times less than another brought a power loss of 0.12% - about the amount lost by having two flies squashed on the windscreen, or less than the test variations. *Das Motorrad* did say that this dyno test said nothing about any changes in viscosity, lubricating performance or durability – but that they are staying on the ball with those questions.

### 12.6 Exception 3 – Clutch Design

This exception is the fact that most m/cs have a manually operated wet clutch. The ability of a clutch – any clutch - to transmit power (without slipping) depends on several things. There is a) the radius of the friction plates, b) the number of the friction plates (together these two make up the friction-plate surface area), c) the compression force holding them together and, of course, d) the coefficient of friction between the plates. (I suppose that in principle you could have friction plates made of Teflon with its very low coefficient of friction. However, you would need a couple of hundred of them, maybe a metre across and pressed together with a hydraulic press!)

The typical dry clutch in an automobile usually has one large-diameter friction plate. Once an asbestos mix, this is now made from organic or Kevlar material. It is air-cooled, it can take higher temperatures and sustain more frequent gear changes without loss of power when compared with a wet clutch. It has an advantage over wet clutches in that wear residues do not contaminate the engine oil. A disadvantage is that getting oil on the friction plate drastically lowers the coefficient of friction and with it, the ability to transmit. The clutch slips. This also happens when the compression force weakens – either willingly when the clutch pedal/lever is not released fully or unwillingly when the clutch is not properly adjusted or springs lose their strength through age.

A wet clutch is cooled by engine oil. Its friction plates are made from paper, cork/neoprene or Kevlar. Powerful clutch springs help squeeze out the film of oil between the plates to reduce the film lubrication effect. Nonetheless, the coefficient of friction between oil-soaked friction plates is less than that of dry plates. Transmission efficiency would be maintained by increasing the friction plate area. However, the very nature of a motorcycle doesn’t allow the plate radius to be very large. The solution therefore is to increase the *number* of friction plates to give a multi-plate clutch. Commonly, 6-8 are used. (The Suzuki GSX-R750 has 19.) The advantage of having a relatively small diameter is retained, with the additional profit of quieter operation.

Primary transmission designers will know how much power they have to transmit. They will know the specification of the oil planned into the engine design. They will know the coefficient of friction between friction plates soaked in *that* oil. They will have design constraints on the size of the plates. They can then calculate the required number of plates and clutch spring strength to get efficient power transmission. Obviously they will engineer in some reasonable leeway that allows for weakening spring strength and friction plate wear. However, they will set limits on the extent of this over-engineering.

Their design intentions get scuppered, however, if the coefficient of friction between the plates suddenly drops – drops so much that its ability to transmit power goes outside the available leeway. Transmission efficiency falls, the clutch slips. This *could* be the problem of using the latest oils that contain friction modifiers. No one knows yet. The jury is still out on this – because the anecdotal evidence is contradictory. Some claim that friction-modified oils give no problems. Others found that they went nowhere very fast because of clutch slip. Then, in between, others got clutch slip only when they started to ride aggressively.

These seeming contradictions *are* explicable in the above terms – in terms of the available clutch-performance tolerances. Clutch slip induced by friction modifiers would depend on the model of m/c and its clutch design. One clutch may be able to tolerate the lowered friction better than another. Then, there is the clutch-status of the actual machine itself. One rider’s clutch may be more worn, weaker than another’s. One must not forget the riding style of the rider him/herself. On this point, imagine someone trolling along, delivering 20 hp to the rear wheel. He/she then drops two cogs and screws the nuts off the throttle, instantly hitting the transmission with another 60 hp. Yet another may be tootling along in 5<sup>th</sup>

gear with 1500 rpm on the tacho – and he/she nails the throttle *without* dropping down the box. The transmission can be expected to behave in a different ways.

### 12.7 But here is THE evidence

For many years, that Woolum evidence from private research was the only material available. Just last week though, the most definitive information to date was published. No, no, it wasn’t a change in heart by an oil manufacturer – deciding to publish some scientific support of its marketing claims. The evidence again came from *Das Motorrad*, that German m/c magazine that does so much good work. In that study mentioned earlier, they wrote that they were going to stay on the ball. They have kept that promise – and how! Often impressed by the investigations conducted by *Das Motorrad*, this time even I was surprised at the extent (and expense) of their “Oil Control” study (Issue 5, 15.2.2002, pp. 116-121).

Clearly, a comparison of oils is only valid when each oil plays on the same, level playing field. How did *Das Motorrad* achieve that? They bought 5 (five!) new Suzuki GSF 1200S Bandits to use! Each machine was run-in identically, according to the official guidelines. They had their initial service and then filled with one of five different oils. All fulfilled the manufacturer’s requirement for an API SF/SG classification. After dyno-testing to determine the baseline power outputs, this gang of Bandits were then sent over hill and dale, plain and mountain until they had shared 6’150 kilometres together – the distance up to the first basic service. Obviously the oil consumption over the test was recorded. After showing their power on the dyno again, the oils were drained and subjected to every test in the book – to ascertain wear, impurities in the oil, viscosity and degradation of the oil and the status of the additive packages. The data were compared with those from identical measures made on the oil as it was put in at the beginning of the test.

Four of the oils were designed for motorcycles: full synthetic *Castrol RS-4T*, semi-synthetic *Liqui-Moly Racing 4T*, mineral Motul 3000 and, from a m/c chain-store and mail-order company, mineral *Hein Gericke 4-Stroke Oil*. The fifth oil was just an ‘engine oil’ from a hardware supermarket, mineral *High Tech Star Motor Oil*. The test-data are summarized in Table 5. (I am grateful to Motor-Press Verlag, GmbH, Stuttgart for permission to use data from *Das Motorrad* for which it has the copyright.)

The first interesting aspect of these data is the oil additive analysis *before* the test. These metals are all part of organometallic or inorganic substances that provide the properties other than lubrication. The levels of these vary in the different oils. The cynic would say that the actual level of this or that is not so important. The oil companies would say that *their* mix is carefully balanced to give the desired – and claimed - engine protection. One of them may be just right for your machine and your riding style – but not all of them.

The relationship between the initial SAE rating and the measured viscosity is not immediately clear. With its 20W ‘cold rating’ the Motul should be the thickest oil and its high viscosity – higher than the 10W Castrol - confirms this. However, although both have a ‘hot-rating’ of ‘50’, the Motul is thinner than the Castrol. With its high Viscosity Index the Castrol synthetic oil thins least when tested hot.

**TABLE 5** MOTORCYCLE OIL QUALITY & ENGINE PERFORMANCE BEFORE AND AFTER 6'150 km ROAD USE

	<b>CASTROL RS-4T</b>	<b>LIQUI-MOLY Racing 4T</b>	<b>MOTUL 3000</b>	<b>HEIN GERICKE 4-Stroke Oil</b>	<b>HIGH TECH STAR Motor Oil</b>
SAE RATING/API CLASS	10W-50/API SG	10W-40/API SG/SH	20W-50/API SG	15W-40/API SF	15W-40/API SF
Base Oil Type	Full synthetic	Semi-synthetic	Mineral	Mineral	Mineral
Cost (Euro/litre)	10.86	8.42	6.70	2.04	1.32
<b>LABORATORY ANALYSIS VALUES BEFORE / AFTER 6150 kilometres</b>					
<b>ENGINE WEAR</b>					
Iron mg/kg	3 / 82	2 / 96	2 / 88	1 / 79	1 / 74
Chromium mg/kg	- / 3	- / 3	- / 3	- / 2	- / 2
Aluminium mg/kg	1 / 49	2 / 32	2 / 36	- / 32	1 / 32
Nickel mg/kg	- / 1	- / 1	- / 1	- / 1	- / 1
Copper mg/kg	- / 22	- / 18	- / 13	- / 14	- / 12
Lead mg/kg	1 / 7	3 / 9	- / 6	1 / 7	1 / 6
Molybdenum mg/kg	- / 78	- / 83	71 / 142	1 / 80	71 / 146
* PQ Index	OK / 110	OK / 46	30 / 36	OK / 88	OK / 64
<b>IMPURITIES</b>					
Silicon mg/kg	5 / 29	2 / 36	7 / 34	7 / 36	8 / 33
Potassium mg/kg	- / 1	1 / 3	2 / 6	1 / 4	3 / 5
Sodium mg/kg	1 / 4	2 / 5	60 / 43	36 / 41	2 / 6
Gasoline %	- / 0.6	- / 0.7	- / 0.3	- / 0.4	- / 0.5
<b>OIL QUALITY</b>					
Viscosity @ 40° mm <sup>3</sup> /s	113.7 / 99.7	89.8 / 98.8	138.2 / 144.6	97.0 / 95.5	102.5 / 106.0
@ 100° mm <sup>3</sup> /s	17.5 / 15.7	13.9 / 14.8	13.4 / 17.0	13.1 / 13.1	13.2 / 13.7
Viscosity Index	170 / 167	159 / 156	126 / 128	133 / 135	126 / 128
Oxidation A/cm	- / 12	- / 11	- / 12	- / 9	- / 11
Nitration A/cm	- / 11	- / 12	- / 12	- / 10	- / 11
Sulphation A/cm	- / 22	- / 9	- / 9	- / 8	- / 9
<b>ADDITIVES</b>					
Calcium mg/kg	2358 / 2540	2104 / 2953	2287 / 2679	1608 / 2312	2273 / 2825
Magnesium mg/kg	20 / 22	226 / 263	393 / 424	78 / 105	27 / 35
Boron mg/kg	- / 18	236 / 248	9 / 30	3 / 19	3 / 20
Zinc mg/kg	1320 / 1239	1286 / 1454	1298 / 1289	1380 / 1409	938 / 1097
Phosphorus mg/kg	1388 / 989	1249 / 1245	1256 / 1095	1429 / 1293	936 / 953
Barium mg/kg	- / 3	- / 1	- / 2	- / 1	- / 3
** TBN mg KOH/g	8.82 / 8.42	9.35 / 7.15	9.57 / 9.14	8.92 / 7.01	7.63 / 8.75
Oil Consumption in Test litres	1.15	1.65	1.45	1.83	2.05
<b>ENGINE DYNO VALUES</b>					
Peak Power kW @ rpm	82 @ 8900 / 82 @ 8800	82 @ 8900 / 83 @ 8800	82 @ 8700 / 84 @ 8900	82 @ 8800 / 83 @ 8600	81 @ 8800 / 81 @ 8700
*** Peak Torque Nm	101 / 102	103 / 102	103 / 104	102 / 104	99 / 100

\* PQ (iron particles present), with total iron, indicates type of wear. \*\* Total Base Number is measure of acid-neutralizing property. \*\*\* Because torque curve is so flat from about 3500-8500 rpm, the rpm for peak is almost a matter of chance. To avoid confusion it is omitted. © Motor-Press Verlag, GmbH, Stuttgart.

Care has to be taken when interpreting changes in the parameters after the oil has done its work. For example, some oils may contain lighter components that evaporate off during use. Apart from losing oil through burn-off, this can be a reason for apparent oil consumption – and the need to top up. On the other hand, base oils and/or viscosity-index enhancers can be sheared into less viscous components. So, the oil can either decrease or increase viscosity. When it comes to other additives, they may break down but the components that are analysed remain in the oil. They can accumulate when the oil is topped up.

When it comes to the laboratory analyses after use, it is striking that “... *from almost all criteria for wear and ageing there are only trivial differences between the various test-results.*” Through use, the viscosity of the mineral-based Motul 3000 and the semi-synthetic Liqui-Moly Racing 4T did increase slightly. From ‘new values’, there was little change in the Hein Gericke 4-Stroke oil and High Tech Star motor oil. The synthetic Castrol RS-4T, however, lost a little viscosity. Whatever these changes, they affected the ‘cold’ and ‘hot’ ratings to a similar extent, because the Viscosity Indices stayed more or less the same during the recommended oil-change period. Sufficient temperature stability seems assured in all oils. Although the shear-stability of the cheaper oils was perhaps less than that of others, there was no unfavourable thickening of the oil when cold and no overt thinning when hot. The losses of viscosity seen by John Woolum were *not* seen here in this detailed test. This can have two causes. Woolum’s private study was not so ‘scientific’ and controlled as that by the motorcycle magazine. Then, there is about 10 years between the two studies. We already noted that the 1990s were very dynamic in respect to oil technology. It is conceivable that the oils recently tested are of a much higher quality than the earlier ones. Although the increasing availability of synthetic components can make the oils more resistant to thermal breakdown and mechanical shearing, mineral oils could also benefit from improved distillation and purification techniques.

Some commentators would take the differences in oil consumption as indicators of quality. Over 6’150 km, 1.15 litres of the expensive Castrol used (costing 12.49 Euros), whereas 2.05 litres of the cheapest supermarket High Tech Star oil was used. This cost 2.71 Euros. Other commentators would take this price difference as a sign of quality!

Engine lubrication experts were called in to assess these data and those on the wear-and-tear evidence. They confirmed the view of the authors. All the minor changes in engine dyno-performance could be put down to test variations. Then, no wear-and-tear measure on the oils themselves and the engine were seen to be critical and virtually none were indicative that the oils had reached any limits during use. To quote: “*Every test-oil passed the long-term demands without problem.*” Nonetheless, it is worth recording the key-word summary of the performance given by *Das Motorrad*.

Castrol RS-4T:

All values harmless. High Viscosity Index reflects high temperature stability. Smaller TBN reduction in spite of lowest oil consumption of all test-oils – also with lowest increase in calcium. After the test-period it remained closest to fresh oil.

Liqui-Moly Racing 4T	Marked increase in viscosity and marked decrease in TBN-values – though both fully harmless. Big increase in calcium values – coming from, amongst other reasons, the high oil consumption. The relatively high Viscosity Index indicates a high temperature stability.
Motul 3000	All laboratory values – apart from the inexplicable PQ Index and sodium value in the fresh oil – unremarkable. The viscosity increase at 100°C is within bounds. Positive, relatively low oil consumption – and only slight fall in TBN values
Hein Gericke 4-Stroke	Relatively large increase in calcium values, together with the relatively constant viscosity, point to only a moderate shear stability. In spite of relatively high oil consumption, the TBN values sink strongly. However, these changes are nonetheless harmless
High Tech Star Engine Oil	Relatively large increase in calcium values, together with the relatively constant viscosity, point to only a moderate shear stability. The fully unusual increase in TBN values – that were low in the fresh oil – is connected with the high oil consumption.

How did *Das Motorrad* view the results overall? The last two paragraphs of the report provide a condensed opinion.

*“Specialists nonetheless note fine differences. For example, in the long-term elevated calcium levels can lead to calcified deposits in the engine and, therefore, greater wear. Overall, the expensive Castrol lost fewest of its (original) properties – though no doubt it had reserves that it didn’t even have to call upon. If the comparison had been in extreme conditions on the race-track, perhaps the differences would have been greater.*

*For use on normal roads, though, there is the important conclusion: with correct oil changes, quite ordinary mineral oils with the recommended API classification are completely acceptable. Even the higher consumption of the cheapest oil does not justify the use of the expensive oil. Then, with every oil-change, the rider saves 43 Euros – and with that buy enough gasoline to make an extra tour.”*

### 13. OIL SUPPLEMENTS

Finally, there is the question of oil supplements. Although they are often called ‘additives’, I call them ‘supplements’ to distinguish them from the additive package that already comes in the oil. They are the products that you just *have* to add to your already additive-laden oil – so “they” say if you love your m/c and wish it long life and a prosperous performance. The advertising for these seems even more aggressive and strident than for the oils themselves. To pre-empt the issue a little, personally I would *never* add one of these to my engine oil!

I already referred to the magic formulae propagated by the giant oil companies – about the miraculous properties of *their* potions. Well, some tin-pot little entrepreneurs reckon *they* have found magic spells that even the giants – oil firms and m/c manufacturers - have not discovered or are not prepared to include and/or recommend for their products. Nonsense! This is the same as saying that these companies are technically incompetent and/or commercially stupid. (This is very different from companies trying to sell something luxurious that exceeds your needs. They would not, dare not, recommend a formulation that could damage your vehicle.) Although written nearly 10 years ago in the 1992 American *Road Rider* magazine, an article by a long-service Gold Wing rider, Fred Rau, is still valid. Background information for the article was obtained from many of the country’s leading research centres, chemical companies, university engineering departments and NASA. It was titled, “*Snake Oil! Is That Additive Really a Negative?*” Fred and *Road Rider* identified four classes of supplements.

- 1) Those that contain PTFE (Teflon – polytetrafluoroethylene) suspended in standard motor oil.
- 2) Again in a standard engine oil, high concentrations of zinc dialkylthiophosphate – an anti-wear agent.
- 3) Standard engine oils with a typical list of additives found in most oils – but in different amounts to that put in by manufacturers.
- 4) Products made up mainly of solvents and/or detergents.

### 13.1 Supplement 1

A typical PTFE-containing product is Slick-50. None of the authoritative sources asked had anything good to say about Teflon-containing products. They had found either no benefit or damaging effects. To understand how this can be, you have to realise that Teflon is an insoluble substance. It is added as a very fine powder. It is supposed to coat metal surfaces with Teflon – just like Mum’s frying pan - to stop parts sticking. How fine is fine? If the suspended powder is too coarse, it will get taken out during the first oil-filter pass – so your money sticks there and degrades the basic function of the filter within minutes. If it is a bit finer it may pass through the filter during those early cold-oil passes. However, as it warms up Teflon swells. If it does this before it gets back to the filter it may restrict or even block some oil galleys. That would starve some engine parts and cause excessive wear. Let us assume, though, that some does get through and does indeed coat those moving parts. Yes, it will reduce friction, lower the energy losses caused by friction and deliver faintly detectable improvements in power. It is also clear that the Teflon has to break down some time. When it does it can form hydrofluoric acid – one of the most corrosive chemicals known. (I should know. 40 years ago I had a lab accident involving this acid!) What that could do to any engine is anyone’s guess. So, those trivial effects would be obtained against a background of long-term damage to the engine because of a compromised lubrication.

### 13.2 Supplement 2

Typical of the second class of supplements is STP/XEP2 with high levels of that zinc compound. As noted, this is already added to standard oils as an anti-wear agent, being a last ditch protection against melt-down and seizure when metal contacts metal in extreme perf-

ormance conditions. Now be honest! How often do you spend a weekend red-lining your bike for hours on end at Donington Park or Daytona race track? If it is not very often, your money may be contributing to deposits on your plugs and valves and slowly degrading any catalytic converter you may have.

Fred Rau drew attention to one aspect of such additives and those that consist of a different cocktail of the additives already in a standard oil. These standard packages have been carefully balanced out to produce a certain type of function and/or protection. Some of the ingredients may interact with each other, synergistically having better effects than each alone. However, upsetting that balance by adding more of one may destroy that useful interaction and cause more harm than good. He made the analogy of a recipe for a super cake – a recipe that amongst its many ingredients calls for two eggs. It would be a grave mistake to think that adding four eggs would make a better cake. The imbalance could ruin the whole thing. More is *not* necessarily better.

### 13.3 Supplement 3

The last type of supplement has been around a long time, but still finds its supporters. It, too, contains elements that are already in standard oils – such as paraffin, acetone, naphthalene, detergents – to ‘clean up’ your engine. In principle, these supplements do the reverse of Teflon- and zinc-containing supplements that aim at coating engine parts with something. The ‘cleaners’ aim at removing such coatings – such as carbon and other deposits. These might have had some uses in the 50s and 60s when engine design and fuel or oil quality was not up to today’s standards, but now they are pretty irrelevant – except for their possible negative effects. If the detergent action is too strong, it may actually wash the proper oil film off the moving engine parts and so stop it lubricating. *Not* very good for the life of an engine! Maybe you have experienced this effect when trying to wax your bike when it is covered with a film of detergent shampoo. It doesn’t!

The article concludes by noting the incredibly high prices for these supplements. As to their effectiveness, it seems that in the few cases where no damaging effects were shown, no positive effects came to light either. It again repeats a theme already addressed – the psychological placebo effect. We want the very best for our m/cs and, if we pay mega-money for something, then “... *it d ... d ... does bring a b ... b ... benefit ...doesn’t it, Mummy?*” I would add another aspect – the ‘guru’ syndrome. This semi-religious syndrome seems to affect m/cyclists quite badly. First of all, they do tend to see themselves as being apart from ‘other’, non-m/cycling people (that is, self-discriminating!). Obviously, then, their m/cs are something special. This could make them susceptible to all sorts of gurus, witch-doctors and quacks – the sort that have been to the edge (of mechanical mayhem) but, having discovered the Elixir of Life, have come back to spread the Gospel to The Unenlightened. Why give your money to a sect when you can spend it on these products. By touching the robes of prophets, converted m/cyclists can then feel smug and content that they know just a little bit more than their fellow riders, the oil companies and the manufacturers of their m/c – even if they are killing it with love.

#### 14. FACTORS THAT COULD INFLUENCE MY OIL CHOICE

So, it is time for me to collect my thoughts together about engine oils – and what I have learned in this exploration - before going on to deal with one last issue relating to motor oils.

- 1) In respect to operating temperatures and engine speeds for developing peak power and torque, with the exception of high-performance sports m/cs, there are few functional differences between modern liquid-cooled m/cs and middle-class car engines.
- 2) The majority of modern m/cs differ from cars in that engine oil also lubricates the primary transmission (clutch and gearbox).
- 3) Of the seven different Owner’s Handbooks available to me, all of them basically recommend only a particular SAE rating and API performance standard for the engine oil. None recommends or rejects mineral- or synthetic-based oils. Neither do they demand only oils specially formulated for m/cs.
- 4) Current API performance standards make no distinction between oils having a mineral or synthetic base. These standards refer to the performance of oils in the engine, not in the transmission or clutch.
- 5) In respect to additives, newer automobile oils labeled as containing friction modifiers or being ‘Energy Conserving’ may be unsuitable for the wet clutches of m/cs and/or moving engine parts subject to high loads. Friction modifiers *may* cause clutch slip. Eco-friendly, extra-low levels of zinc and phosphorus may increase wear on, for example, high-performance cams and high-load bearings. On the other hand, racing oils with high anti-wear levels of zinc and phosphorus may not be good for modern m/cs fitted with catalytic converters and may lead to engine deposits after long-term use.
- 6) The anecdotal evidence of other riders and/or world champions in bar-bull is worthless. Testimonials from racers are also worthless because you would be ill-advised to use race-oil in a road-bike – and you do not know if the oil used is the one you buy.
- 7) Backyard scientific analyses – “my oil looks as new, so there is no need to change it”- are also worthless. Keen senses can detect burn products, gasoline and coolant in oil. However, they do not detect shearing and loss of viscosity. (Stand up all those that can immediately tell a 0W-30 oil from a 20W-50!)
- 8) Oil companies make assertions about the performance of their m/c products. If they have evidence that these assertions are true, it is not published.
- 9) In respect to costs, oils with a mineral base are the cheapest. Synthetic base-oil products are the most expensive, both for automobile and m/c oils. Oils specifically designated for m/cs are more expensive than automobile oils having the same base oils, SAE viscosity rating and API standard.
- 10) Only three studies on the performance of various oils in m/cs were identified. These were *not* published by oil companies. One (1994) was the result of small-scale private research on viscosity changes. Another (2001) examined engine power performance with various oils. The third (2002) was from the

same large m/c magazine as the second. It also measured power, but its main aim was to test extensively the ‘on-the-road’ performances of synthetic-, semi-synthetic- and mineral-based oils sold for use either in m/cs, automobiles or ‘engines’.

- 11) The private research suggested that m/c engines, with wet clutches, do indeed cause more viscosity loss to engine oils than automobile engines with dry clutches. However, in m/cs, oils specifically designated for m/cs are *more* susceptible to this viscosity loss than oils recommended for automobiles, according to this study. In a later, more complete test no relevant changes in viscosity were detected in five motorcycle oils.
- 12) Synthetic base oils are more uniform, more thermally stable, more shear-stable and more expensive than mineral base oils. At the end of the oil-change interval, they retained their properties better than other oils.
- 13) Irrespective of the oil studied – synthetic- semi-synthetic- or mineral based, designated for m/cs or automobiles – no significant differences in engine wear could be detected. At the end of the test-periods, all used oils still retained the properties necessary for satisfactory lubrication, though the synthetic-based m/c oil was best.
- 14) Apart from the restrictions noted, no convincing evidence could be found that m/c-specific engine oils are actually superior to automobile oils with correct SAE and API ratings. Synthetic-, semi-synthetic- or mineral-based m/c oils are not worse than each other – at the time of recommended oil changes.
- 15) The pattern of riding by the owner may cause more engine wear than a slightly incorrect choice of oil. Short rides, frequent stops and starts, particularly in cold weather or frequently bouncing off the red-line/rev-limiter are not good for any engine whatever its oil.
- 16) A choice of oil is only relevant if you do your own servicing. A dealer will put in what he has, not an oil from the supermarket. (But you’d better check!)
- 17) A widespread recommendation is to run-in new engines with mineral-based engine oils before switching to any synthetic or semi-synthetic oil. The reason given is that mineral oils allow the greater wear needed for engines to ‘bed-in’. (This is an inexplicable contradiction because the available evidence is that mineral oils do not cause greater wear!)
- 18) With today’s oils it is no problem to mix various types, such as synthetic- with mineral-based. However, this should be done only temporarily because the mixed additive packages may not be fully compatible
- 19) There is no evidence to support the use of additional oil supplements/additives – but evidence that they can be harmful.
- 20) Informed professional opinion, independent of oil companies, does not state that this or that type of oil *must* be used, except for it having the recommended SAE and API specification. It does sometimes *advise* against using oils with certain additives. However, almost universally it insists that regular oil and oil filter changes should be made.

### 15. IN FOR A PENNY, IN FOR A POUND? – OR – PENNY WISE, POUND FOOLISH?

When choosing the oil for your m/c, what are your priorities? Do you want to save money or do you want the very best for your motorcycle? Let us take the first issue – saving money. The first way of saving money is to stretch out the oil change intervals. If someone is already using a car oil, the thinking might go like this. My new car handbook recommends oil changes every 15’000 miles with that oil. Now, that car oil worked well in the m/c on the 8’000 mile schedule, so if it’s being advocated for 15’000 miles, then I can switch to that. Right? Wrong! It might not be that the oil has got better, just the car. What retained sufficient performance for 8’000 m/c-miles may not be good enough for 15’000. Don’t be greedy! You are saving on the car oil.

But let’s get back to that average rider – like you or I - with an average riding style (interpret that as you will!), an average mileage of 8-10’000 miles a year and having a winter break of a couple of months. Ignore things like road tax, insurance, Channel ferry charges, road tolls in Europe, workshop charges if the rider doesn’t do his own routine maintenance. Let us look just at the seasonal material costs. Do you have paper and pencil ready?

You know the average fuel consumption of your bike. Let’s say it is 40 mpg (Imperial gallons). That means you use 250 gallons of fuel. From current fuel prices you can easily calculate and note down the annual fuel bill. About every second year you will need a set of tyres – so add half its price to your list of annual expenses. If you are conscientious, you will change the brake fluid and fork oil every 2 years, maybe the brake pads as well. Note down half the cost of all these. Then, you will need two oil changes with filters. Add the cost of filters to the list. What is the intermediate total so far?

Most m/cs will need about 7-8 litres of engine oil per year, without any topping up. Just considering m/c-specific oil, a quick look at M & P’s 2001 UK mail-order catalogue – and excluding oils specified for racing - reveals the following prices for 2 x 4 liter cans. At £27.50, the cheapest oil is the Silkolene Super 4 10W-40 – “*a top-quality mineral-based multi-grade suitable for use in all modern 4-stroke motorcycles. Certified JASO MA*”. The most expensive is Castrol R4 Superbike 5W-40 – “*an advanced, fully synthetic 4-stroke engine oil. It’s unique formula increases both engine power and acceleration whilst providing complete engine protection, outstanding oil consumption control and wet clutch performance, API SG, JASO MA*” - at £63.

So, using the Silkolene oil instead of the thinner Castrol would about halve your oil bill. What if, instead of the cheaper Silkolene, you used BP or Mobil automobile oil (assuming these do not contain friction modifiers) instead of a m/c-specific oil? Because I don’t know your local prices I’ll leave that one to you. When you have done that, you have got your list of annual overheads – so, on to my final question on oil economics. What, *relative to your overall annual material costs*, could you save if you chose:

- a) this or that m/c-specific oil,
- b) an oil designed for automobiles or

- c) to stretch recommended oil-change intervals because you reckon oils are better today than yesterday.

Guessing that oil costs are a trivial part of the total I suggest that you would save bugger all – because, even by my maths, half of bugger all is still bugger all. O.K., you may think that every penny saved is wise. However, one must place a cost on the consequences of a mistaken choice.

When it comes to avoiding a rude shock, here I recall that advice coming *invariably* comes from tuning experts, engine builders and very experienced mechanics. It is independent of the oil you actually use. They say that the very best thing for protecting your engine against wear is to abide by the manufacturers’ recommended oil-change intervals. The second best thing they recommend? Change the oil even more frequently! This is clearly illustrated by an article in the December 2001 issue of the AMA *American Motorcyclist*. Entitled “*The Long Haul: How to Ride It (Almost) for Ever*”, it reported on riders that have more than 100’000, 200’000, even 300’000 miles on the clock. What are the primary words of advice on achieving this? “Change your oil often.”!

## 16. OUR MOTORCYCLES AND OUR OILS

So, the central issue is that the choice of oil finally depends only on what is best for your m/c. Because the best isn’t necessarily the most expensive, you can still include a cheaper ‘Best Buy’ in that choice. Only *you* can decide that on the basis of the m/c you ride and the way you ride and maintain it. I just tried to point out the sorts of questions you should be asking yourself – and why. However, at this point I confess that I have deceived you. I purposely made the same mistake as many do. I immediately jumped in to answering questions, solving problems, raised by the advertising of oil companies and by the views of our mates. I did not ask the basic, Number 1 question: “*Do I have actually have a problem to solve?*” The answer to *that* question starts with Table 6. (I should have started - and ended! - with this table – but then I wouldn’t have been able to bore you so long, would I?)

My brother, wife and I own or have owned all the m/cs listed in Table 6 during the last 20 years. The list suggests that we have a certain confidence in Honda and its ability to build m/cs. That being said, it would seem a little perverse to act as if Honda didn’t know what oils to recommend for its machines. Those oil recommendations listed all originate from official Honda work-shop manuals. The ones for the GL1000 are the most detailed. Indeed, taking Honda’s recommendations for the GL1000 literally, one *could* use a supermarket ‘motor oil’ if it had the correct SAE and API designations.

Earlier we saw that current API service classifications include the required specifications from previous standards. Therefore, all of these machines will be happy with the highest API classification listed, that is, SG. As to multi-grade viscosity, although a couple of recommendations call for the slightly thinner 10W-30, all of these machines could accept SAE 10W-40. Further, Honda say nothing about whether the oil should be mineral-, semi-

<b>TABLE 6:</b>				
<b>HONDA OFFICIAL WORKSHOP MANUAL RECOMMENDATIONS FOR OIL</b>				
<b>Model &amp; Configuration</b>	<b>Year</b>	<b>Honda Recommendation</b>	<b>SAE Rating</b>	<b>API Class</b>
<b>GL 1000 K1</b> Liquid cooled Flat four-cylinder	1976	Hondaline oil or <i>equivalent</i> . High detergent, premium quality <i>motor oil</i> meeting or exceeding US <i>automobile</i> requirements for API service classification. Non-detergent, vegetable or castor-based racing oils are <i>not</i> recommended	10W-40 20W-50 (others according to local climate)	SE
<b>CB 750 K6 Four</b> Air-cooled In-line four-cylinder*	1976	Hondaline oil or <i>equivalent</i> . High detergent, premium quality <i>motor oil</i> meeting or exceeding US <i>automobile</i> requirements for API service classification.	As Above	As above
<b>CBX 1000Z</b> Air-cooled In-line six-cylinder	1978	Honda 4-stroke or <i>equivalent</i> .	10W-40	As above
<b>CM 125C</b> Air-cooled Parallel twin cylinder	1982	As Above	As Above	SE or SF
<b>CB 250RS</b> Air-cooled Single cylinder	1982	As Above	10W-30	As above
<b>GL 1100</b> Liquid-cooled Flat four-cylinder	1982	As Above	10W-40	As above
<b>GL 650</b> Liquid cooled Flat four-cylinder	1983	As Above	As Above	As above
<b>GL 1200</b> Liquid cooled Flat four-cylinder	1987	As Above	As Above	As above
<b>CB 450N</b> Air-cooled Parallel twin-cylinder	1988	As Above	As Above	As above
<b>CB 500R</b> Liquid cooled Parallel twin-cylinder	1994	As Above	10W-30	SE, SF or SG
<b>GL 1500</b> Liquid cooled Flat six-cylinder	1998	As Above	10W-40	SF or SG
<b>VFR 800Fi</b> Liquid-cooled V four-cylinder	2000	Only high detergent quality <i>motor oil</i> meeting or exceeding API Classification. Base the viscosity grade on local average temperatures.	10W-40 20W-50 (others according to local climate)	SE, SF or SG
Note 1: The italic emphases are added				
Note 2: Not one recommendation (1976-1998) mentions mineral or synthetic bases.				
* This has a dry sump. All others have a wet sump.				

synthetic- or synthetic-based. All they say is that it should be a detergent-containing oil that reaches or surpasses a certain U.S. automobile API classification. Not a word about it being specially formulated for m/cs.

Typically, Honda recommends its own Hondaline range of oils (though I know no one who uses them!). Just to check whether there are signs of Honda reacting to the many developments made by the oil companies themselves, I looked up the oils in the Hondaline range ([www.hondamotorcycles.com](http://www.hondamotorcycles.com)). Two types are on offer in the year 2002 – the mineral-based Pro-Honda GN4 and the semi-synthetic Pro-Honda HP4 multi-grade oils, both available either as SAE 10W-40 or 20W-40. All of them meet the API service classification SF/SG. Perhaps I am sticking my head in the sand, but somehow I trust Honda to know what is best for its motorcycles. Honda has more to lose by proposing the use of an inadequate lubricant than an oil company has to gain by offering excesses. Honda seems content with mineral- or semi-synthetic based oils meeting a functional standard (SF/SG) set in 1988/1993.

So, if an oil is an SAE 10W-40 multi-grade belonging to the API class SF or SG, it will suit *all* machines listed in Table 6 (and 2002 models), according to Honda. These ‘old’ machines vary from a lowly 125 cc beginner’s machine that pours out a stunning 13 hp at 4’800 rpm to a 1047 cc hyper-sports machine that red-lines at 10’500 rpm and produces a peak 105 hp at 9’000 rpm. In between are tourers and sports-tourers. Their ages stretch back over more than 20 years. From us they all get the same oil – and nothing else. Until last year this was the mineral-based *Elf 1 Moto DX Ratio (anti-clutch-slippage), SAE 20W-50, API SF*.

Yes, it *is* an oil specifically formulated for m/cs – but why the brand Elf? Simple! Because our dealer used it – and we are lazy. We are too lazy to do our own servicing, particularly when the weather is good enough for working on the bikes it is also good enough for riding. Yes, it *is* a bit on the thick SAE-side for winter riding but in Switzerland there is not much of that. In any case, our m/cs are garaged, not being exposed to winter chills. Certainly there is no need to change the oil for a thinner grade when (if!) summer comes. Yes, it *is* more expensive than 10W-40 mineral-based automobile oil, but the difference is a trivial part of our overall costs. And did it protect our bikes? Well, we can only assume so. A few years ago I imagined that the GL 1200 was beginning to sound like a bag of old nails – and that after only 107’000 hard mountain and motorway miles (172’000 km) since we got it new. (Why is another story. However, from Day 1 I religiously followed Honda’s service schedules and practiced correct winter lay-up procedures.) So, during one of those winters, I had my dealer look for those nails – to do a re-build. Apart from some light blow-by burns in the pots, everything – valve-train, crank, gear-box - looked like it had come straight off the shelf. (That’s an expensive imagination I’ve got! Why is another story.) It now has 217’000 km (135’000 mi.) on the clock, so the mineral oil it had couldn’t have been bad, could it?

Ah! But did you notice that I said this was the oil we *did* use – until last year? So what has changed? Quite simply, my dealer has changed the oil he stocks. I have over 17 years of experience - and trust - with my dealer. If he has a reason to change, who am I to argue? The reason for change was quite simple. Hans, my dealer runs a racing/tuning shop. Last year he was on the track with tuned Honda Fireblades. In rapid succession two engines

blew up – with capital head damage that could be only due to lubrication failure. Hans had reached a performance limit of that oil. The problem did not occur after upgrading the oil. Now, I have no immediate plans to match our GL1200 against Fireblades, not even the CBX 1000Z. However, we now know (or Hans knows from bitter, expensive experience) that the limit of that mineral-based oil can be reached. Therefore we are willing to pay that little bit extra for our oil and so extend the reserve envelope in our less than sporty m/cs. So from now on we are using Elf Moto 4 Eco – as used in Hans’ Fireblades. To quote the blurb, this is a: *“Special motorcycle lubricant, reinforced with synthetic base oils. Its new generation formulation incorporates anti-clutch-slip technology with improved lubrication performance. Specification: JASO MA, API SG, anti-clutch slippage, superior friction properties, 10W-40.”*

## 17. MOTORCYCLE OIL STANDARDS

But! But ... times are changing, so are technologies and knowledge. Yardsticks used before may not apply in the future. That API SF standard is for engines from 1980-88. Therefore, in 2002 it is a 20-year old standard. That private research by John Woolum was conducted over 10 years ago using oils that, at the most, met that 1980-87 standard. However, in this time other standards have changed. Those of engine design and construction, of its materials, of its operating conditions have all marched on since then. These developments were pursued either in their own right or in response to environmental pressures.

Engine oil, either directly or indirectly through its interaction with engine function, contributes to environmental emissions. These change, too. Oil companies are now better able to ‘design’ components that serve new demands and functions. They can design synthetic base-oil components having higher Viscosity Indices and shear-resistance (in the gearbox) than of old. This reduces the quantity of viscosity enhancers required to make multi-grade oils. This prevents an oil quickly ‘falling out of grade’. Additives necessary for certain protections are better understood now, and can be chosen for a particular application. Instead of having just ‘engine oil’, we now have oils designed for more specific functions. It might be that the old API SG category is the last one that can be used for *any* automotive application, in spite of what API claims. Engine oil is no longer engine oil.

Traditional oils met the needs of traditional owners and traditional engines. They still meet the needs of conventional riders and machines. Modern oils seem to offer more reserves – that may not be necessary. However, modern road machines are much more highly developed than before. Advances have been made in the materials used. Environmental issues have become prominent – and the role of lubricants can’t be forgotten in this context.<sup>1</sup> The evidence shows that mineral-based traditional oils still do a good job at a reasonable price. More expensive, modern m/c-specific oils just seem to do a better one.

---

<sup>1</sup> More efficient lubrication lowers power losses – so fuel consumption improves. Better wear-protection makes engines last longer – there is less scrap metal to be recycled. Lower oil consumption and better and/or fewer additives mean less pollution – from burned oil or wastes. More constant formulations not only give more constant lubrication properties – they make oil recycling easier.

These developments were recognized by the major automotive manufacturing nation, Japan. You may have noticed in some oil descriptions above that I listed but didn’t comment on a so-called JASO specification. Well, the JASO MA classification for m/cs originates from the Japanese Automotive Standards Organization – again a body made up from government, national vehicle makers and oil producers. In 1994, it was recognized that Japan, as a leading m/c manufacturer, had no national standards for m/c engine oils. During 1998 such standards were developed. Special attention was paid to the issue of new oils - with lower friction and viscosities for greater fuel economy – that cause clutch slip, valve-train and transmission wear. Test procedures and standards addressing these issues were established in 1998. Guidelines were published in 1999 and last revised in September, 2001.

In the classification code, MA, the ‘M’ denotes that the oil is designed for m/c use. The ‘A’ shows that it meets the JASO test limits for clutch slippage – better said, a lack of it. To start with, though, the oil must meet other international standards such as API (SE, SF, SG, SH or SJ) or those of other test agencies (e.g. ACEA, ILSAC or CCMC). Because the JASO standards are relatively new, not many m/c oils have been submitted for testing. Just because an oil carries no JASO designation does not say anything about its clutch-slip properties. Manufacturers would see no need to test automobile oils for m/c use, even though they could be used there. Currently, SAE and API certification are considered obligatory, the JASO not. So, even a m/c-specific product need not be tested – yet still be good.

## 18. MY CONCLUSIONS AT THE BEGINNING OF 2002

Earlier I summarized the findings of my investigation – 20 points in all. Overall, I have no problem in accepting that modern synthetic-based m/c oils are superior to part-synthetic-based oils, with both of them being better than the traditional mineral-based oils. Also, oils passing the new, 2001 JASO MA certification are proven to be acceptable in motor-cycles with wet clutches. This is *not* saying that traditional m/c oils or oils for automobiles are or have become bad. Indeed, the engines of our own machines – listed in Table 6, with the oil specifications recommended by Honda – were designed on the basis of those traditional engine oils. Here, the API classifications originate from the late 1970s, early 80s. Into the second millennium they have served our machines well. A conservative attitude would say that what you know is what you can trust.

On the other hand, anyone would be foolish not to use the best oil that he/she could afford. Some ‘small-budget’ riders may have to count every penny. For them, even though the costs of oil are a relatively small part of overall running costs, that affordable oil may not be the best according to manufacturers’ claims or the available evidence. Traditional mineral-based oils seem to be perfectly adequate. Indeed, so long as they contain no friction-reducing additives, there is no evidence that automobile oils would be harmful. However, it doesn’t matter whether budget oils or top-of-the-market oils are used, the greatest mistake would be to default on correct oil-change intervals.

If you have read so far, you may put on a quizzical face when I say that the choice of oil is relatively simple. You *need* the SAE-rating and the API classification recommended by the m/c manufacturer – which should protect the engine of that m/c in normal use. You need no friction reducers – which could impair wet-clutch operation. Anything else is a matter of what you *want*. If you want economy, that will influence your choice amongst the oils that satisfy your needs. If you want reserves in performance and protection – reserves that you do not throw away again by not keeping to oil-change schedules – then you would consider synthetic-based oils rather than mineral-based automobile oils. If you wanted an oil that met every known standard, then you would look for a JASO certification. This you would not find on a supermarket automobile oil. Indeed, you may not find it on a top-line m/c oil. Such certification costs money and not even every m/c oil supplier is prepared to pay that. The extensive foregoing text was not trying to say that the choice is complicated. It was trying to give the background to those straightforward choice factors.

With Table 6 and the discussion about it, we illustrated our choice up to last year. Since the early 1980s and until recently we have run Honda m/cs ranging from lightweight commuters to out-and-out sports machines. They have all been lubricated according to Honda’s recommendations. There was cause to open up only one of them – a GL1200 after way more than 160’000 km (100’000 miles). There were no signs of wear in the valve train or gearbox. As technology advanced and new oils came on to the market, those machines did not suddenly start to die like mechanical flies. Manufacturers’ claims about the new oil products were made, but evidence was not provided to show that they do indeed perform better than traditional oils - when service schedules were followed. The evidence, such as it is, was provided by others. The oil companies can’t dispute that evidence – without producing their own. The only *technical* evidence on a can of oil is the SAE rating, the API classification and, sometimes, the JASO certification. Advertising claims are *not* evidence. So, without further *technical* evidence, there is no technical reason to use these new oils instead of others that have exactly the same ratings, classifications and/or certifications.

There could be a *psychological* reason for change, though – and that is the one addressed by the ad-men. Our choice was based on those three needs – having the recommended SAE viscosity rating, meeting the required API performance standard and having no friction-reducers. We wanted a m/c-specific oil. We wanted some ‘reserves’ in the oil, where normal use did not reduce its quality to a lower limit within the usual oil-change interval. We did not want to pay for anything we did not want. Therefore we were satisfied with a traditional mineral-based m/c oil. As to those performance reserves, they may still be there for our street machines, but with problems arising in extreme situations (those Fireblades on the track), *some* limitations have shown up. That was a big enough psychological reason to follow our dealer and to upgrade our oil by two levels – to a semi-synthetic oil with a JASO MA certification. With the extra cost being a minor part of running and caring for those loved ones – correct servicing, fuel costs, wear-and-tear items such as tyres, brakes, etc. – *we* find the choice justified. (As did acquiring a 60 litre drum of the stuff at discount prices.) As in everything – youse pays yer money, an’ yer takes yer choice!

19. EPILOGUE

So, dearly beloved, having begun, now I will end my Jungle Stories - about “How The Engine Gets Its Oil”. It is a jungle tangled with conflicting information, hysterical advertising and mythical bar-room ‘beasts’ that could eat up your m/c. Obviously this is not the definitive article on the subject. (If you know any better – and also care – please take the time and energy to share your knowledge with the rest of us. We all would profit.) Obviously I care. I care about our motorcycles. I care about yours. However, my greatest care is that you form your own opinion - make your own decisions. Perhaps this assembled information can help you. Paradoxically, that aspect of concern – your personal choice - is captured in a modified quote from Dan the Mechanic (<http://www.dansmc.com>).

WHATEVER IT IS,  
IF YOU DO, IT’S OK.  
IF YOU DON’T, IT’S O.K.  
I DON’T CARE.  
IT’S *NOT* MY BIKE!

© Trevor White 7<sup>th</sup> March 2002  
e-mail: TGWhite@compuserve.com  
CH-3173 Oberwangen

LITERATURE SOURCES

- Bell, A.G.** (1998), Four-Stroke Performance Tuning, 2<sup>nd</sup> edn.. 327 pp., Haynes Publishing, Yeovil, UK.
- Cameron, K.** (1998), Sportbike Performance Handbook, 176 pp., MBI Publishing, Osceola WI.
- Hartmann, J.** (1996), High Performance Automotive Fuels & Fluids. 128 pp., MBI Publishing, Osceola WI.
- Hertneck, H.** (2001), Kraftbrühe – mehr Leistung durch Öl?. *Das Motorrad*, 26, 123. (From the German - Power Brew – more power with oil?)
- Hertneck, H.** (2002), Ölkontrolle –Öllangzeittest. *Das Motorrad*, 5, 116-121. (From the German - Oil Control – A Long-term Oil Test)
- Mehl, B. & L. Oliver** (2001), The Long Haul: how to ride it (almost) forever. *American Motorcyclist*, December, 34-39.
- MCN** (2001), There’s Friction Between Them. *Motor Cycle News*, August 1<sup>st</sup>, 45.
- McoN** (1994), Motorcycle Oils vs. Automotive Oils. *Motorcycle Consumer News*, February, 1994. In: [www.ducatimeccanica.com/oil.html](http://www.ducatimeccanica.com/oil.html), see also [www.nightrider.com/biketech/oiltest1.htm](http://www.nightrider.com/biketech/oiltest1.htm)
- MMI** (1994), The Complete Guide to Motorcycle Mechanics. 378 pp, Prentice-Hall, Eaglewood Cliffs, NJ.

**Oltman, S.** (2000), Motorcycle Oil Standards – Finally! *Wing World*, September, 22-29.

**Rau, F.** (1992), Snake Oil! Is that additive really a negative? *Road Rider*, August.

([www.vtr.org/maintain/oil-additives.html](http://www.vtr.org/maintain/oil-additives.html))

**Shell Oils** (2001), *Biker's Bible*. 194 pp., Pecher & Böchmann, Essen, FRG.

### SOME WEB-SITES

ACEA (Association des Constructeurs Européens d'Automobile): [www.acea.be](http://www.acea.be)

Amsoil: [www.amsoil.com](http://www.amsoil.com) and [www.syntheticlubes.com/raceoils.html](http://www.syntheticlubes.com/raceoils.html)

API (American Petroleum Institute): [www.api.org](http://www.api.org)

Aral Oils: [www.aral-lubricants.com](http://www.aral-lubricants.com)

Bel-Ray: [www.belray.com](http://www.belray.com)

Dan the Mechanic: [www.dansmc.com/4STROKE\\_OIL.HTM](http://www.dansmc.com/4STROKE_OIL.HTM)

Elf Oils: [www.elf-lube.com](http://www.elf-lube.com), particularly <http://64.86.72.238:8214/en/file/part7/chap1/texte.htm> and particularly <http://64.86.72.238:8214/en/file/part5/chap1/texte.htm>

Hondaline: [www.hondaline.com](http://www.hondaline.com)

JASO (Japanese Automotive Standards Organisation): [www.jalos.or.jp/onfile/jaso\\_e.htm](http://www.jalos.or.jp/onfile/jaso_e.htm)

Mobil Oils: [www.mobil1.com/motorcycle/index.jsp](http://www.mobil1.com/motorcycle/index.jsp)

Motorcycle Performance Guide: [www.nightrider.com/biketech/oilinfo1.htm](http://www.nightrider.com/biketech/oilinfo1.htm)

Shell Oils: [www.shell.com](http://www.shell.com)

The Master Strategy Group: [www.msgroup.org](http://www.msgroup.org)

Vintage Triumph Register: [www.vtr.org/maintain/oil-overview.html](http://www.vtr.org/maintain/oil-overview.html)