THE EXPERT
STEWART SANDERSON

Having worked as a tuner for 17 years, Stewart 'Stu' Sanderson is one of the most-respected names in the business.

A Level 5-trained fuel-injection technician, Stu has worked for a Ford Rallye Sport dealer, a well-known fuel injection specialist and various tuning companies.

Eight years ago he joined forces with Kenny Walker and opened up Motorsport Developments near Blackpool (01253 508400, www.remapping.co.uk), specialising in engine management live remapping, as well as developing a range of Evolution chips which are now sold all over the world.

He is the creator and administrator of www.passionford.com, which he started in 2003. It has grown rapidly from a few friends contributing, to one of the biggest Ford communities on the web.

Stu's enviable knowledge of the workings of modern-day Ford performance engines means that every month he's just the man to explain how and why things work, and importantly how they can be improved.

THANKS
SIMON AND GUY AT OPIE OILS **WWW.OPIEOILS.CO.UK** FOR THEIR HELP WITH THIS ARTICLE.

TECH

ENGINE COOLING

PART TWO

THIS MONTH STU LOOKS AT THE ENGINE'S PRIMARY COOLING FLUID – OIL.

Cooling doesn't get much more extreme than this

I hope you all learnt a little about engine cooling from last month's article and are now fully conversant with all things relating to water-cooling your engine. This month I'd like to continue along the same sort of lines, but instead of water talk about the engine's primary cooling fluid, engine oil.

WHY USE OIL

The oil in your engine's sump is pumped around the engine with the intention that it will be found between any moving objects. Its purpose is to reach and stay between these moving objects to ensure that their surfaces never directly touch each other and cause wear or damage, even under extreme pressure.

Having oil between the moving parts offers various benefits, some more obvious than others. The engine oil drops friction which increases power, it cools the components down by removing heat, it prevents corrosion on all the bare metal parts in your engine and it also ensures that no metal to metal contact occurs, thus having a massive effect on engine longevity.

You may be surprised to know that it also cleans the engine of various contaminants. OK, some of you will say that the oil filter does that, but how do you think the dirt gets to the oil filter to start with? The oil took it there to be filtered. In many cases it was removed from the internal engine components by special chemicals within the oil designed to clean up the engine internally in a bid to enhance the oil's life by keeping it cleaner for longer.

"A MINERAL OIL BREAKS DOWN FAR FASTER THAN A SEMI OR FULLY SYNTHETIC."

DIFFERENT TYPES

We generally have mineral oil and semi/fully synthetic. It is worth knowing that there are actually different versions of these too. In an attempt to keep this reasonably simple let's just concentrate on the main ones.

Mineral oil

The most common and cheapest form is simple mineral oil. This is refined from good old petroleum, so you might say it is the more natural of the two oils. It tends to be the cheaper of the three types and the well-known brands where specified by the vehicle manufacturer should provide adequate protection for your engine under normal conditions, until the chemicals within it start to break down.

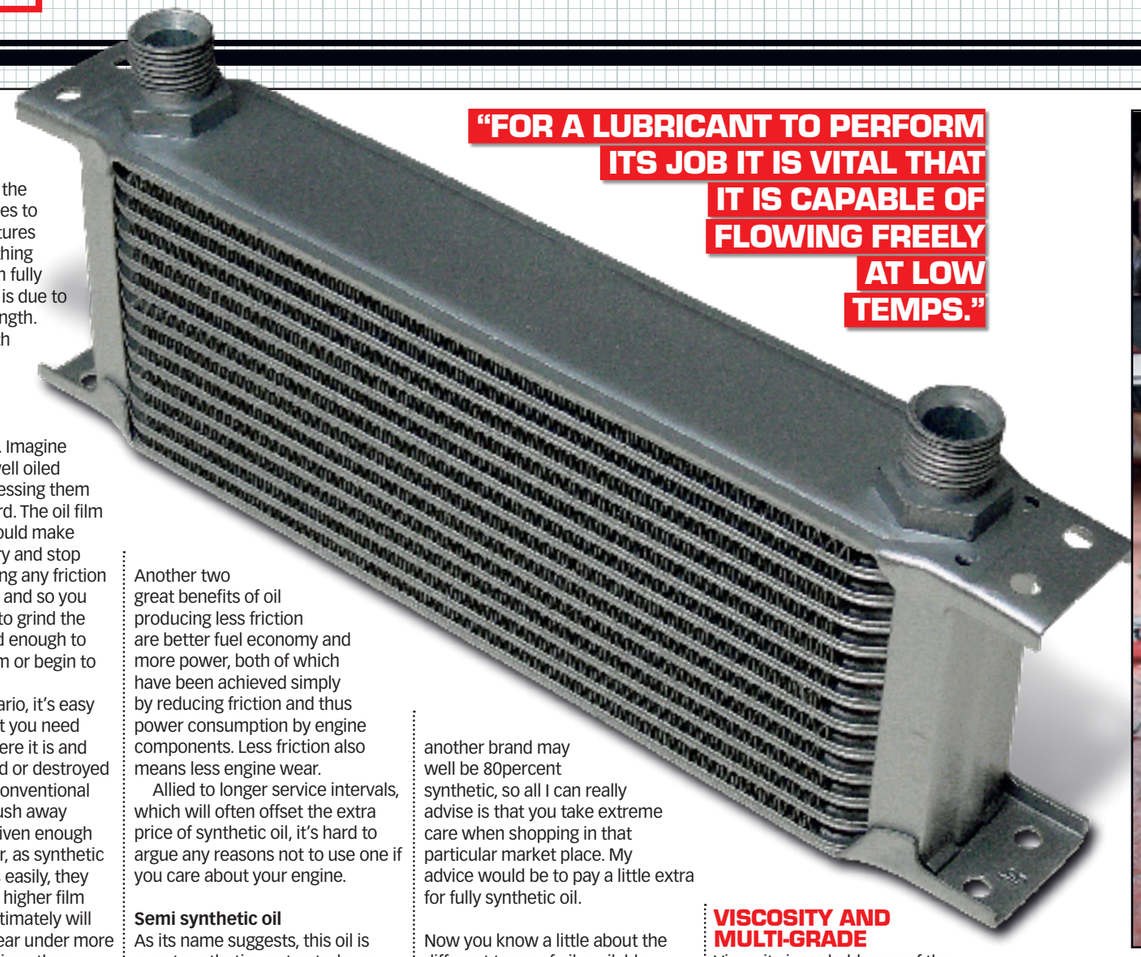
A mineral oil breaks down far faster than a semi or fully synthetic. Generally speaking it will also carry a few other negatives too. Not only do they break down easier under extreme pressure but they also overheat faster and don't last as long as synthetics under extreme use. Nor do they lubricate as well when the engine is cold. The protection from it is usually just adequate.

Synthetic Oil

These oils are state-of-the-art lubricants that are far more stable under extreme temperatures and load, while generating far less friction in operation than any mineral oil could ever dream of. This oil doesn't start to evaporate until it reaches a temperature greater than 600 degrees F, which is a whole lot more heat protection than its mineral cousin, which will normally start to evaporate somewhere around the 350 degrees F mark.

From a lubrication

There is a huge range of oil options available to you



"FOR A LUBRICANT TO PERFORM ITS JOB IT IS VITAL THAT IT IS CAPABLE OF FLOWING FREELY AT LOW TEMPS."

point of view you are dealing with the cream of the crop. When it comes to extreme temperatures and pressures nothing can beat a modern fully synthetic and this is due to its better film strength.

The film strength is the lubricant's amount of resistance to separating under extreme pressure. Imagine having two very well oiled metal bars and pressing them together really hard. The oil film on the surface should make them quite slippery and stop you from generating any friction from the pressure and so you should be unable to grind the bars together hard enough to actually mark them or begin to wear them out.

Given this scenario, it's easy to understand that you need that oil to stay where it is and not to be displaced or destroyed by the pressure. Conventional mineral oils will push away from each other given enough pressure. However, as synthetic oils don't shear as easily, they can maintain a far higher film strength, which ultimately will prevent engine wear under more demanding conditions than a mineral oil can ever claim.

Modern synthetics also tend to heat up less in the first place, potentially lowering your engine's temperature under extreme use, which is an excellent property to have.

Another two great benefits of oil producing less friction are better fuel economy and more power, both of which have been achieved simply by reducing friction and thus power consumption by engine components. Less friction also means less engine wear.

Allied to longer service intervals, which will often offset the extra price of synthetic oil, it's hard to argue any reasons not to use one if you care about your engine.

Semi synthetic oil

As its name suggests, this oil is a part synthetic, part petroleum base, and all brands differ in their effectiveness. We don't really have space to discuss the benefits of these oils and it would be quite hard to do so. An oil could be classed as semi synthetic if it is only 10percent synthetic, whereas another brand may well be 80percent synthetic, so all I can really advise is that you take extreme care when shopping in that particular market place. My advice would be to pay a little extra for fully synthetic oil.

Now you know a little about the different types of oil available, and you know why you need it, you just go and buy a can right? Wrong. Unfortunately, this is where it becomes more complex. You need to buy the correct viscosity oil, and it will almost certainly be a multi-grade.

VISCOSITY AND MULTI-GRADE

Viscosity is probably one of the most misunderstood aspects of engine oil yet it is undoubtedly the most important. Viscosity is a measure of the force required to shear (break down) the oil at certain speeds and temperatures. Oils only work as lubricants because they have viscosity, and it is the viscosity of the lubricating oil that protects our engine components when they are coated in the oil.

Do this regularly to increase the life expectancy of your engine

Multi-grade simply means that the oil in the can will conform to more than one viscosity rating depending on its temperature. You will usually see two numbers on the can. The first one will have a W next to it. The second number is always higher than the first and is commonly 30, 40, 50 or 60. The first and second numbers are not related as they are the results of different tests, as you will learn.

For a lubricant to perform its job it is vital that it is capable of flowing freely at low temperatures so that it gets around the engine in a fraction of a second at start-up, otherwise engine damage would occur. However, it also needs to be thick enough when hot to do the job of protecting an engine under full load. In order to achieve this, the chemists at the oil companies designed a lubricating oil that could vary in viscosity depending on temperature and called it a multi-grade.

To determine the different grades a low temperature test was introduced and its results were always marked with a 'w' (meaning winter). This rating indicated the oil's ability to flow at low temperatures, and lower meant better or nearer to water in layman's terms. So a 10w 50 will flow better cold than a 15w 50.

The second number is a rating from a very different test. This test results in what is known as the SAE (Society of Automotive Engineers) number and is measured in 'Centistokes' (CST) at 100 degrees C. Centistokes is the measure of a fluid's resistance to flow (viscosity). It is calculated in terms of the time required for a standard quantity of fluid at a certain temperature to flow through a standard orifice. The higher the value, the more viscous the fluid, but remember that thicker is not necessarily better even though it is commonly perceived to be. Also remember that the hotter the oil gets the less stable it becomes, with temperatures exceeding around 120 degrees C being a common degradation point in modern synthetics. Mineral oils can become unstable far earlier.

Taking this into consideration you should be able to see that when cold:
A 5w-40 will flow better than a 10w-40
A 10w-50 will flow better than a 15w-50
A 5w-40 is the same flow when cold as a 5w-30

When the engine oil is at full operating temperature:
A 10w-50 is thicker than a 10w-40
A 15w-50 is thicker than a 5w-40
A 0w-40 is the same thickness as a 10w-40

The original manufacturer of your engine is fully conversant with oil technology and will not have chosen oil for its engine that doesn't do the job. It will have specified the viscosities based on intended engine speeds, loads, oil pump capacities, manufacturing tolerances, ambient temperature conditions and a host of other things.

If the engine has been extensively modified, the operating conditions may well be outside the original design envelope. The stress on the oil caused by increased maximum revs, power output and temperature may indicate that oil of a different type and viscosity grade would be beneficial. Always tread carefully, especially if opting for a multi-grade that appears less viscous than the OE suggested one as this can affect hydraulic components such as followers, tensioners and valve timing controllers quite badly.

If you choose to use a higher viscosity oil than what is recommended, at the very least you are likely to reduce performance of the engine. Fuel economy will likely go down and engine performance will drop. In the winter months it is strongly recommended that you do not use a heavier grade oil than is recommended by the manufacturer. In cold start

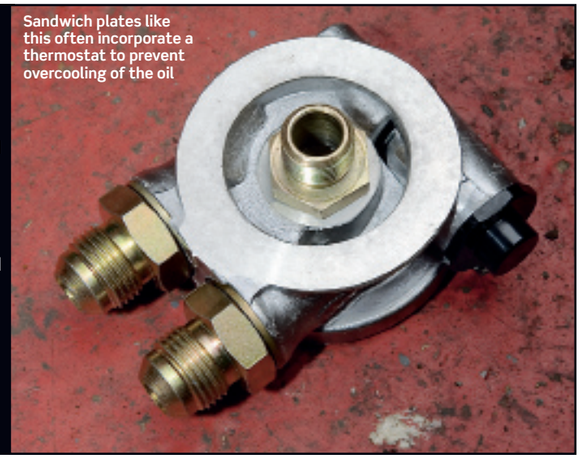
CONTROLLING THE OIL TEMP

The problem with fitting an oil cooler is that the oil will end up too cool if we are not generating enough power and heat to need one in the first place.

How do we stop the oil cooler from overcooling the oil when we are not using full power round a racetrack, and causing a need for more oil cooling? The answer is simple; get a system with a thermostat in it.

The thermostat is a simple valve in the sandwich plate that is controlled by temperature. When it senses that the oil behind it is getting to optimum temperature it opens and allows that oil to leave the engine and head down to the radiator to be cooled and allowed back into the engine to be heated again.

Conversely, when it senses the oil is too cold it will close and stop the oil flowing through the radiator to be cooled, directing it back out of the sandwich plate and into the engine. This allows an engine oil to get to full operating temp quickly, just like it did as standard, and ensure that no overcooling occurs.



Sandwich plates like this often incorporate a thermostat to prevent overcooling of the oil

conditions you could very well be causing more engine wear than when using a lighter viscosity oil.

WHERE HEAT COMES FROM

The engine oil will increase in temperature from the moment we start the engine up. It will increase to a certain point and then level out as the natural cooling effect of the airflow created by the car in motion cancels out the excess heat generation in the engine, and temperatures naturally stabilise. It will then only rise further if we use more power, which of course generates more engine heat not only in the bores and cooling system but also in the oil due to the pressure it is under to keep the moving parts away from each other.

This temperature is dangerous to our oil once it passes a certain point because the hotter our oil, the less shear stable it becomes. So, we need to look at cooling it down if we start to exceed the engine use that the manufacturer intended for the vehicle and its standard cooling systems.

HOW WE COOL THE OIL

Adding a system to cool oil is very simple. Much like the radiator that cools the water in our engine, we use a similar system for oil, but instead of running water through the radiator, we run oil through it.

There are various ways to connect these into our engines but commonly we use a simple sandwich plate that goes between our oil filters and engines. The oil that used to flow in one side of the oil filter and out of the other now travels through the filter, out of the filter through the sandwich plate, into some pipe work, through a radiator where it is cooled by airflow. The cooled oil then travels back through more pipes and back into the engine as normal.

There are a few well-known oil cooler manufacturers about. You should take their advice as to what system you buy as they sell various different types and sizes depending on how much cooling you actually need. The radiators are sized in 'rows' and more rows equal more cooling and therefore, a greater oil capacity.

If you're fitting any sort of 'cooler' you need to ensure a good flow of cool air

"IT IS ALWAYS BEST TO USE THE THINNEST OIL THAT YOU CAN GET AWAY WITH."

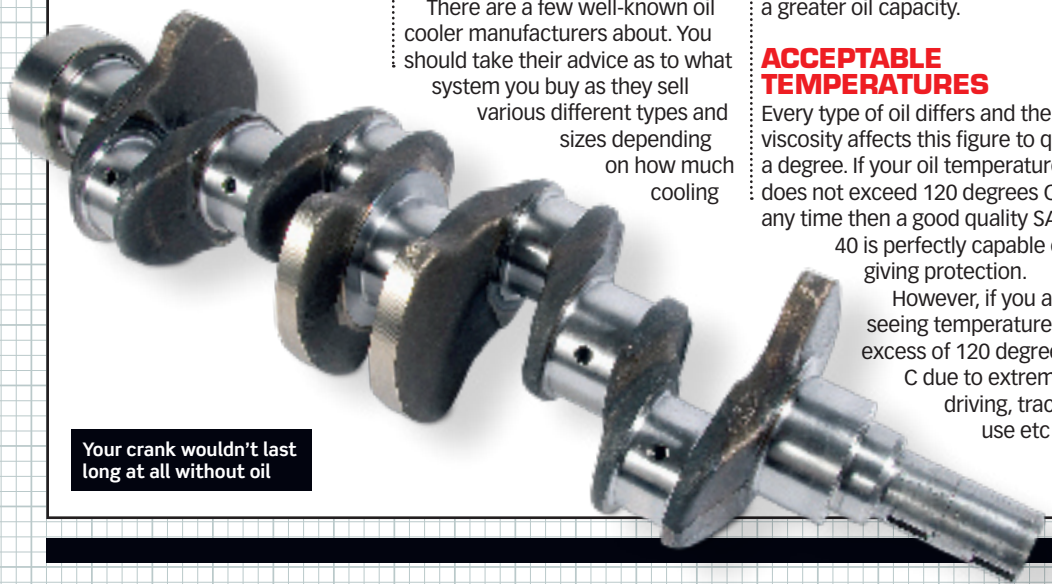
ACCEPTABLE TEMPERATURES

Every type of oil differs and the viscosity affects this figure to quite a degree. If your oil temperature does not exceed 120 degrees C at any time then a good quality SAE 40 is perfectly capable of giving protection.

However, if you are seeing temperatures in excess of 120 degrees C due to extreme driving, track use etc then there is a strong argument to use an SAE 50 as it will have more viscosity at these excessive temperatures. There are, as always, trade-offs here.

Thicker oils cause more friction and therefore more heat and they waste power and affect fuel consumption so it is always best to use the thinnest oil that you can get away with and still maintain good oil pressure.

Ideally use the thinnest oil your engine design can handle, then if you start to reach temperatures that could cause degradation and loss of lubricating ability and sheer strength, look to introducing oil cooling systems to get those temperatures back down to acceptable levels.



Your crank wouldn't last long at all without oil