Motorcycle oils – Getting to heart of the slippery stuff!

Everyone seems to have an opinion about motorcycle oils – let's see if we can nail some facts.

Motorcycle oils may share the same basic technology as their cousins in the car oil world. However there are some fundamental differences.
A motorcycle engine can have twice the specific power of a car engine and has half the volume of oil in the crankcase, creating very severe conditions for the lubricant.

Motorcycle oils operate in a harsh, high heat environment. The oil needs to lubricate and protect the engine and usually the gearbox and clutch, with a relatively small sump. Motorcycle oil can experience three times the stress of a car oil.
This hostile high engine RPM environment is reflected in the much lower mileage oil change intervals, compared to car engine oil.

Let's start by having a look with those all-important oil viscosity numbers. We will then have a look at the JASO specifications and why Fully Synthetic engine oil has some amazing advantages over semi synthetic and mineral oil.

The odd thing about viscosity. If you ask 10 people and there will be 10 different answers.
We are going to look at three key concepts relating to oil viscosity.

- *What is viscosity?*
- *Kinematic viscosity*
- *Dynamic viscosity*

Concept 1 - What is viscosity and what does, for example, 10W-40 really mean?
Let's take the 10W part. Most of us know this is the cold start rating. But how is it calculated?
Firstly, the W stands for winter.
The second number, the 40 is the viscosity at normal operating temperature. This is tested at 100°C.

We need to have a better an understanding of what viscosity is, before moving on to defining how we measure it.

Viscosity is the fluids resistance to flow. Or put simply, is the liquid thick or thin? Take water and honey; no misunderstanding here.

The other crucial point is that oil thickens up when it gets colder. A delegate once said to me when I was doing oil training. "You mean like honey taken out of the freezer compared to honey taken out of the microwave". She couldn't have put it better!
We will stick with the honey example. I know we don't usually put honey in the microwave, but it works for this article.

The oil chemists measure viscosity in two different ways. The first way is called *Kinematic viscosity* and the second way is called *Dynamic viscosity*. They both have their uses.

Concept 2 – *Kinematic viscosity* is used to measure the second number – 40 in our example
Kinematic viscosity – measures the normal operating temperature viscosity – it is measured at 100°C.
Kinematic viscosity is measured in *Centistokes cSt*. It is named after an Irishman called Sir George Stokes from the 1840s. (You may see it shown on specification sheets as *mm2/s).*

The test oil is timed as to how long it takes to travel through a glass tube. It is the force of gravity that is at work here. The higher viscosity oil takes longer to drip through this machine called a viscometer.

Another way of looking at *Kinematic viscosity* is to turn our two jars of honey upside down. The honey out of the microwave will end up a sticky mess on the floor, the honey out of the fridge will take much longer to drip onto the floor.
In both instances, in the laboratory and the kitchen, it's gravity that is the force.

Viscosity is only relevant if a temperature is stated. Saying the honey won't pour easily is a bit pointless unless we substantiate that the honey was at a particular temperature.

We can now make sense of some of the numbers on an oil specification sheet.
The SAE J300 table (SAE: Society of Automotive Engineers) lists the acceptable ranges for the viscosity grades. We see that the viscosity range of 40 grade is between 12.5 and 16.3 centistokes.
The Valvoline SynPower 4T motorcycle oil specification sheet below, has a viscosity of 14.5 centistokes at 100°C. Which neatly demonstrates a precisely blended oil.
A point to remember: 75% of the engine wear comes from cold starts. It pays to choose your oil wisely.

SAE J300 table		
SAE Viscosity Grade	Minimum Kinematic viscosity (cSt) 100°C	Maximum Kinematic viscosity (cSt)100°C
8	4	<6.1
12	5	<7.1
16	6.1	<8.2
20	6.9	<9.3
30	9.3	<12.5
40	12.5	<16.3
50	16.3	<21.9
60	21.9	<26.1

Valvoline SynPower 4T 10W-40 Motorcycle oil	
SAE Viscosity grade	10W-40
Viscosity *mm2/s* @ 100°C	14.5 cSt

Concept 3 – *Dynamic Viscosity* is used to measure the first number – 10W in our example
Dynamic Viscosity measures the cold start performance.
This is the force it takes to stir the oil, when it is very cold, eg, at minus 25°C. Reverting back to our honey. If you try to stir the honey taken out of the freezer, it is likely to snap the spoon!
The force that stirs the oil comes from the test machine in the laboratory. The force that stirs the honey comes from your arm.

The cold start 10W is measured at a very cold temperature when the oil will have a high viscosity.
There are two distinct tests:
Firstly, the *Low Temperature Cranking test* - Does the oil allow the starter motor to turn and start the engine?
The second test is the *Low Temperature Pumping test* - Is the oil sufficiently fluid to be pumped through the oil pump?

To get a 10W rating the oil must pass these two tests at minus 25°C for the *Low Temperature Cranking* and minus 30°C for *Low Temperature Pumping.*

SAE J300		
SAE Viscosity Grade	**Low temp cranking (cP)**	**Low temp pumping (cP)**
0W	6,200@ - 35°C	60,000@ -40°C
5W	6,600@ -30°C	60,000@ -35°C
10W	7,000@ -25°C	60,000@ -30°C
15W	7,000@ - 20°C	60,000@ -25°C
20W	9,500@ - 15°C	60,000@ -20°C

The Dynamic viscosity is measured in *centipoise cP. (*You may see it referred to by the SI unit *Millipascal-second mPa.s).*
Centipoise is named after a Frenchman called Jean Louis Poiseuille also from the 1840s.

A quick recap on our 10W-40 oil
We now know the cold start of 10W is measured at really cold temperatures and it has two SAE tests to pass.
The oil needs to allow the starter motor to start the engine and secondly pump the oil through the oil pump.
The viscosity is the *Dynamic viscosity* and it is measured in *centipoise cP.*

The normal operating temperature viscosity for a 40 grade oil needs to have a viscosity range on the SAE chart of between 12.5 and 16.3 centistokes – at 100°C.
The viscosity is the *Kinematic viscosity* is measured in *centistokes cSt (*or *mm2/s*).

This leads us on neatly to the JASO specifications
JASO stands for Japanese Automotive Standards Organisation
It is the regulatory body that sets the standards for motorcycle oils. The JASO T903 standard was introduced in 1998 in response car engine oil using friction modifier additives for fuel economy reasons. These friction modifiers had mischievous written large for motorcycle clutches!
The JASO standard was introduced to address the clutch slippage issues. The standard became globally recognised for 4 stroke motorcycle lubricants.
In 2006 JASO introduced the MA or MA2 designation for wet multi plate clutches. MA2 lubricants have the bar set higher in terms of clutch performance
Oil for dry clutch engines use the MB specification and 2 stroke oil uses FB, FC and FD

JASO set the T903 tests, which are three tests to tackle the challenge the oil has with wet multi plate clutches.
Dynamic Friction Index DFI
This tests how power is transferred whilst being operated under slip conditions. How does the clutch feel when engaging?

Static Friction Index SFI
How much torque can be applied to a fully engaged clutch before slipping?

Stop Time Index STI
How fast the clutch engages when the lever is released?
JASO also have a set of what they call the Physocochemical properties that motorcycle oil has to achieve as well.

JASO T903:2016 (Annex A)		
	JASO MA	JASO MA2
Dynamic Friction Characteristic index (DFI)	>= 1.35 and <2.50	>=1.50 and < 2.50
Static Friction Characteristic Index (SFI)	>=1.45 and <2.50	>=1.60 and <2.50

Stop Time Index (STI)	>=1.40 and <2.50	>=1.60 and <2.50

There is an additional challenge for motorcycle oil that is required to lubricate the gearbox as well as the engine.
One of the key oil additives is a viscosity index improver. These are molecules that expand like a coil spring when they warm up. In a sense locking in the correct viscosity of the oil. The gearbox unfortunately acts like a meat grinder and chops up the viscosity index improver. The oil then loses viscosity – A good reason to change your oil on a regular basis.
Talking of additives. What do they do? Well amongst other things they control the sludge, varnish and deposits. As well as acid neutralisation and help retain shear stability, which is ensuring the oil stays at the correct viscosity. Additives work hard and they can deplete over time – yes regular oil changes!

A question for you: Have you ever thought where the oil goes when you top up the oil level? If you thought - up the exhaust pipe or a puddle on the floor – you would be correct. However there is a third reason. It is oil evaporation. The lighter molecules in the oil evaporate. JASO set limits on how much oil can evaporate under test conditions – It's called the NOACK standard and the current limit is set at 20%.

So is Fully Synthetic oil worth the extra cost?
The simple answer is yes. Fully synthetic has some amazing properties that help deal with the demanding motorcycle engine environment. (However always check the handbook recommendations for the viscosity and synthetic applications)

Fully synthetic oil has excellent high temperature stability, excellent low temperature performance and superior heat removal. It also has low volatility, which helps with oil evaporation.
Fully Synthetic oil resists oil oxidation significantly better than semi synthetic or mineral oil. Oxidation can cause oil degradation which leads to sludge and varnish deposits. Sludge is a killer for engines. Unfortunately oxidation is dramatically accelerated at higher temperatures.
Fully Synthetic oils have a naturally high what is called *Viscosity Index*. This means less change of viscosity between cold start up and normal running temperature. This is a good thing!

With our new oil knowledge, can we now make better informed decisions?
There are certainly clues to guide us in the right direction for choosing high quality motorcycle oil.

Fully Synthetic oil has many benefits, assuming the handbook recommendation is OK. The correct viscosity - obviously and the oil is supplied by a well-recognised oil company that is in the business of motorcycle oils.

Go for JASO MA2 rather than MA. The industry seems to have moved towards MA2 for the majority of motorcycle oils anyway.

Give your motorcycle generous oil change intervals – we don't want those *viscosity index improvers* getting chopped up and lowering the viscosity.

Finally, if you have the specification sheet - look for the *Viscosity Index*. The higher the number the better. A figure around 160 is what you expect to find with a premium brand Fully Synthetic motorcycle oil.

Simon Michell
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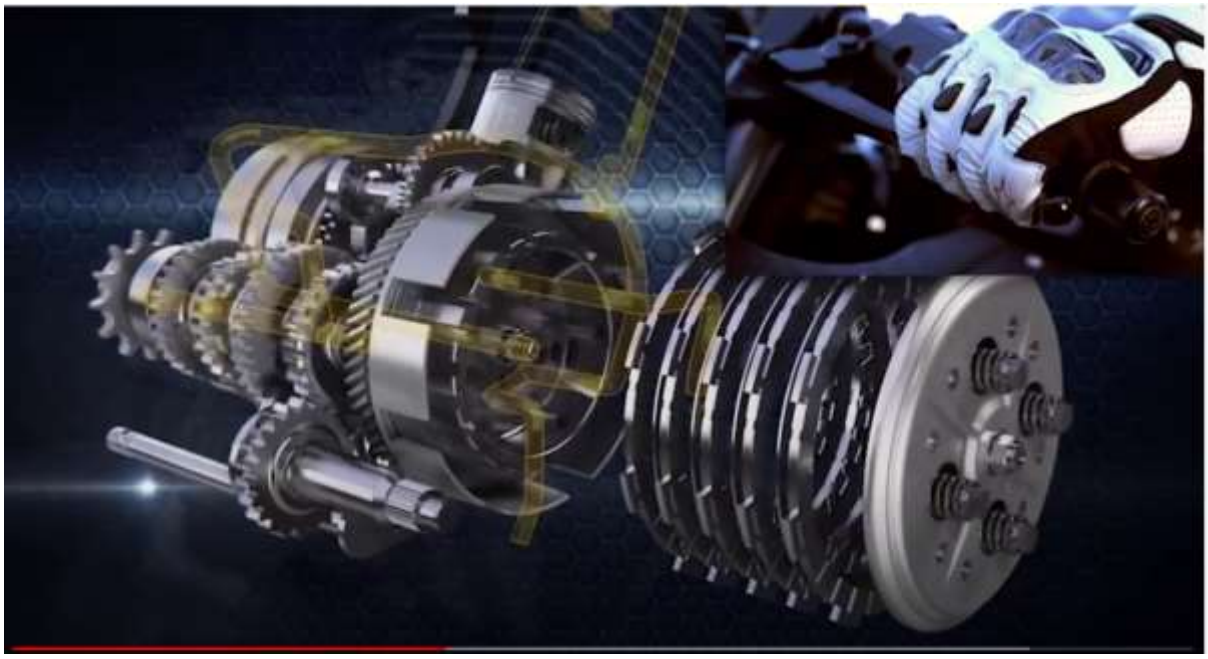

https://www.youtube.com/watch?v=QMXM4GDBUsI
Lubrizol additives