

ZDDP – What's Your ppm Level?

This is an extract of an article by Richard Long of the Southern Classics Society, first published in the TVR Magazine:

Classic car petrol engines (1950 through to 1990) will by now have many years and miles under their pistons, and their care is just as important as modern day units; perhaps even more so. What may be good oil for one type of engine could be an anathema for another. So what do classic car engines need from oil that is suitable for their longevity and protection?

One of the key components is the zinc level in oil and this is defined as "parts per million (ppm)". The zinc element is actually contained within a compound called Zinkdialkyldithiophosphate (ZDDP) and its inclusion is a critical factor for old style engines. Through past decades the level of ZDDP has been decreasing due to modern catalytic convertors and far more efficient engine design. Modern "cats" cannot deal or survive with the phosphorus that is also contained within ZDDP; as a result modern car manufacturers have progressively required a reduction of this additive in oil. That's understandable. However, where does that leave a classic car owner in deciding what oil to choose for their classic car in the 21st Century?

It's an interesting question and a far from a straight forward topic.

So what does ZDDP bring to the oil party? Firstly we need to look at why it is an important factor. The majority of classic car owners will have tappet followers that are "flat-bottomed", that is to say the bottom surface is flat to the naked eye. These followers have an extremely tough life; probably only second to cylinder head valves. As the camshaft turns, each lobe per revolution makes contact with the followers. The shape of the lobe is designed so that at its peak revolution it will push the follower up which then pushes the tappet rod up and opens the valve in the cylinder head, via the rocker. The valve is seated extremely tight by single or double springs to form a gas tight seal within the cylinder head combustion chamber.

So as you can see the force placed upon the bottom of the cam follower is significant to say the least. This "super-pressure" contact causes friction and as we know friction causes component wear. This is where ZDDP plays its part. Zinc is a polar molecule, so it is attracted to steel surfaces. Under high heat and extreme load (pressure), the Zinc reacts with the steel surface and creates a phosphate glass film that protects the steel surface by forming a sacrificial layer that covers the peaks and fills in any indents on the steel surface. Basically your flat bottomed follower really does become 99.9% flat and smooth. By forming this protective layer the cam lobes and flat bottomed followers are heavily protected against friction wear; remember friction wear can never be eliminated but much can be done to slow the process down.

So ideally to get the best protection the oil needs a high ZDDP, but modern oils of today do not contain this but rather "other additives" which oil manufacturers keep close to their chest as it's all about marketing and protecting their "recipe". That is little or no comfort for the classic car owner who relies on a decent multigrade mineral oil with a generous level of ZDDP contained therein.

Of significance, many oils that say "classic car oil" do not actually contain enough ZDDP or worse still a mere trace. So, what level of this additive does a classic car owner require to feel confident that the oil in their car engine is not only lubricating but also protecting those parts under extreme pressure. Without a doubt an owner should be looking for an oil that contains a minimum of 1000ppm of ZDDP and to a maximum of 1600ppm. In fact an oil containing in excess of 1500ppm may cause more harm than good; such high levels of ZDDP are specifically manufactured for race engines and it is not an oil that can be purchased off the shelf. Some classic car oils only contain 800ppm and these oils are insufficient to fully protect metallic components. Oils such as Halfords Classic 20W/50, Comma Classic 20W/50 and Castrol XL 20W/50 are below the 1000ppm level and contain only 800 ppm. Sorry to give you that bad news, but the price of those oils may provide a clue.

So what oils provide in excess of 1000ppm? Well, oils such as Penrite, Millers and Morris as these companies specifically manufacture their oil to be suitable for classic cars and deliver a high Zinc content.

What is odd or perhaps not when you look at it, is that companies such as Penrite and Millers are more than happy to quote their ZDDP levels; whereas to get Castrol or Halfords to divulge their content is another matter entirely. Their corporate stock phrase will be that there are sufficient additives to meet the required standard.

So what is the required standard and again another interesting point; as engine technology has improved over the years the requirement for ZDDP has reduced to the point that it is no longer added in that pure form. Additionally, modern oils are now either semi or fully synthetic with ever decreasing viscosity levels and higher levels of detergent; this is because modern petrol engines are cleaner and their metallic components are under less stress compared to cars from the '50s through to the '90s.

In fact for oil manufacturers to make multigrade mineral oils with a high level or any level of ZDDP costs money and what's the point in that when classic cars make up a tiny percentage of cars on the road. Additionally, as cars become mechanically more efficient the "make-up" of the oil must correlate with those changes. The internationally recognized index for oils is the API (American Petroleum Index) and this code can be seen on all oils from multigrade to fully synthetic.

Table 1 provides a snapshot of the current ongoing list of oils:

Category	Status	Comments
SJ	Obsolete	For 1996 and older automotive engines
SH	Current	For 2001 and older automotive engines
SL	Current	For 2004 and older automotive engines
SM	Current	For 2010 and older automotive engines

The index started at SA which covered engines built after 1930 and contained no additives at all. When oils are improved a new category is added (not all A-Z letters are used); most of these improvements are with additives and the general "make-up" of the oil. Currently the API stands at SN:

www.api.org/products-and-services/engine-oil/epics-categories-and-documents/oil-categories#tab_gasoline

For owners of classic cars ranging from the 1950's to the mid-90's the highest API code you should be putting in your engine is SL (up to year 2004). Higher than that the level of ZDDP becomes seriously depleted or even absent and modern additives are included to deal with corresponding modern engines. These modern day additives will not contain the "care products" that your classic car engine requires. The API codes are found on the oil container, so have a look at your current oil container and see where your oil is pitched. Ideally it should either be SG, SH, SJ or SL; anything higher or lower will not be suitable and may fail to protect component wear within the engine - not just in areas that require high ZDDP levels.

I popped in to my local Halfords the other day to check what their 20W/50 classic car oil is rated api; on the container it shows SE which is way down the scale of protection. In fact the API index throws a caution in with that grade stating the oil is unsuitable for vehicles built after 1979. Although the oil will cover most classic cars prior to that year its level of protection is low. Yes it lubricates but its actual long term critical component protection is questionable. It's green in colour and of course is identical to Comma 20W/50 oil; where the same statement above applies. The Halfords tin listed various additives - nothing specific but certainly no clue as to the ZDDP level. The same applies with Comma oil. Without a doubt you get what you pay for or can afford.

Conversely Millers Classic 20w/50 is high in ZDDP and the fact is actually stated on the container. Looking at their website technical section it shows the level to be 1100ppm and the oil is rated SJ on the API Index; Excellent news.

Another example is Penrite Classic 20W/50, again the container shouts out high zinc level and this oil is rated at SL. So Millers and Penrite are delivering exactly what you should be looking for in a classic car oil and is certainly the quality of oil you should have in your engine.

It is possible to buy ZDDP in a bottle and add that to your engine oil. However there is a lot of controversy about this and it boils down to one thing. When oil is manufactured all the additives are gradually mixed throughout the process which ensures that they blend properly with the oil and equally important that the additive is in an "active state" to react to the operating conditions in the engine. Bearing in mind the process that ZDDP works under to achieve protection, there is some concern that the "over the counter" additive may not be as effective compared to its application and inclusion during oil manufacturing.