



ZPlus, LLC
Burlington, NC 27215
www.zddplus.com

ZDDPlus™ Tech Brief #1

Introducing ZDDPlus™

Who is ZPlus, LLC?

ZPlus, LLC is a company formed by classic car enthusiasts to meet the needs of classic car aficionados. We have seen that the automotive industry in general is changing in response to the environmental and financial pressures of today, with little concern for the classic car industry. We are engineers and automotive technicians by trade, and bring many years of problem solving experience to the task of keeping our classic cars operational and running better than new. We hope one of the solutions we have designed for our own use will meet your needs as well. We have developed ZDDPlus™ to address the need of classic car owners for oil that will meet the specifications of the original oil for which their engines were designed.

Why do we need ZDDPlus™?

As part of an effort to reduce vehicle emissions, the U.S. EPA offers vehicle manufacturers “credits” for early implementation as well as penalties for violation of emission reduction standards. The EPA’s program called for 100,000-mile catalytic converter life by 2004, 120,000 miles by 2007, and 150,000 miles by 2009. To achieve these goals, automotive manufacturers have pressured their oil suppliers to remove substances from motor oils that would shorten the service life, including the proven antiwear additive ZDDP (zinc dialkyldithiophosphate). Zinc and phosphorus from the ZDDP can be present in small amounts in the exhaust gas of an engine depending on the amount of oil which is consumed in combustion. Phosphorus in particular has been singled out as an element which can coat the catalyst reducing the amount of catalyst exposed to the exhaust gases and ultimately increasing emissions at the tailpipe. As a result of the EPA mandate, the phosphorus level in engine oils (from the ZDDP) has been declining since the introduction of SJ oils in 1996, roughly coinciding with the implementation of OBD-II.

What Is ZDDP?

To quote one 2005 research study: “The most common antiwear additives used in engines are zinc dialkyldithiophosphates (ZDDPs), which have the chemical formula $Zn[S_2P(OR)_2]_2$, where R is an alkyl group. ZDDPs have successfully been used for over 60 years, and to date no superior antiwear additive has been developed for use on steel.”¹ ZDDP has an excellent track record at protecting the sliding metal-to-metal cam lifter interface. Historically, ZDDP has been added to oils in amounts resulting in approximately 0.15% phosphorus and 0.18% zinc. ZDDP protects by creating a film on cams and flat lifter contact points in response to the extreme pressure and heat at the contact point. The film of zinc and phosphorus so formed provides a sacrificial wear surface protecting the base metal of the cam and lifter from wear. In the course of normal service, this conversion of ZDDP to elemental zinc and phosphorus depletes the ZDDP level in the oil. Studies show that depending on the specific engine and severity of duty, after 2000-4000 miles of operation, the level of ZDDP can drop below that considered adequate to provide wear protection to the cam and lifters.

¹ Nicholas J. Mosey, Tom K. Woo, Department of Chemistry, University of Western Ontario, London, Ontario, Canada, N6A 5B7 and Martin H. Müser, Department of Applied Mathematics, University of Western Ontario, London, Ontario, Canada, N6A 5B7, “Popular Mechanisms for the Functionality of Lubricant Additives.”

According to the SAE Tech Bulletin # 770087,² operation of a flat-tappet engine without adequate antiwear additives such as ZDDP quickly leads to lifter foot scuffing and cam lobe wear. Camshafts are typically only surface hardened leaving the core ductile for strength. According to the SAE Bulletin, once cam lobe wear reaches 500 µm (0.020"), "subsequent wear is usually rapid and catastrophic." In order to make engines last in the absence of ZDDP, virtually all IC (internal combustion) engines designed in the last ten years utilize roller lifters. Today, ZDDP has been removed from practically all automotive engine oils, rendering them unsuitable for use with older engines with non-roller lifters.

ZDDPlus™ is the ONLY antiwear component which re-establishes the ZDDP levels our classic car's engines were designed for, while allowing the car owner to use the base oil of their choice. While some off-the-shelf additives may have some ZDDP, the amount per bottle is small, and when enough is used to get the proper concentration of ZDDP, there is a quart or more of unspecified oil that comes along with it. This dilution of 20% of your oil with unspecified oil also means there is 20% less of the proper additive package. The chart below compares the amount of ZDDP in ZDDPlus™ to GM EOS, a leading additive which claims to provide ZDDP-based wear protection. The ounces of each additive given in the chart is what you would have to add to 5 quarts (160 ounces) to achieve the target phosphorus level listed in red.

Dosing Comparison of ZDDPlus™ and GM EOS

Product	Amount Used (oz)	Phosphorus (ppm)	Zinc (ppm)	P to Zn Ratio	Density (g/ml)
ZDDPlus™	4	51,500	71,800	0.717	0.990
GM EOS	16	5,300	7,100	0.746	0.908
Average SM Oil	160	600	800	0.750	0.860

Target ppm Phosphorus Concentration	Ounces of ZDDPlus™	Ounces of GM EOS
700	0.3	2.9
800	0.7	5.7
900	1.0	8.6
1000	1.3	11.4
1100	1.7	14.3
1200	2.0	17.2
1300	2.3	20.0
1400	2.7	22.9
1500	3.0	25.7
1600	3.3	28.6
1700	3.7	31.5
1800	4.0	34.3
1900	4.3	37.2
2000	4.7	40.0

— 1 bottle GM EOS

— 2 bottles GM EOS

— 1 bottle ZDDPlus™

² Loren G. Pless, and John J. Rodgers, "Cam and Lifter Wear as Affected by Engine Oil ZDP Concentration and Type," SAE pub 770087 (1977), 4

Why do we need additives?

Modern engine oil is a precise mix of base oil with additives which can total 10% or more of the oil by volume. These additives are more expensive than the base oil by volume, and oil companies are in business to make a profit. Common sense says that these additives are there with good reason.

Modern engine oil is a multi-purpose fluid in an engine, carrying the heat away from hot spots and releasing it in the sump, as well as providing lubrication to critical areas which need protection against wear. Different additives are put in the oil in order to address the needs of each specific engine system that is supplied with oil:

- ✿✿ The crankshaft and connecting rod bearings discharge oil into the spinning reciprocating assembly, and an anti-foaming additive keeps the oil from turning into foam.
- ✿✿ The heat developed on high-pressure contact areas can exceed the breakdown temperature rating of the base stock, so heat stabilizers are added in order to fight viscosity breakdown and ashing.
- ✿✿ In multi-viscosity oil, the multi-viscosity characteristic is established by an additive.
- ✿✿ Acids and byproducts of combustion are neutralized by other additives.
- ✿✿ A dispersant additive helps keep particulates in suspension.
- ✿✿ Detergents are added to bind with contamination and encapsulate it, and to lower the surface tension to a specific value to help keep contaminants in suspension and off of the metal engine parts. Some detergents also interact with the EP additive to gain an additional level of wear protection.
- ✿✿ The sliding cam-to-cam-follower interface in a non-roller lifter engine requires a special EP additive, which has historically been the ZDDP that is now reduced in practically all automotive oils.

ZDDPlus™ contains the proper amount of ZDDP to give a 0.18% zinc and 0.13% phosphorus level when a single 4 oz bottle is added to a normal 5-quart oil change. This level of zinc and phosphorus is the level designed into pre-OBD-II oils. The ZDDP present in the oil may make this amount higher. Using ZDDPlus™ affords you total control over the characteristics of the oil in the engine by allowing you to use the full 5 quarts of high-grade automotive oil of your choice.

What about off-the-shelf additives and supplements?

Automotive industry-approved oils have always been more than adequate for the engines designed when the oil was current. The use of current grade oils has always been adequate to satisfy car manufacturer's requirements and warranty demands. Historically, with few exceptions, newer grades have superseded the performance of their predecessors. The removal of ZDDP has resulted in a clear change to that philosophy. It has never been necessary or desirable to include additives or supplements to any industry approved oil to meet car manufacturer's specifications or warranty requirements. In virtually all cases, off-the-shelf additives amount to little more than automotive snake oil. Consequently, if these additives actually had adequate levels of ZDDP, they would be incompatible with modern engines and void manufacturer's warranties. Due to this unprecedented turn of events in emissions requirements, ZDDPlus™ should not be confused with an off-the-shelf additive. ZDDPlus™ should be considered a replacement for a missing oil component critical for older cars.

Why can't we use diesel CI/CJ-4 rated oils?

There are some diesel engine rated oils on the market which may still have some ZDDP. There are problems associated with using these oils in a normal gasoline engine which can become severe in a high-performance gasoline engine. One issue is the high amount of detergent additive, and another is the high viscosity.

High-detergent oil has a lower surface tension and lower shear pressure rating which can cause higher bearing wear in gas engines. A diesel engine needs oil with very high-detergent capabilities in order to hold the large amount of combustion by-products in suspension, but it is not optimized for a gasoline engine. The bearing journal size-to-displacement ratio on a gasoline engine is designed around the use of a lower-detergent oil and relies on a high shear rating of the oil.

The other problem with high-detergent oil is that it actually reduces the friction reduction the ZDDP affords, especially in a high-performance, high valve-spring-pressure engine.

The viscosity rating of most diesel rated oils is higher than optimum for our higher revving gasoline engines, and can cause oil starvation or bearing overheating at high rpms.

Why can't we use racing oils?

There are some racing oils which maintain a level of ZDDP. Racing oils are optimized for short-term severe duty, in contrast to oil designed for day in, day out street operation. The additive package in racing oil does not have the same detergent characteristics which are designed into extended service oils. As a result, racing oils may not have the capability of neutralizing acids and keeping contaminants in suspension. Also, the breadth of choice of viscosity, so important to correct street engine operation over a broad temperature range, is not available in racing oils.

By using ZDDPlus™ in addition to a modern high-quality SM oil of the proper viscosity, the correct EP lubrication level is established, and the oil characteristics remain optimized for your engine.