

Supplemental Information for 220-805 ZDDPlus Oil Additive

"If you're currently putting mileage on your classic vehicle and using the latest API grade SM oil, you are almost certainly doing irreversible damage to your engine."

William C. Anderson, 'New Oils and Old Cars',
Old Cars Weekly 48 (2007-08030)



What is It?

Zinc Dialkyl-Dithio-Phosphate (ZDDP) is an oil supplement which has been, up until recently, the primary extreme pressure (EP) ingredient in all quality motor oils. It has been used for over 70 years.

How does it work?

ZDDP, when exposed to heat and pressure, forms a protective zinc-phosphate film on the surface of the metal. The exact nature of the process at the molecular level is still under investigation, but recent research suggests that large numbers of cross-links between the zinc atoms in the zinc-phosphorus molecules form, transforming a viscoelastic fluid of loosely interacting zinc-phosphorus molecules into a chemically connected network. This increases the strength of the film, and that significantly improves its capacity to accommodate and redistribute applied loads which in turn reduces wear on the underlying surface. Because of the pressure required to trigger this event, ZDDP is particularly effective in protecting steel and cast iron surfaces. As soon as the pressure at the contact interface is reduced, the cross links break down and the film dissipates back into the oil solution. Simply put, ZDDP prevents parts (the cam lobes and the lifters for example) from making contact, and this greatly reduces the tendency of parts to scuff and gall under heavy-loaded conditions. It's important to note that the wear protection properties are due only to the characteristics of the ZDDP molecule and not to zinc (Zn) or phosphorus (P) in the oil in other forms or from other sources.

Why do I suddenly need ZDDP?

Let's back up a minute and talk about oil classifications. The system in use today comes from the American Petroleum Institute (API). In this system, the prefix S or C identifies the basic category, S being for gasoline engines, C being for diesel engines. The second letter corresponds to the grade, and SA and CA were the designations for the first two API oil grades. As new specifications were developed, a succession of letters was assigned, and 13 grades later, we are up to SM, the current grade for gasoline engines. Oil for diesel engines is up to CJ. Generally speaking, every change in specification since the 1930s represents improvements based on a better understanding of oil, lubrication, and the evolving needs of machinery. And generally speaking, the newer oil could safely be used in cars built to use an earlier specification. There are two exceptions. Engines built to use SA grade oil (a straight non-detergent mineral oil) could not use the SB grade oils. The second exception is more recent, and it applies to engines built through the mid 1980s. It is primarily due to the reduction of ZDDP.

With that background information, let us consider exactly why the loss of ZDDP creates problems for older engines, and why it is not a problem for modern engines. According to the SAE Tech Bulletin # 770087, operation of a flat tappet engine without adequate EP additives such as ZDDP quickly leads to

49 lifter foot scuffing and cam lobe wear. Camshafts are typically only surface hardened leaving the core
50 ductile for strength. According to the SAE Bulletin, once cam lobe wear reaches 0.0002, "subsequent
51 wear is usually rapid and catastrophic." Two ten-thousandths of an inch is one fifth the thickness of an
52 average human hair. In order to make engines last in the absence of ZDDP, virtually all engines designed
53 to run on gasoline in the last ten years utilize roller lifters. The sliding cam-to-cam-follower interface in a
54 non-roller lifter engine requires a special EP additive, which has historically been the ZDDP.

55 ***Why can't I buy modern oil with ZDDP in it?***

56 Up to 1988, the API specification for "SF" motor oil called for ZDDP concentrations of 0.15% by weight.
57 Up to about 1993 the API grade "SG" oils contained in excess of 0.12% ZDDP by weight. However, these
58 are now "obsolete" specifications, and ZDDP has been phased out gradually because it will damage the
59 catalytic converter. The EPA has required the automobile manufacturers to design and use catalytic
60 converters that last for 100,000 miles (2004), and that increases to 150,000 miles by 2009. To achieve
61 these goals, automotive manufacturers have worked closely with the oil industry to develop oils that do
62 not have substances that would shorten the service life of the catalyst. No matter how fresh an engine is,
63 some oil is burned in the combustion chamber. If the motor oil has ZDDP in it, small amounts of zinc and
64 phosphorus will show up in the exhaust system. These elements can coat the catalyst, reducing the
65 amount of catalyst exposed to the exhaust gases, and that will increase emissions at the tailpipe. The
66 ZDDP level in motor oil, which had declined since 1988, began to disappear in the mid 1990s as a result
67 of the EPA mandate. This roughly coincides with the implementation of OBDII.

68 ***What about Racing Oil? Doesn't that have ZDDP?***

69 There are still some racing oils that contain ZDDP, and they do offer some additional protection. The
70 actual percentage of ZDDP in racing oil is based on the intended use of that oil, and it may not be the
71 optimal concentration of 0.15% found in the API SF oils. There are also other factors to consider. Racing
72 oils are optimized for short term severe duty, in contrast to oil that has been designed for operation on the
73 street for months at a time. The additive package in racing oil does not have the same detergent
74 characteristics which are part of the additive package in oil designed for extended service. This means
75 racing oil may not neutralize acids and keep contaminants in suspension. Racing oil generally is not multi-
76 viscosity, which is a key feature of oil designed for use in street cars over wide temperature ranges.

77 ***Don't oils for diesel engines still have ZDDP?***

78 Yes, some do. However, diesel oils have three characteristics you need to consider; the detergent
79 additives, viscosity, and the amount of ZDDP in the oil.

80 ***Detergents:*** A diesel engine needs oil with very high detergent capabilities in order to hold the large
81 amount of combustion byproducts in suspension. High detergent oil has a lower surface tension and
82 lower shear pressure rating. The bearing journal size-to-displacement ratio on a gasoline engine is
83 designed around a lower detergent oil with a high shear pressure rating. Using a API CJ grade oil for a
84 diesel engine in a gasoline engine can lead to higher bearing wear. Another problem with high detergent
85 oil is that the additives that keep contaminants in suspension actually reduce the wear protection provided
86 by the ZDDP, especially in a high-performance engine with high valve spring pressures.

87 ***Viscosity:*** Diesel engines have larger bearing clearances, and they run higher viscosity oils as a
88 result. The viscosity rating of most diesel rated oils is actually higher than you would normally use in a
89 gasoline engine, which runs at higher RPM. In some cases, using high viscosity oil can cause oil
90 starvation in bearings at high RPM.

91 ***ZDDP:*** It can be difficult to determine exactly how much ZDDP is in a quart of API CJ oil. The amount of
92 ZDDP in diesel oils was reduced in 2007, and in the long run It may be a moot point, because the best
93 information we have indicates that new diesel oils in development will have further reduced levels of
94 ZDDP.

95 **What about GM's Engine Oil Supplement? Isn't that ZDDP?**

96 GM's Engine Oil Supplement (EOS) did contain significant amounts of ZDDP, and it was the most
97 concentrated ZDDP supplement available. It was intended to boost ZDDP levels of oils that already
98 contained EP additives. It was available for over 20 years, until it was discontinued by GM in early 2007

99 **So what am I supposed to do now?**

100 Classic car magazines, club newsletters, restorers, machine shops, and the forums on the web abound
101 with information about oil and classic cars. Like all hot topics, there is a great deal of information out
102 there, some good, some bad. The fact is that our vintage English cars have lubrication issues not found in
103 modern engines. If your owner's manual calls for SF grade oil, or an earlier grade oil, the engine will need
104 ZDDP. There are two approaches. One is to use modern SM grade oil and add back in the ZDDP. The
105 second is to use oil formulated specifically for older cars. These oils typically meet the older SF or SG
106 specification. Moss carries a specially formulated 20W/50 motor oil under 220-810. It is made here in the
107 US and it is one solution. We also carry the ZDDP so you can decide which solution that makes sense to
108 you.

109 **So what exactly is ZDDPlus, and how is it used?**

110 **How much?**

111 One 4-ounce bottle of ZDDPlus™ mixed with 5 quarts of oil will bring the level of ZDDP up to 0.15% **by**
112 **weight**, the same level found in API SF grade oil available up to 1988. You can add ZDDPlus at any time,
113 it is just more convenient to do it when you change the oil. It is interesting to note that there is more ZDDP
114 in a 4 oz bottle of ZDDPlus than there was in a 16oz bottle of GM's Engine Oil Supplement (EOS).

115 **Can I use it with Synthetic Oil?**

116 ZDDPlus™ should be compatible with all conventional and synthetic oils intended for automotive use.
117 Remember that most of these oils contained higher amounts of ZDDP for years.

118 **What if my oil already contains some ZDDP?**

119 Tests have shown that concentrations from 0.2% up to as much as several percent by weight have no
120 effect in terms of wear protection, but higher concentrations do prolong the useful life of the additive.

121 **How long can I keep a bottle on the shelf?**

122 Years. As long as it is kept sealed and the temperature is kept between 0 and 120° F, the shelf life of
123 ZDDPlus™ is essentially the same as regular motor oil. In an unsealed container, ZDDPlus™ has a
124 tendency to absorb moisture, not unlike brake fluid. While absorption of water will degrade its
125 performance, heating an open bottle of ZDDPlus to a temperature slightly above 100°C (212°F) will drive
126 off the moisture. It should be used –mixed with oil – as soon as practical after that treatment. Once mixed
127 with oil, it no longer will absorb water.

128 **How long does it last in the engine?**

129 Oil, and the additive packages in the oil, break down over time. How long that takes depends on how the
130 car is driven, how much blow-by there is, and other environmental factors. Classic British cars tend to be
131 driven periodically, and they sit for long periods of time. Because the combustion by-products form acids
132 in the sump, a car that is driven on weekends still needs to have the oil changed regularly. For years
133 Moss has passed on the advice of numerous restoration specialists, all of whom suggest that the oil be
134 changed every 3,000 miles or every 6 months, whichever came first. Adding ZDDPlus™ does not change
135 that.

136 **If ZDDP is so good, shouldn't I use it on all my cars?**

137 No. Remember that modern engines (certainly anything built after the mid 1990s) are designed to use the
138 modern API SM grade oils. They have been tested for hundreds of thousands of miles, and so long as
139 you follow the manufacturer's maintenance schedule, you will be fine. And adding ZDDP to an engine that
140 has a catalytic converter will damage the converter, and that will increase emissions out the tailpipe. Air
141 pollution aside, eventually, you will be buying new catalytic converters.

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