Camshaft lobes have been disappearing faster than a politician's promise, and engine builders have been wondering why. Has the "hanging chad" reared its ugly face again?

The Lost Lobe Chronicles

BY **DAVE EMANUEL**

Whenever conversation rolls around to the "secrets" of building high performance engines, someone invariably notes that he would like to have been "a fly on the wall" at a shop that's known for its engine-building prowess. These days, a fly wouldn't hear much besides a string of expletives normally uttered by politicians, followed by statements like, "I've been building engines for 30 years, and I've never had a cam failure until two years ago. What the hell is going on?

The question is not, "What's going on? it's, "What's going out?" The answer is zinc—specifically zinc dialkyl dithiosphosphate (abbreviated as ZDDP or ZDP). Zinc/phosphorous compounds provide a number of tangible benefits when included as a part of the motor oil's additive package. Although base stock influences an oil's lubrication performance, the additive package is what sets one brand or type of oil apart from others. Obviously, oils with high ZDP content have different lubricating qualities than those with low or no ZDP blended in. Primary among zinc's benefits are its anti-wear characteristics, particularly between mating surfaces that are under extreme pressures. ZDP also has beneficial anticorrosive and anti-oxidant properties.

Ironically, the elimination of ZDP has more to do with sulfur (in the form of sulfated ash) than the zinc compound itself. "Sulfated ash" pertains to the metallic compounds contained in traditional motor oil's additive formulations. Some amount of ash invariably finds its way into an engine's combustion chambers and ultimately into the exhaust system. The compounds produced when the ash is combusted reduce the efficiency of catalytic converters and oxygen sensors. It's specifically the effect on catalytic converters that is the primary motivation behind the elimination of sulfated ash compounds—which is a bit of a mystery considering that a Federally-mandated warranty covers all original equipment catalytic converters for a period of 8 years or 80,000 miles (for all new 1996 and later vehicles). You have to wonder how real the threat is from sulfated ash, considering that catalytic converter warranty claims are extremely rare, and converter failures usually result from other causes (like engine misfire or faulty injectors).

Whether or not sulfated ash has had a measurable effect on catalytic converter operation, its reduction has changed the face of the oil cans found on the shelves of auto parts stores. It wasn't too many years ago when those shelves were filled with cans of oil that met requirements of both gasoline and diesel engines. Since 2004, when "SM", the latest API (American Petroleum Institute) category was introduced, such oils have been increasingly harder to find because of the drastic reduction in ZDP levels. As a result, the latest and greatest oils for gasoline engines, (API "SM" rating) are not suitable for use in diesels, which means they're also unsuitable for use in engines equipped with flat tappet camshafts. Although ZDP levels have also been reduced in diesel oils, (CJ-4 being the latest category) they are still high enough to offer extreme pressure anti-wear protection.

The reduction and elimination of ZDP in motor oils is possible because roller lifters have eliminated the use of flat tappet lifters in virtually all engines produced during the past few years. Were that not the case, camshaft and lifter failures would keep every engine rebuilder in the country working 24 hours a day. The cam lobe/flat tappet interface is continually subjected to the highest pressure loads encountered in an internal combustion engine and ZDP in motor oil enables the long term survival of this interface.

Obviously, shops that rebuild older engines are left out in the cold without adequate protection if they use "SM" or similar oils during break-in— or if they neglect to advise their

customers against doing so. Unfortunately, reduction of ZDP content hasn't been widely advertised, and as a result, the incidence of rebuilt engine failures reported by AERA members has increased dramatically in recent years, and is directly related to use of motor oils with insufficient ZDP content.

Excessive wear resulting from use of motor oil with insufficient zinc content typically occurs during break-in of a newly rebuilt engine. That's the worst possible time for an engine builder because a customer with a flat-lobed camshaft in a newly rebuilt engine will undoubtedly blame the failure on the engine's builder. The best way to eliminate the problem is to get the zinc back in. You can accomplish this by simply adding an engine break-in lubricant. For decades, General Motors' "EOS" (Engine Oil Supplement) has been a popular "do it yourself" ZDP additive. Obviously, EOS works well in any engine, not only those produced by GM. In fact, some Porsche repair shops recommend the addition of EOS at every oil change. Another readily available ZDP source is camshaft break-in lube offered by Comp Cams and other performance camshaft manufacturers.

Diesel, "racing oil" and some motorcycle oils, like Harley-Davidson's Syn3, have relatively high ZDP content, making them viable sources of ZDP. Chevron Delo 400, Mobil Delvac and Shell Rotella are all designed for use in "heavy duty diesel engines" and consequently contain reasonable quantities of ZDP. Air-cooled engines have unique lubricating requirements compared to their water-cooled counterparts, and consequently have higher ZDP levels. However, ZDP levels found in motorcycle oils and racing oils can vary widely, so if you plan to use one of these, make sure it does contain a useful amount of ZDP.

Unfortunately, ZDP content data is not easy to find. Although you'll find several web sites with extensive listings of motor oils and their ZDP content, most of the information is several years old and does not apply to currently available oils. If you have any doubts about the ZDP content of a specific motor oil, just look at the API "donut" on the label— if it doesn't contain a "CF" "CF-2", "CF-4" "CG-4", "CH-4", "CI-4" or "CJ-4", the oil isn't rated for use in diesel engines and consequently contains little or no ZDP. Also keep in mind that CJ-4 oil has a lower ZDP content than other "C" category oils. ZDP levels are measured in parts per million or ppm, but in some cases, you may find "zinc and phosphorous" or ZDP content expressed as a percentage. (Phosphorous refers to the phosphate in zinc

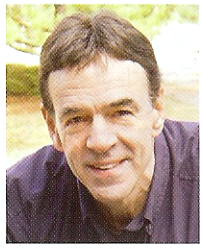
diakyl dithiophosphate.)

So if some ZDP is good, conventional wisdom would have it that more is better. As usual, conventional wisdom is out of touch with reality. Even in oils that have extremely high levels of ZDP, those levels are typically only 1300 to 1500 ppm (Which is the equivalent of .13% to .15%.). And that's all you really need after initial break-in is completed. For reference, motor oils with an API rating of "SJ" have a ZDP content of .10% or less. "SM" motor oils have less than .08% ZDP and some have as little as .05%. On the other hand, once ZDP levels exceed 1500 to 2000 parts per million, the potential for burned ash accumulations in the ring lands and on the piston domes increases dramatically. It's for precisely this reason that most cam manufacturers recommend draining ZDP-spiked oil (and refilling the crankcase with unspiked oil) within a few hundred miles after engine break-in is completed.

It's only a concern if an excess amount of ash is present in the combustion chambers of engines equipped with catalytic converters, but ash accumulations in the ring lands is a potential trouble source for all engines. Over time, these accumulations can interfere with ring-cylinder wall seal and can actually lead to cylinder wall scoring.

One piece of conventional wisdom that is usually correct is to avoid using motor oils that don't have the API seal or donut on their containers. Such oils are usually of questionable quality at best. But if you're looking for oil that has a reasonable ZDP content, your best bet may in fact be "donut-less" oil because API requirements don't apply to oils labeled as "racing", "heavy-duty" or "off-road". However, the caveat about quality still applies. If you purchase any oil that doesn't contain the API donut, make sure it's manufactured by a reputable, well-known company.

It's obviously too late to make a long story short, and now that you know more about ZDP than you care to, it should be equally obvious that you have two choices—you can use current "SM" rated oils and pour in a ZDP additive, or you can find a diesel, racing, motorcycle or off-road oil and eliminate the need for an additive. One solution isn't necessarily better than the other, but one may be significantly less expensive. ■



With six technically oriented automotive books and over 1,500 magazine articles to his credit, Dave Emanuel is regarded as one of the nation's most respected automotive journalists. During the past 20 years, his work has appeared in popular publications such as Motor Trend, Road & Track, Hot Rod, Corvette Fever and Popular Science to name only a few of the more than twenty magazines.

Dave's technical expertise and extensive hands-on experience, combined with his personal relationships with many of the nation's top high performance engine builders and Detroit engineers, allows him to provide readers with unique insights into the high performance and racing aspects of engines and drivelines. Dave is also involved with private enterprise and offers insight on yet another possible power source. Go online for more information: **www.randomtechnology.com**