SynMax Performance Lubricants
13750 Metric Drive, Roscoe, IL. 61073 www.synmaxperformancelubricants.com

TECHNICAL BULLETIN – API Modern Street Motor Oil vs. Break-In Motor Oil

API (American Petroleum Institute) Question: Modern Street vs. Break-In Motor Oil:

The purpose of this technical bulletin, is to lay out the facts about Break-In and street (standard automotive) engine oil formulations that are API rated / licensed or are NOT API rated / licensed, zinc diorgano dithiophosphate (ZDDP) and the chemical limits associated with some of the different API ratings. Answering much that has been written and discussed about today's engine oils not being the same as they use to be and their use in Break-In engine applications especially in those Break-In engine applications that employ the use of flat tappet or roller type lifter camshafts.

Articles have been written by oil marketing companies, stating that if the engine oil has an API rating of either SJ, SL, or SM or has an API license as indicated by the presence of the API "Donut" on the container that it either does not contain any zinc diorgano dithiophosphate or enough zinc diorgano dithiophosphate (also known as ZDDP) in order to prevent premature flat tappet or roller camshaft failure. Just because an engine meets or exceeds a particular API Service Classification or is licensed by the API this does not mean that the particular engine oil can or cannot be used in Break-In applications and will or will not protect against premature flat tappet & roller camshaft wear.

The ability for flat tappet & roller camshaft wear (also bearings and other components) to be reduced (increased durability) is subject to the total amount of anti-wear additives and surface technology used within the formulation. This requires study for the customer to get the current facts (2008 and beyond). Information contained within this document will answer many of the questions that need to be answered. Remember to always ask questions and find out for yourself.

The Importance of Zinc Dithiophosphate:

One of the primary functions of engine oil is to reduce wear. This is particularly important heavily loaded applications, such as those found racing engine that employ the use of flat tappet and rolling cam followers. **Normally metal-to-metal contact is prevented by the engine oil's lubricant film being thick enough to keep the contact metal surfaces of the engine separated**. However, during periods of high shock loading, high pressures, high speeds, heavy loading, or at cold start-up, **the lubricant (or hydrodynamic) film between the two metal surfaces is either squeezed out or rupture.** This "lubrication film squeezing" out not only causes the two metal surfaces to come into contact with each other, but also causes the entire load to be carried by the contacting metal surfaces of the two mating parts. **Once this "lubrication film squeezing" occurs, severe wear, galling and eventual failure of the metal surfaces can take place, unless some means is found to prevent metal-to-metal contact.**

Thoughts as stated in the book Lubrication Fundamentals; "In heavy loaded applications, flat tappet cam followers operate on partial oil films at least part of the time. **Lubrications with advanced anti-wear additives are necessary if rapid wear and surface distress are to be avoided.** The oil additive zinc diorgano dithiophosphate (ZDDP) is to provide anti-wear activity for the camshaft and lifter. With the increase use of roller follower cams (in production and higher performance engines), the requirements for anti-wear have been changed to prolong the life of emission control devices".

The high valve spring pressures in pushrod engines require higher levels of formulated anti-wear, especially flat tappet engines. Again the book Lubrication Fundamentals shares this thought: **"Loading on the rubbing surfaces in the valve train may be high, particularly in high speed engines**, where still valve springs must be used to ensure that the valve close rapidly and positively. **This loading can result in lubrication failure unless special care is taken in the formulation of the lubricant"**.

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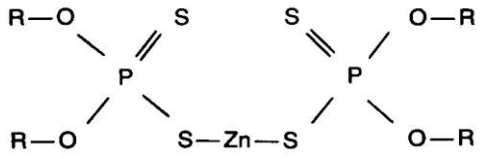
Anti-wear additives are used within the formulation of the engine oil to combat metal-to-metal contact. Anti-wear additives prevent metal-to-metal contact by adding film forming compounds which protect the metal surfaces either by a physical absorption or a chemical reaction with the metal surface, just when temperatures rise due to initial metal-to-metal contact in order to form a low shear film at the point of contact. **These films are weaker than the underlying metal and can easily slide over each other without welding or causing other damage also reducing wear. The films formed by anti-wear additives also prevent excessive friction energy losses.**

ZDDP is a universal type of additive since it not only functions as an anti-wear additive but also as an oxidation and rust and corrosion inhibiting additive.

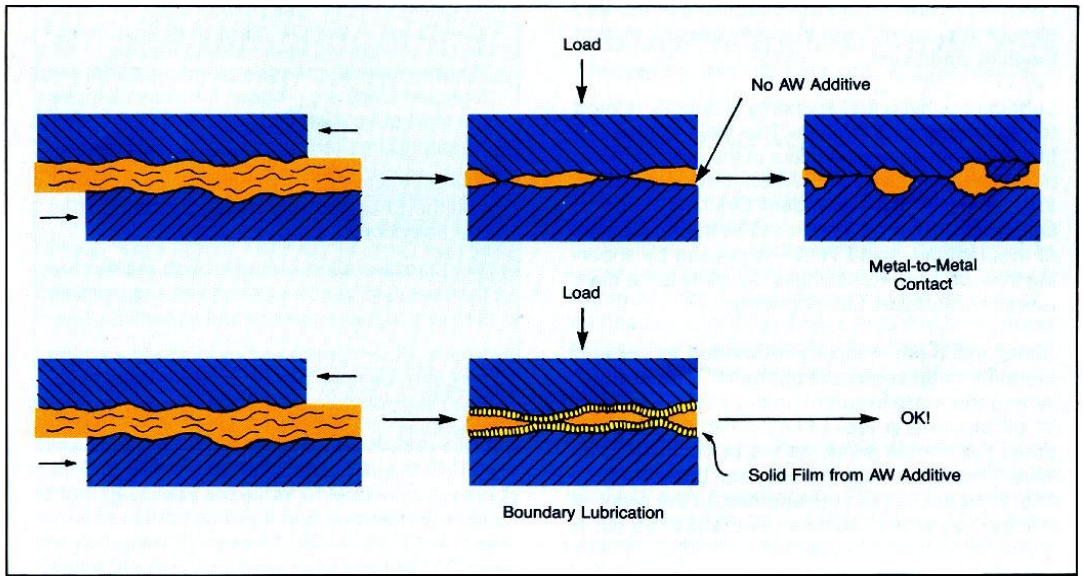
ZDDP comes apart at high temperatures in the engines to form protective films of zinc sulfides and zinc phosphates. These films bond to the metal surfaces and prevent the metal surfaces from contacting with each other. As fresh metal is exposed by rubbing, the ZDDP forms new films and so on until the anti-wear additive is used up.

ZDDP chemical structure looks like this:



The R's can be either alkyl (straight or branched hydrocarbon chains) or aryl (aromatic hydrocarbon rings) or a combination of both. The main purpose is to make oil-soluble all of the inorganic compounds in the molecule (such as the zinc, ZN) so they can be carried by the engine oil where it is needed.

Anti-Wear Additives Mode of Action



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API Engine Oil Ratings and Symbols:

The API administers the licensing and certification of engine oil performance standards through the Engine Oil licensing and Certification system. This system's purpose is to define, certify and monitor engine oil performance.

To qualify for a license or certification engine oil marketers must submit an application in which they identify each product's brand name, viscosity grade and API category being licensed. They must attach data sheets reporting the chemical and physical properties of each viscosity grade for each brand name being submitted. The candidate engine oil must be supported by engine testing using the American Chemical Council's Code of practice and must comply with the API's base oil interchange/viscosity read-across guidelines. The marketer must sign an affidavit that test data is available to support the performance claims.

If the candidate engine oil qualifies, the oil marketer must enter into a formal licensing agreement to display the API Certification Mark (Starburst) and/or API Service (Donut) on their oil containers. They must also pay licensing and annual royalty fees associated with engine oil licensing and certification. Licensed and certified engine oils are subject to review by the API's Aftermarket Audit Program.

Once engine oil is licensed the marketer can then display the API's engine oil symbols on its containers. The API labeling system consists of two symbols: the API Service Symbol and the API Certification Mark.

API Service Classifications

There are currently three active API "S" service classifications for passenger car engine oils. They are:

API SM is the newest category. It was introduced on November 30, 2004 and provides full protection for all gasoline engines. API SL, designated for 2001 model year & older, is scheduled to become obsolete.

SM (Current) 2004 for all automotive engines currently in use introduced November 30, 2004 SM oils are designed to provide improved oxidization, resistance, improved deposit protection, better wear protection, and better low temperature performance over the life of the oil. Some SM oils may also meet the latest ILSAC specification and/or qualify as energy conserving.

SL (Current) 2001 and older Gasoline Engine Service

SJ (Obsolete) 1997 and older Gasoline Engine Service.

SG (Obsolete) 1989 and older Gasoline Engine Service.

SF (Obsolete) 1980 and older Gasoline Engine Service.

SE (Obsolete) 1972 and older Gasoline Engine Service.

Zinc and Phosphorus Levels in Engine Oils:

For the past decade phosphorus levels in engine oils that are designed to be used in passenger car, truck and SUV gasoline powered engines have been lowered in order to protect the emission control systems of these vehicles.

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Phosphorus in engine oils can deactivate the noble metal catalysts found in the vehicles emission system by coating and building up on the active catalyst sites, causing irreversible damage that accumulates over time. As a result, increased levels of harmful emissions such as NO_X, carbon monoxide and hydrocarbons pass through the catalytic converter unchanged and into the atmosphere.

Because of this potential it has resulted in reductions in phosphorus levels beginning with the introduction of ILSAC GF-2 specification (the starburst symbol you see on quart and gallon containers).

This reduction in phosphorus also resulted in a reduction in the amount of zinc present in the engine oil since the primary source of phosphorus comes from the Zinc Diorgano Dithiophosphate (ZDDP) aka Zinc Dithiophosphate (ZDP) in the shorter version.

The ILSAC GF-2 set phosphorus limits of (1000 ppm) 1.0% by weight max for engine oils used in passenger car, truck and SUV gasoline engines. **By the 2004 model year with the introduction of the ILSAC GF-4 specification (the latest API Starburst Classification) phosphorus levels were reduced to (600 ppm) .6% by weight min to (800 ppm) .8% by weight max** with an additional requirement that engine oils that meets both the ILSAC GF-4.

These restrictions and limits on phosphorus can be further confirmed in the API's "*1509 Engine Oil Licensing and Certification System 15th Edition, April 2002 Technical Bulletin 3 August 19,2004*" and in the following statement on page 2 of the American Petroleum Institute's "*Form BGF4SM Engine Oil Licensing and Certification (EOLCS) Application For Licensure Part B-Product Data Sheet":*

Phosphorus limits of 800 ppm max and 600 ppm min apply to API SM SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30 oils. **A phosphorus limit of 1000 ppm max applies to API SJ** SAE 0W-20, 5W-20, 5W-30 and 10W-30 oils **and API SL** SAE 0W-20, 0W-30, 5W-20, 5W-30, and 10W-30 oils.

Limit of (1200 ppm) 1.2% by weight max applies to API SH SAE 5W-30 and 10W-30 oils (SH must be preceded by a "C" category). If CF-4, CG-4, CH-4 and/or CI-4 categories precede SM or SL and there is no API Certification Mark, the limit for phosphorus does not apply.

Many experts in the automotive industry (including cam shaft and engine builders) have previously agreed the use of heavy duty diesel truck oil for the break in process because of the higher levels of Zinc (ZDDP) – up to (1500 ppm) 1.5% by weight.

This idea worked previous to 2007 before the updated diesel oils where forced to reduce the anti-wear content within the oils (CI-4 Plus) to 1200 ppm (1.2% by weight).

Reason is that newer engine truck designs (2007 or newer) have catalytic converters with modern emission systems – just like their automotive little brothers.

FACT: 1000 - 1200 ppm (1.0% – 1.2% by weight) is not enough anti-wear protection for the high performance component Break-In applications (especially cam & solid or rolling lifters).

Customer users need to be educated – oils which were selected previous to 2007 for break-in or other performance applications, needs to be seriously re-evaluated. That is why Titan Performance Lubricants has provided a special product for break-in only applications.

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True motor oils are considered "for off-highway / off-road use only" or on the label because they have a full load of anti-wear and specialty additives. Specialty break-in oils normally aren't embossed with the consumer-friendly API donut or starburst insignia. Such Break-In oils won't meet manufacturer's warranty requirements for new vehicles, may degrade catalytic converter performance in long-term use.

Specially formulated break-in motor oil contains more anti-wear additives than modern diesel truck oil, as well as other performance-enhancing ingredients specifically designed for hardcore, high-performance break-in gasoline engine usage.

Current diesel oils not have friction modifiers claimed as helpful in preventing piston scuff on high-performance gasoline engines during the break-in process.

NOTE: High levels of Zinc/ ZDDP anti-wear application break-in motor oils, because of the aggressive use of anti-wear additives (1500 – 2000+ ppm) 1.5% - 2.0% by weight or greater is designed for short term break-in or heavy duty use and is not recommended for long term use (2 hours dyno or testing time) By preventing metal-to-metal contact, damaging frictional wear is prevented from occurring, especially in heavily loaded valve-trains that employ flat tappet camshafts.

By having this additional anti-wear(frictional modification and anti-oxidation protection that is needed), Titan Performance Lubricants break-in engine oil is specifically designed for the application **will providing a superior margin of protection against bearing, component and valve train wear, which in turn can help with increased engine piston ring / cylinder wall mating performance.**

SynMax Break-In Motor Oil is the best for the application:

- **"Heavier weight density" petroleum base oils with a proprietary "sticky" additive designed to work upon, protect and cleanse metal surfaces during the short term break-in process. This also helps with improved and immediate piston ring / cylinder wall mating and power-up sessions.**
- **Higher levels of Zinc (ZDDP) for much needed anti-wear protection (2000 ppm) during the highest RPM, Torque and Performance requirements**
- **Detergency to properly cleanse internal motor parts etc., with oxidation protection.**
- **Low Detergency allows increased compression performance.**
- **NO MOLY allowing the clean and exact leveling of the metal surface micro peaks and valleys for premium matching of internal motor components.**

The amount of ZDDP / anti-wear present in break-in oil application can be found in Table I

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TABLE 1

PRODUCT NAME SAE WEIGHT	DESIGN APPLICATION	BASE OIL TYPE(ADDITIVES)	ZINC(ZDDP) & SYNMAX™ ANTI-WEAR PPM
SYNMAX™ Racing #640520 (SAE5W-20) #640530 (SAE5W-30) #640540 (SAE5W-40) #640550 (SAE5W-50)	Professional Competition Racing ONLY	PAO & Synthetic (DLA* Technology)	1500 – ZDDP 2000 SynMax™
SYNMAX Racing™ #682050 (SAE20W-50)	Professional Competition Racing ONLY	100% Petroleum (DLA* Technology)	1500 – ZDDP 2000 SynMax™
Classic Hot-Rod™ #771030 (SAE10W-30) #771040 (SAE 10W-40)	Older OEM Design Classic & Hot-Rod Engines	100% Petroleum (Moly)	1500 – Zinc 1500 – Phosphorus 500 SynMax™
SYNMAX™ Street and Heavy Duty Performance #880520 (SAE5W-20) #880530 (SAE 5W-30) #881030 (SAE 10W-30)	Standard Automotive Applications for Street and Heavy Duty	PAO & Synthetic (DLA* Technology)	800 – Zinc 800 – Phosphorus 400 SynMax™
SYNMAX Break-In™ #181045 (SAE10-45)	Break-In Motor Oil Special Formulation	100% Petroleum	2000 – Zinc 2000 – Phosphorus
		*Diamond Like Additives™ (DLA)	(Typical Average) (PPM - parts per million)

