SynMax Performance Lubricants
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TECHNICAL BULLETIN – API Question: Race Oil vs. Street Oil

API Questions answered regarding Race Oil vs. Street Oil both in design and application.

This technical bulletin will lay out the facts and differences about racing (professional competition off-road) 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 racing engine applications especially in those racing 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 racing 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 people want to know. 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 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"**. Bottom Line: for success Professional Competition Race Engines require oils specifically created for the application.

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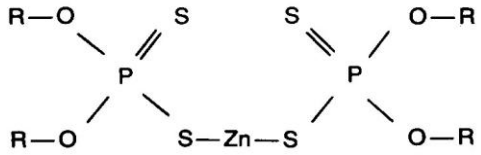
Anti-wear additives are used within the formulation of the engine oil to combat metal-to-metal contact. Anti-wear additives prevent metal-to-metal contact by adding film forming compounds which protect the metal surfaces either by a physical absorption or a chemical reaction with the metal surface, just 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.

There are many types of anti-wear additives, yet the most widely used and predominant type of anti-wear additive used in the formulation of engine oils for the past 50 years is zinc diorgano dithiophosphate (ZDDP). 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.

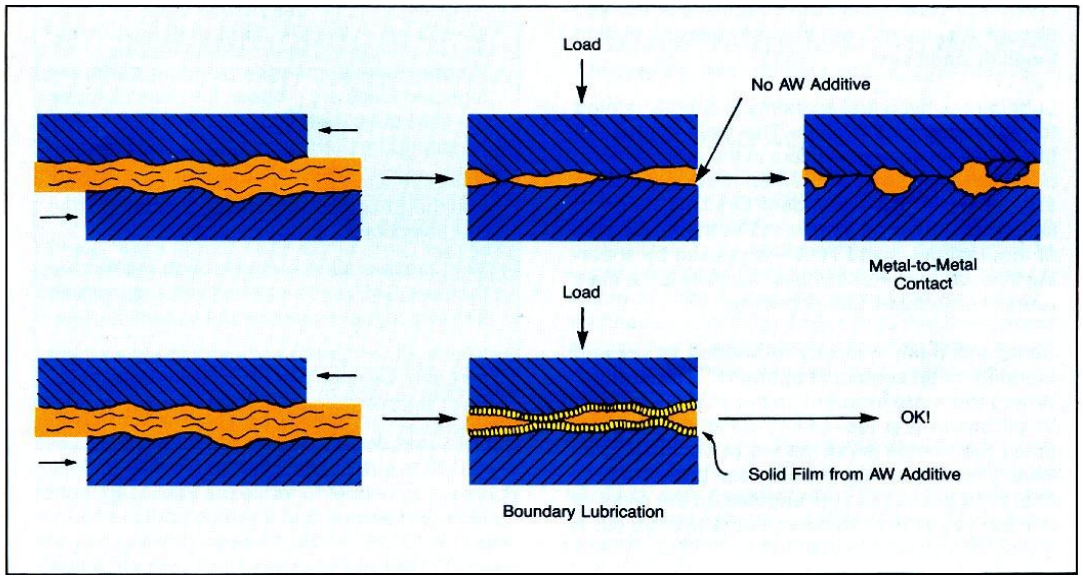
ZDDP comes apart at high temperatures in the engines to form protective films of zinc sulfides and zinc phosphates. These films bond to the metal surfaces and prevent the metal surfaces from contacting with each other. As fresh metal is exposed by rubbing, the ZDDP forms new films and so on until the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

When the levels exceed 1200 ppm (.012) – maximum 1500 ppm (.015) and the engine (hi-performance or older) has combustion or piston ring blow-by problems can happen. Once the oil enters the combustion chamber (from blow-by) Zinc phosphate particles will separate from the oil under extreme combustion temperatures (explained above). These Zinc phosphate particles will attach unto the crown of the piston. Valve face and imbed into the spark plug. This further created "hot spots" upon these components causing detonation commonly called "combustion detonation" or "pre-detonation" or "spark detonation".

Problem which happens with high levels of Zinc phosphate particles attaching or coating upon a catalytic converter causing damage, is the same principal which applies to the piston combustion area.

SynMax™ solves many of the problems regarding high levels of anti-wear or Zinc (ZDDP):

SynMax Performance Lubricants has provided a proven solution for the required higher levels of anti-wear 3000 ppm + for the ***"off road - professional competition race only"*** application. SynMax uses a proprietary anti-wear additive (originally developed by a confidential program for the military) which works in team work with the Zinc (ZDDP) named SynMax™. This SynMax™ special formulation increases the ppm level – (often in racing applications – doubling the anti-wear levels of most race oils) without increasing the adverse effects of high levels of regular Zinc (ZDDP) above 1500 ppm (.015). SynMax uses an additional 2500 ppm of their proprietary formulation which takes up to 3Xs the amount of heat compared to standard ZDDP (over 1000F) while it operates and burns cleaner. This greatly reduces the effects of pre-detonation from hot spots upon parts within the combustion chamber. Since most racing or older engines have combustion blow-by, the SynMax™ advantage solves the problem.

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 an 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.

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API Service Symbol

The API Service symbol, which is commonly called the Donut, is used for both diesel and gasoline engine oils. The Donut is designed to provide specific information to the consumer regarding the engine oil's viscosity grade, the service classification and specific information such as if the engine oil meet energy conserving capabilities or supplemental specifications such as API CI-4 Plus. The Donut can be placed anywhere on the container.

The API symbols compare as follows:

The Donut Symbol

- Is displayed on only some API licensed products.
- Applies to gasoline engine oils only.
- Engine oils displaying this symbol:
  - Meet the most up-to-date performance standards set by ILSAC.
  - Must be energy efficient, so only certain viscosity grades are eligible.
  - Must be suitable for all previous performance standards.

The Starburst Symbol

- Is displayed on only some API licensed products.
- Applies to gasoline engine oils only.
- Engine oils displaying this symbol:
  - Meet the most up-to-date performance standards set by ILSAC.
  - Must be energy efficient, so only certain viscosity grades are eligible.
  - Must be suitable for all previous performance standards.

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API Certification Mark

The API's star shaped Certification Mark is commonly called the Starburst. This symbol tells consumers that the engine oil meets the most up-to-date requirements for gasoline powered vehicles as outlined by the latest ILSAC Specification. (Currently GF-4). Engine oils carrying the Certification Mark are energy conserving and are suitable for all previous model years. The mark is always displayed on the front of the container**.**

The API Certification Mark remains the same for a given application even if a new minimum engine oil performance standard is developed by ILSAC. Many automobile manufacturers recommend and specify the use of engine oils that carry the API Certification Mark.

All engine oils that are licensed through the API must display the API Service Symbol (Donut). Those engine oils that display the API Certification Mark (Starburst) must meet additional requirements above those service classifications used for the API Donut. Gasoline engine oils that meet both the API and ILSAC Standards are engine oils that are preferred for and specified for use by gasoline vehicle OEMs. API licensed engine oils that meet Starburst requirements must display both API symbols.

API Service Classifications

The API Service Categories are named with an alphanumeric system that consists of two letters that sometimes are followed by a number. The first letter is always either "S" for gasoline engine service or "C" for commercial diesel engine service. Second letter increases sequentially with each new category as engine oil evolve to match new performance requirements. Number 2 or 4 may also follow the two letters in the "C" classification to identify if a motor oil is formulated for two-stroke or four-stroke diesel engines.

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.

ILSAC Specifications:

The standards developed by ILSAC are the basis for API and automotive industry standards for passenger car engine oil quality. The ILSAC specifications not only incorporates the various ASTM engine sequence and laboratory bench tests used to qualify an engine oil as meeting a certain "S" category, but it also can include more stringent pass/fail limits for these engine sequence tests and laboratory and additional test methods, such as for fuel economy tests and chemical limits.

Only engine oils meeting the SAE Viscosity Grades 0W-XX (such as 0W-30), 5W-XX (such as 5W-20, 5W-30, etc) and 10W-XX (such as 10W-30) can qualify as meeting the ILSAC specification.

The most current specification is ILSAC GF-4, which became active on July 31, 2004. Previous specifications, which are now obsolete include GF-1, GF-2, and GF-3. ILSAC GF-4 is backward compatible with all previous GF standards

Although the ILSAC GF standards apply only to a limited set of viscosity grades-namely SAE 0W-XX, 5W-XX and 10W-XX multi-grades, where "XX" can only be 20,30,40,50 and 60, practically speaking only the –20 and –30 grades stand any chance of passing the fuel economy requirements that have been set by the ILSAC GF specifications. Because of the requirements for ILSAC GF-4, particularly in the area of fuel economy.

Only SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30 viscosity grades can meet both the requirements of ILSAC GF-4 and API SM Service Classification.

The API SM service classification parallels the ILSAC GF-4 standard in all respects except for the fuel economy requirements. In fact as applied to these ILSAC specified SAE viscosity grades, there are virtually no differences between the two standards. This results in for the first time, all SM qualified engine oils that are marketed under the SAE viscosity grades that are defined in the ILSAC GF-4 standard being required by the ILSAC/Oil Committee to also meet the stricter chemical limits for phosphorus and sulfur and fuel economy limits of the ILSAC GF-4 standard.

Where ILSAC defined SAE viscosity grades are not used or specified the definition of the API SM Service Classification excludes any form of chemical limits for sulfur and phosphorus

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TECHNICAL BULLETIN – API Rating Question: Racing vs. Street Oil

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. 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 the 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 0.1% by weight maximum 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 0.06% by weight minimum to 0.08% (800 ppm) by weight maximum with an additional requirement that engine oils that meets both the ILSAC GF-4.**

API Service Classification SM for SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30. For all other viscosity grades such as SAE 0W-40, 5W-40, 5W-50, 15W-40, 15W-50, and 20W-50 or those engine oil that meet only the API Service Classifications Gasoline Engine Oil Service Classifications SL and SM or API Service Classifications SL/CF, SM/CF, CF-4/SL, do not have any restrictions on the amount of phosphorus that can be present in the engine oil.

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 0.08 max and 0.06 min apply to API SM SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30 oils. A phosphorus limit of 0.10 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.**

A limit of 0.12 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.[6]

***SPECIAL NOTE:* SynMax Performance Lubricants automotive products (Street & Heavy Duty Performance) meets and exceeds API Service Classification SM for SAE 5W20, 5W30, 10W30 oils**

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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 (0.15). That 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 (0.12). Reason is that the newer engine truck designs (2007 or newer) have catalytic converters with modern emission systems – just like their automotive little brothers.

FACT: 1000 - 1200 ppm (0.10 – 0.12) is not enough anti-wear protection for the high performance component 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 SynMax Performance Lubricants has provided a special product for break-in applications and competition race only applications.

Today's true racing motor oils are marked "for off-highway / off-road use only" or "for competition use only" on the label because they have a full load of anti-wear and specialty additives. Specialty racing oils normally aren't embossed with the consumer-friendly API donut or starburst insignia. Such racing oils won't meet manufacturer's warranty requirements for new vehicles, may degrade catalytic converter performance in long-term use. Most cases have not been formally submitted to the oil industry's current benchmark performance test and validation procedure.

Even better than diesel oil are specially formulated racing motor oils. Although the most expensive solution, these oils usually contain even more anti-wear additives than diesel truck oil, as well as other performance-enhancing ingredients specifically designed for hardcore, high-performance gasoline engine usage. Current diesel oils not have friction modifiers claimed as helpful in preventing piston scuff on high-performance gasoline engines, especially if running modern low multi-viscosity oils (5W20 or 5W30).

SynMax Performance Lubricants provides field tested proven performance driven engine oils (and other specialty products) to the racing and automotive industry developed at the highest levels of aerospace and chemical engineering SynMax engines oils contain a sufficient amount of ZDDP / SynMax™ anti-wear additives to protect against premature wear for the specific application(s).

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NOTE: High levels of Zinc/ ZDDP anti-wear application racing oils, because of the aggressive use of anti-wear additives (1500 ppm 0.15 or greater) is designed for short term racing or heavy duty use and is not recommended for long term use or long drain interval applications (standard automotive like 5,000 – 7,000 miles+). Such long term applications require a street or heavy duty performance designed oil.

In addition to a sufficient amount of ZDDP SynMax™ anti-wear each of the engines oils SynMax's proprietary additive named: Diamond Like Additive™ (DLA) Technology (a special combination of nano diamond carbonates). ZDDP/SynMax™ (aka Zinc) and (DLA) are polar molecules, so they attract to carbon steel surfaces where they react with heat and friction to create a coating superior to Moly (MoS2).

Diamond Like Additive™ (DLA) Technology gets into and upon the smallest cracks, sprawls and fissures of the metal surfaces performing two main duties 1) increasing the durability and 2) decreasing friction by providing a plating action (through heat and physical friction upon the metal surfaces of the components to form a long lasting slippery solid lubricant film, which prevents the metal surfaces from coming into contact with each other. By preventing metal-to-metal contact, damaging frictional wear is prevented from occurring, especially in heavily loaded valve-trains that employ flat tappet camshafts.

The use of Diamond Like Additive™ (DLA) Technology is particularly well suited for use in racing engine applications where adverse conditions such as high pressures, high shock loads, high speeds and long duration races cause the engine oil's lubricant film to break down and prevent metal-to-metal contact. Temperature and pressure between the mating metal surfaces causes the Diamond Like Additive™ (DLA) Technology to be physically attracted into and upon the metal's surface.

Co-efficiency friction performance comparison with moly alone:

Diamond Like Additive™ (DLA) Technology 0.0275 vs. Moly 0.08 (co-efficiency of friction)

In addition to these aspects it has been found that Diamond Like Additive™ (DLA) Technology not only enhance ZDDP / SynMax™ anti-wear and friction reducing capabilities but also function as an antioxidant which enhances the engine oil's resistance to high temperature oxidation therefore increasing the performance of oil viscosity stability.

By having these additional anti-wear, frictional modification and anti-oxidation protection that is needed, SynMax Performance Lubricants engine oil that are specifically designed for the racing application will provide a superior margin of protection against bearing, component and valve train wear, which in turn can help with increased engine performance (higher horsepower and torque at lower rpm's), durability and longer engine life.

These same advantages for the high performance or competition professional racing area's also apply to standard automotive applications to increase fuel efficiency (economy), durability and longer oil drain intervals.

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The amount of ZDDP / SynMax™ anti-wear present in different designed engine oils used in Racing, Street Automotive or Classic Hot-Rod applications can be found in Table I.

TABLE 1

PRODUCT NAME SAE WEIGHT	DESIGN APPLICATION	BASE OIL TYPE (ADDITIVES)	ZINC(ZDDP) & SYNMAX™ ANTI-WEAR % WEIGHT
SYNMAX™ Racing **#640015 (SAE 0W-10)** **#640015 (SAE 0W-15)** **#640520 (SAE5W-20)** **#640530 (SAE5W-30)** **#640540 (SAE5W-40)** **#640550 (SAE5W-50)**	**Pro Stock** **COLD QUALIFY** **Competition Racing ONLY**	**PAO & Synthetic** **(DLA* Technology)**	**.1500 – Zinc** **.1500 – Phosphorus** **.2500 SynMax™**
SYNMAX Racing™ **#682050 (SAE20W-50)**	**Competition Racing ONLY** **Alcohol applications.**	**100% Petroleum** **(DLA* Technology)**	**.1500 – Zinc & Phous.** **.2500 SynMax™**
Classic Hot-Rod™ **#771030 (SAE10W-30)** **#771040 (SAE 10W-40)**	**Older OEM Design Classic & Hot-Rod Engines**	**100% Petroleum** **(DLA* Technology)**	**.1500 – Zinc & Phous.** **.500 – SynMax**
SYNMAX™ Street and Heavy Duty Performance **#880520 (SAE5W-20)** **#880530 (SAE 5W-30)** **#881030 (SAE 10W-30)**	**Standard Automotive Applications for Street / Heavy Duty**	**PAO & Synthetic** **(DLA* Technology)**	**.800 – Zinc & Phous.** **.400 SynMax™**
SYNMAX Break-In™ **#181045 (SAE10-45)**	**Break-In Motor Oil** **Special Formulation**	**100% Petroleum** **(Low Detergent)**	**.2000 – Zinc & Phous.**
		***Diamond Like Additive**	**(Typical Average)**

