STEEL SHIELD TECHNOLOGIES

Automotive System

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE

We're the Champion, let's help you make yours !

THE **ABF** Technology

www.steelshieldtech.com.hk

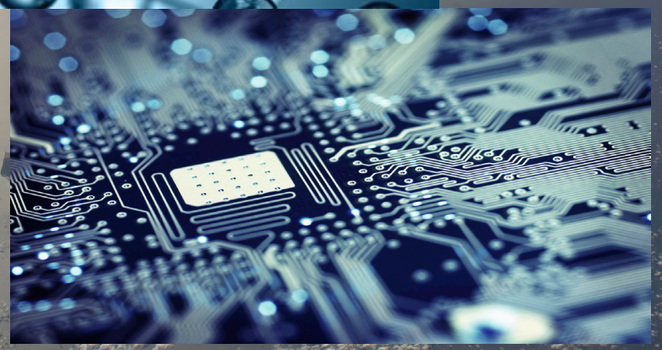
Serving the Industry since 1985

World's 1st Ionic-Maglev Lubrication Technology

CONTENTS

World's 1st Ionic-Maglev Lubrication Technology

WORLD'S 1ST IONIC-MAGLEV
LUBRICATION TECHNOLOGY



1. MAKING A DIFFERENCE IN LUBRICATION

"It is our conviction that to be the best is not sufficient, we are here to make a new World Standard in Lubrication."

Company Vision & Commitment

Steel Shield Technologies sole purpose is to manufacture premier quality metal treatments, additives, greases and lubricant oils that have been tested to exceed the normal parameters of extreme pressure and anti-wear products in the aftermarket, hereby offering matchless performance and unsurpassed protection against wear while saving maintenance costs, downtime, energy and improving overall functionality of your machineries.

Steel Shield, Not Just Oil, It's Technology which makes a difference to the World of Lubrication.

Steel Shield aims at helping customers to achieve the highest return on investment (ROI). Steel Shield is committed to strengthening business and global commerce through manufacturing and distributing, World-wide, the full line of ABF Technology products made in the USA, Singapore and Hong Kong.

2. THE CORPORATION & FACILITIES

Steel Shield Technologies Inc. (USA) with its history traced back to 1985 when in USA, Pennsylvania the scientist Dr. George C Fennell in the research and development of high-end specialty lubricants invented the unique ABF Formula – Ionic Levitation. In the same year Muscle Product Corporation trading as MPC was founded by George Fennell, brother Jay Fennell and father, Richard Fennell and the purpose was to market his invention MT-10. In 2006 at a board meeting held on 22nd May George resigned all his duty from MPC. In the same year George found STEEL SHIELD TECHNOLOGIES INC and renamed his invention MT-10 as Steel Shield. As of then MPC and its products are no longer being supported by George either in performance or quality.

The Company's blending and manufacturing capabilities are state of the art and the ability to produce limitless volume of product is unsurpassed as well as the product quality. The equipment is all stainless steel including the flow lines, pipes and couplers. All pumps and gauges are digitally interpreted and of the highest quality and accuracy to ensure production of the most superior quality lubricants.

STEEL SHIELD TECHNOLOGIES (ASIA PACIFIC) LIMITED WAS INCORPORATED IN 1996 IN HONG KONG TO PROVIDE DISTRIBUTION AND TECHNICAL SUPPORT FOR THE ENTIRE ASIA-PACIFIC RIM.

3. INVENTOR SCIENTIST - DR. GEORGE C FENNELL

Father of ABF Technology
Doctor of Astronomy and Astrophysics

Accreditation:

SAE (Society of Automotive and Aerospace Engineers) Member

ASNE (American Society of Naval Engineers) Member

NCMA (National Contract Management Association) Member

STLE (Society of Tribologists and Lubricant Engineers) Member

In 1985, Dr. George C Fennell, a former scientist in Astronomy and Astrophysics doing consulting and contract work in advanced lubrication and surface Tribology, formulated a revolutionary metal treatment oil additive which can activate "ABF" (Advanced Boundary Film) through a proprietary and unique "electro-chemical ionization" (ECI) process. He has been known in the industry as the "Father of ABF Lubrication".

On the basis of ABF technology, a series of specialty lubricants have been developed to meet the stringent requirements of various purposes and working conditions, as to date is still the most advanced formula in lubrication.

Over the years, there have been countless people trying to resemble Dr. Fennell's unique formula and advanced chemistries, none was found even remotely close. To this date, Dr. Fennell is still the leader in tribology and lubrication.

4. THE BIRTH OF STEEL SHIELD TECHNOLOGY

BIO-ORGANO LUBRICATION TECHNOLOGY

During World War II, the German Science and Technology Research Institute was commissioned to develop a new lubricant technology in meeting the stringent demand for heavy duty military application such as artillery, armored vehicles, tanks, battleships and fighter-aircrafts to avail them in performing their maximum fighting capacity with minimal maintenance.

The scientists proposed the concept of Zero friction, i.e. Faraday's Law Like-Charge-Repel.

Shortly after WW II, a great number of intelligent scientists migrated to the United States from Europe. One of them was the grandfather of Dr. George Fennell, who came to USA along with him a large volume of research data and material about Zero friction. The old scientist continued to pursue his scientific research and eventually in 1986 his grandson Dr. George Fennell came with a breakthrough in the technology. Through Electro Chemical Ionization (also known as Reactive Chemical Bonding) Dr. Fennell was able to realize Maglev between two metallic surfaces and to achieve a close to Zero Friction Coefficients.

The great accomplishment was the result of relentless efforts of 3 generations scientists over half a century. In recognition of the excellent contribution of Fennell's family to the country, the US Government has named the street outside their old factory Fennell Avenue as a compliment.

SOMEWHERE, SOMETHING INCREDIBLE IS WAITING TO BE KNOWN.

~Carl Sagan

5. ABOUT ABF TECHNOLOGY

BOUNDARY FILM LUBRICATION THROUGH ADVANCED HALOGENATION TECHNIQUES: OXIRANE ACID SCAVENGING AND ORGANO-METALLIC SUBSTITUTION

BY GEORGE C. FENNELL

Steel Shield Technologies' mechanism of operation is based upon Tribology methods that improve lubricity and load carrying capacity by improving surface characteristics and creating a stable chemical, corrosion controlled halide-based boundary film. Steel Shield's active components react with each other and the contacting asperities of the metallic surfaces to provide five mechanisms of improvement.

1. Advanced chemical boundary film formation through reactive chemical bonding.
2. Ring opening, oxirane acid scavenging and advanced corrosion inhibition.
3. Organo-metallic substitution of surface metal and free radical reactionaries.
4. Improved surface smoothness and rolling out of irregular contacting asperities.
5. Re-conditioning and molecular reconstruction of the original contacting metal surfaces.

The process of advanced boundary film formation is accomplished with an advanced combination of halogens that are controlled and rendered non-corrosive to the base metals of the system and pose no threat to the ozone layer or waste oil recovery systems due to their origins and long chain molecular lengths. These halogens initially react under thermal conditions with the organo-metallic reagents to form surface attaching compounds, thereby limiting and controlling the formation of halides from the base metals themselves. These surface attaching reagents or "electro-negative compounds" seek out and affix themselves to the lower surface areas referred to as micro-pores and fissures, as all metals are crystalline in structure and exhibit a lattice type matrix. This complex process also incorporates Van der Waal forces and dipole-dipole surface reactions. During this process, surface lapping and asperity (irregular microscopic contacting and opposing surfaces) roll-out is also achieved, yielding improved spread characteristics of the surfaces themselves. Due to the increase of film strength by the filling of the micro-pores and fissures, along with thermal modification of the asperities, the resulting effect is a gradual rolling out or flattening of the metal asperities rather than a breaking off or chip-away process, which would create metallic debris in the lubricant leading to abrasive wear from wear metal particles. The resulting improvement in the opposing metal surfaces further increases the fluid film strength, which is dependent on the degree of surface roughness and viscosity.

Viscosity, however, is a lesser consideration when incorporating boundary additives or halogenation techniques.

In general, boundary friction and wear consists of two components, a shear or adhesion component and a plowing or deformation component. Considering the following equation:

$$Fs = SAr$$

Where Fs is the shear component, which predominates except when asperities sink too deeply into a boundary lubricant film or a soft opposing surface. When movement or sliding occurs, the shear friction force depends on the shear resistance per unit area, S, of any "boundary film" in the real load-supporting area between asperities. Dividing by the load, W gives the shear contribution to the friction coefficient, becoming independent of total load and apparent area of contact:

$$fs = S * Ar / W = S / Pp \text{ or } S / Pe$$

The boundary film shear resistance, S, is assumed equal to the plastic flow shear stress, Tp, of an ideal elastic, plastic solid. Such a solid gives shear stress independent of strain and strain rate at strains sufficiently large enough to cause plastic flow. The conditions that produce the "glass transition" from liquid to plastic-like behavior are dependent on the viscosity of the material at normal temperatures and pressures and the variation of viscosity with temperature and pressure. In other words, glass transition depends strongly on chemical composition.

These results show that liquid lubricants act like plastic solids in the films between asperities. Therefore, S=Tp in the previous equation and the friction coefficient is Tp/Pp or Tp/Pe. Since Tp is a weak function of temperature and pressure, and Pp or Pe are independent of apparent contact load, the frictional coefficient for a given combination of lubricant and sliding surfaces tends to be independent of operating conditions.

Elasto-hydrodynamic lubrication (ELH) on an asperity scale deposits film material between sliding surfaces in "micro-rheodynamic" (micro-RHD) lubrication. As one surface slides, each asperity carries with it an aggregation of SST additive. Sufficient pressure and temperature is developed within the film to elastically deform the asperity and to force the extreme pressure reagent between the surfaces or into the micro-pores and fissures. During this time, high thermal conditions involving pressure and asperity contacts initiate a re-conditioning of the surfaces utilizing the existing oil to quench and cool the surfaces in the same process. A thermal restructuring of these asperity contact areas creates a deviation from the normal crystalline structure of the metal, expanding it into an austenitic crystalline pattern, which is more evenly structured and allows the SST additive to bond to the actual lattice of the metal, endowing it with new and unique properties upon cooling.

Organo-metallic substitution is a technique developed and designed to inhibit the process of halide formation from the base metals of the system under reaction. For example, instead of the halogen reacting with the iron in the system to form iron halides, a boundary surface salt, it reacts with a reagent having very similar properties to the iron atom itself, thereby forming a organo-metallic complex without scavenging the target metal surface itself, and depleting the metal in a chemically corrosive wear syndrome.

The process is very similar or analogous to the saponification of organo-metallic compounds in the manufacturing of greases. During this reaction or saponification, compounds react at a certain catalytic temperature and exchange characteristic components to form new compounds. These new chemical compounds are then used to aid in a boundary regime by providing an added protection to the actual surfaces being lubricated. Ring opening oxirane acid scavenging and corrosion inhibition is another chemical technique used to neutralize acids and inhibit oxidation and corrosion. This technique involves the use of specifically engineered complex ethylene oxide; oxirane rings, that possess reactive reagents which will cause a cleavage of the ring when encountering acids or strong alkaline. These reactions occur in the presence of both anionic- and cationic-type catalysts. Anionic catalysts can include alkoxide ions, hydroxides, metal oxides, and some organo-metallic derivatives while Lewis acids and protonic reagents initiate cationic reactions.

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n H2C - CH2 n

The lubricity, load carrying capacity, surface improvement, and wear reduction are greatly improved while corrosive aspects of halogenation are virtually eliminated.

References:
CRC "Handbook Of Lubrication, Theory And Practice", Volumes 1 & 2, by E. Richard Booser, Ph.D., Society of Tribologists and Lubrication Engineers (STLE), copyright 1992, Eighth Printing.
"Organic Chemistry" 4th Edition, by Robert Morrison, Ph.D. and Robert Boyd, Ph.D., copyright 1983 by Allen & Bacon.
"Lubrication - A Tribology Handbook", edited by M.J. Neale OBE, BSc(Eng), published by Society of Automotive Engineers (SAE), copyright 1993, Butterworth-Heinemann, Ltd.
CRC "Handbook Of Chemistry and Physics", 1986 Edition, by CRC Press, edited by David R. Lide, copyright 1986 by CRC Press.

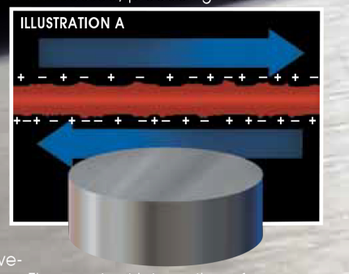
Steel Shield Technologies Has Redefined Lubrication.

Webster's Dictionary defines lubricants as substances capable of reducing friction, heat and wear when introduced between two solid surfaces. From the initial development and use of lubricants, chemical technology has constantly advanced to make them more effective. From changes in refinement processes to the development of additives, the concentration has always been to increase the ability of the lubricant to reduce the friction, heat and wear. **Steel Shield Technologies** has changed the approach to lubrication and, in essence, given new definition to the term. First, there are a few points to consider.

Metal Against Metal

The structure of all metals creates a surface characterized by a series of sharp peaks and valleys, some microscopic and some larger. As two metal surfaces contact each other and move in opposite directions, friction is caused, producing heat and metal deterioration. This friction-causing physical dynamic is heightened by the electromagnetic field created on the surfaces of each metal. The sharp peaks, known as asperities, and valleys, referred to as micro-pores and fissures, have opposite electro-magnetic charges. **Illustration A** shows a new metal with positive-charged asperities and negative-charged micro-pores and fissures. The constant interaction of these opposite-charged features works to weaken the structure of the metal, causing eventual deterioration of the surface of the part.

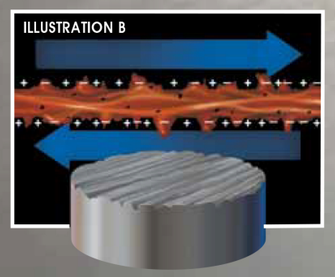
ILLUSTRATION A



Normal Lubricants Help

All lubricants help to slow this process to different degrees. **Illustration B** shows the results after a period of time of use of a typical oil lubricant. The constant friction and electro-magnetic interaction has caused the weakened metal to break off or chip away creating metallic debris in the lubricant leading to abrasive wear from wear metal particles. This fact is evidenced in the need to change the engine oil of automobiles frequently as the lubricant "breaks down" due to the heat and metallic debris.

ILLUSTRATION B



Advanced Boundary Film Technology- There Is No Better Protection Against Wear.

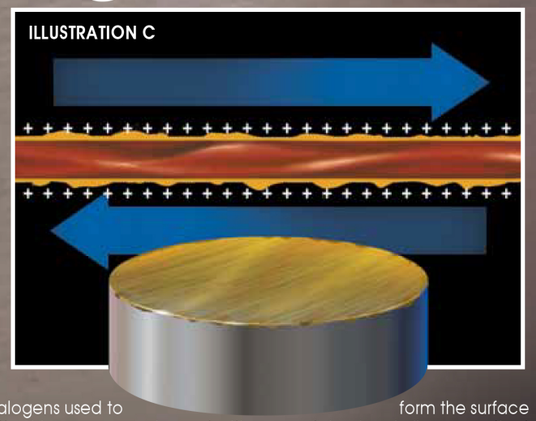
See Extreme Condition Lubrication Test At www.steelshieldtech.com

Steel Shield Technologies has redefined lubrication by breaking away from the standard approach to making the lubricant more effective through adjusting the refinement process or through the use of additives. Instead, **Steel Shield Technologies** approaches lubrication by improving the surface characteristics of the metal through the process of **Advanced Boundary Film** formation. This technological breakthrough is accomplished by addressing the naturally formed asperities, micro-pores and fissures and the electro-magnetic charges they create.

Steel Shield products consist of an advanced combination of halogens which react under thermal (heated) conditions to form electro-negative surface attaching compounds. They seek out and affix themselves to the lower surface areas, filling the micro-pores and fissures. As this process is working, the thermal conditions are effecting the asperities. Instead of breaking off because of a weakened metal state, the asperities gradually roll out or flatten. So while the micro-pores and fissures are filling up, the asperities are flattening for an end result of a metal surface that is greatly improved. Created in this process is a total positive state of polarity. When the metal surface polarity becomes uniform in charge, there is a reduction in friction due to the Faraday reaction of like-charges. This electrochemical process continues at the molecular level to form an **Advanced Boundary Film** on the surface of the metal. **Illustration C** shows the end result of the production of the **Advanced Boundary Film** and the resulting uniform positive polarity.

Another aspect of this advanced technology is the organo-metallic substitution which is the chemical process designed to inhibit halide formation. Here, the

ILLUSTRATION C



halogens used to form the surface attaching compounds react with reagents having similar properties to the iron atom. The halogens, therefore, do not scavenge the target metal surface to find iron with which to react, forming halides and creating a chemically corrosive wear syndrome. Instead, an organo-metallic complex is formed as the basis of the **Advanced Boundary Film.**

Industrial Success Comes To The Consumer

Steel Shield Technologies is now bringing this breakthrough technology to the consumer after great success on the industrial level. The level of commitment to the Steel Shield product in the railroad industry is an indication of its performance in the most extreme conditions imaginable. This same technology is now available to you.

As has been explained, the **Advanced Boundary Film Technology** is a redefining approach to lubrication which provides outstanding benefits to the user.

Practical Elimination Of Metal-To-Metal Wear

Steel Shield Technologies addresses the three areas that cause the weakening and deterioration of the metal surfaces:

- The physical friction of rough surfaces
- The opposite electro-magnetic charges that exist on the metal surface
- The chemical reactions that produce corrosive agents.

Advanced Boundary Film Technology instead strengthens the metal and practically puts an end to metallic debris in the lubricant.

Reduced Operating Temperatures

Friction is reduced so significantly that the operating temperature in treated mechanisms is notably reduced. The end result is a stronger metal that maintains its original specifications and performance level. An example of the reduction of operating temperatures is found in the independent tests that show a drop of an average of 30 Fahrenheit degrees in treated automobile engines.

Increased Effectiveness Of The Lubricant

Whatever lubricant is used as the carrier of the **Steel Shield Technologies** additive, that lubricant is allowed to perform at its maximum efficiency. Lubricant flow will be enhanced with the elimination of rough metal surfaces; the reduction of heat and elimination of metal debris will protect the lubricant from "break down."

7. MAJOR BREAKTHROUGHS IN LUBRICATION TECHNOLOGIES

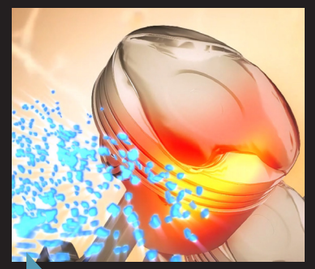
1. Virtual Zero Friction - RCB Ionic levitation
Faraday's Law like-charges Repel & Dipole-Dipole Reaction

2. Dynamic Heat Transfer
Lubricant accumulates at the hot spot automatically

3. Non Corrosive Cleansing
Metal sludge repelled via induction and removed

Virtual Zero Friction Technology

Lubricants Accumulate at Hot Area & Protect



Clean Engine By Repelling Metal Debris

4. Metal Surface Re-hardening
From Shear Friction to Surface Lapping

5. Eliminate System Dysfunction
Not Just Oil, It's Technology

Metal Surface Hardened & Stronger

Engine Keep Running at High Efficiency

8. RCB ELECTROCHEMICAL IONIZATION ADVANCED LEVITATION TECHNOLOGY

Metal Surface Positively Charged

Metals Repel Each Other

Magnetic Levitation

Near Zero Friction

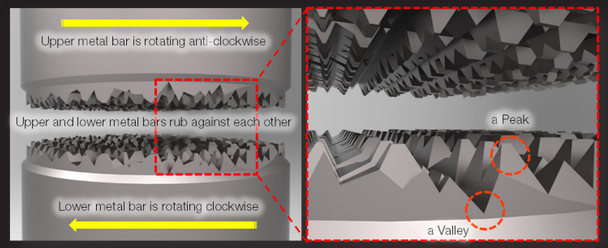
Positively Charged Metal Surface

Repel Each Other

9. ABF TECHNOLOGY DETAILED EXPLANATIONS

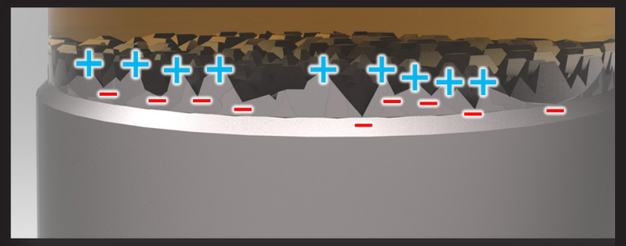
1. METAL SURFACE

Under microscope, metal surface characterized by series of peaks and valleys, Peaks (known as “asperities”), and Valleys (referred to as “micro-pores” and “fissures”).



2. CHARGES OF THE METAL SURFACE

Peaks are positively charged and Valleys are negatively charged.

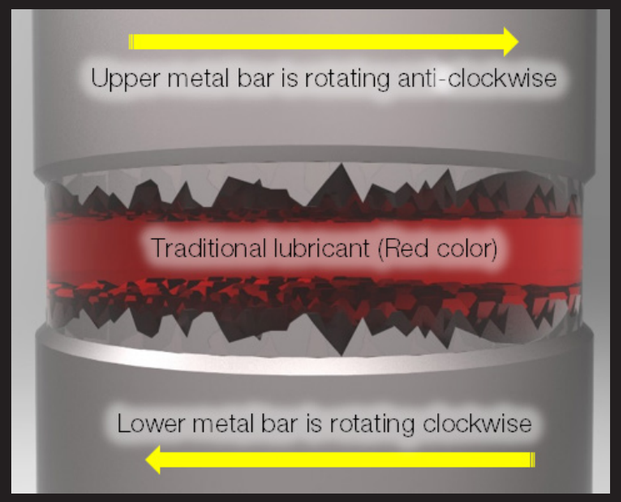


3. TRADITIONAL LUBRICANTS

A. Traditional lubricants help slow the process of heat and friction to some degree.

B. When 2 metal surface contact each other and move in opposite directions, friction is caused, producing heat & metal deterioration.

C. Constant friction & electromagnetic interaction causes the weakened metal to break off creating metallic debris & particles in the lubricants



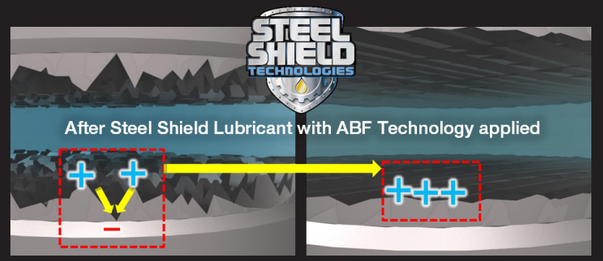
4. STEEL SHIELD TECHNOLOGY

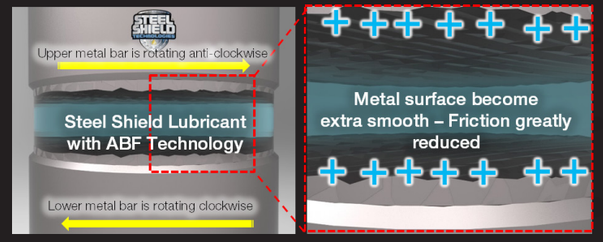
A. Forms electro-negative surface attaching compounds to seek out & affix themselves to lower surface areas filling the micro-pores & fissures.

B. Asperities roll out or flatten creating greatly improved metal surfaces.

C. Created in this process is a total positive state of polarity.

D. When metal surface become uniform in charge, there is a reduction in friction due to Faraday reaction of like-charges.





5. ADVANCED BOUNDARY FILM

A. Advanced methods of tribology that improve lubricity and load carrying capacity

B. Reacts chemically under thermal conditions with the contacting metal surfaces to form a complex surface-attaching film of protection

C. Surface smoothing is accomplished resulting in improved spread characteristics of the surfaces themselves

D. Increases fluid film strength resulting in greatly reduced wear while imparting extreme pressure properties (EP)

10. ADVANTAGES & TARGETED INDUSTRIES

1. Concept

Van der Waals Forces
Dipole-Dipole Surface Reactions

2. Advantages

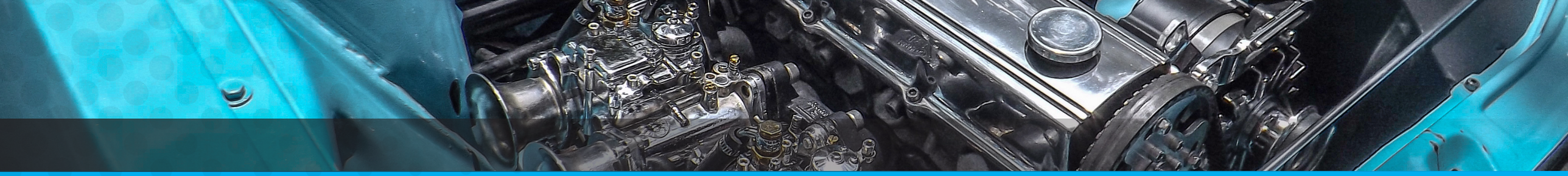
Reduces Friction and Wear
Provides Smoother Operation
Improves Lubrication
Non-Toxic and Helps Build Green Environment
Improves Machinery Functionality
Improves Fuel Economy
Reduces Operating Temperatures
Protects Moving Metal Parts
Eliminates Cold Start Problems
Reduces Maintenance & Downtime
Extends Component Reliability & Parts Life

4. Targeted Industries

Automotive & Racing, Airlines & Ground Equipment,
Rail & Mass Transit, Shipping
Gas, Oil & Energy Industries, Mining & Drilling
Lifts, Air Conditioning & Cold Storage Systems
Industrial, Agriculture, Construction & Naval Engineering
Military & Law Enforcement units

II. AUTOMOBILE ENGINE OPERATIONS & LUBRICATIONS

"The primary objectives of lubrication of reciprocating engines are the prevention of wear and the maintenance of power-producing ability and efficiency. These objectives require that the lubricant function effectively to lubricate, cool, seal, and maintain internal cleanliness. How well these factors can be achieved depends on the engine design, fuel, combustion, operating conditions, the quality of maintenance, and the engine oil itself."



11A. DESIGN AND CONSTRUCTION CONSIDERATIONS

FEATURES THAT AFFECT LUBRICATION

Among the design and construction features that affect lubrication are the following:

1. Combustion cycle: whether two stroke or four stroke
2. Mechanical construction: whether trunk, piston, or crosshead type
3. Supercharging: whether the engine is supercharged (via supercharger, turbocharger, or blower) or naturally aspirated
4. General characteristics: describing the lubricant application system as a whole

COMBUSTION CYCLE

In a reciprocating engine, the combustion cycle in each cylinder can be completed in one revolution of the crankshaft (i.e., one upstroke* and one downstroke of the piston) or in two revolutions of the crankshaft (i.e., two upstrokes and two downstrokes). The first engine is referred to as a two-stroke-cycle, or more simply, a two-cycle engine, while the second is referred to as a four-stroke-cycle, or four-cycle engine. Either cycle can be used for engines operating with spark ignition (gasoline or gas) or compression ignition (diesel). The four-stroke-cycle engine, which is more widely used, is described first.

FOUR-STROKE CYCLE

The sequence of events in the four-stroke cycle is illustrated in Figure 10.1. On the inlet or intake stroke (Figure 1), the intake valve is open and the piston is moving downward. Air or an air–fuel mixture is drawn in through the cylinder that fills the intake valve. In diesel engines only air is drawn or forced into the cylinder intake stroke; fuel is introduced through a high pressure injector at the top of the compression stroke. In most gas and gasoline engines, an air–fuel mixture is introduced through the intake valve. Newer four-cycle engine designs use injection of the fuel directly into the cylinder similar to diesel engines. As the piston starts moving up (Figure 1), the intake valve closes and the air (or charge) is compressed in the cylinder. Near the top of this compression stroke, fuel is injected and/or a spark is passed across the spark plug. The fuel ignites and burns, and as it expands, it forces the piston down on the power stroke. Near the bottom of this stroke, the exhaust valve opens so that on the next upward stoke of the piston the burned gases are forced out of the cylinder. The assembly is then ready to repeat the cycle.

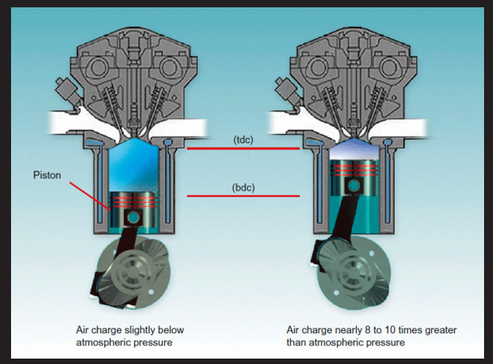


FIGURE 1 - FOUR STROKE CYCLE

- Top left: The piston is moving downward, drawing in a charge or air or air–fuel, mixture
- Top right: The valves are closed and the piston compresses the charge as it moves upward
- Bottom left: Fuel has been injected and ignited by the high temperature compressed air, or a spark is passed across the spark plug igniting the air–fuel charge, and the piston is pushed downward on the power stroke by the expanding hot gases
- Bottom right: The burned gages are forced out of the cylinder through the open exhaust valve.

Most four-cycle engines are equipped with poppet valves in the cylinder head for both intake and exhaust. Various arrangements are used to operate these valves. In the conventional arrangement, a camshaft is located along the side or center of the cylinder block depending on engine configuration. It is driven from the crankshaft by gears, by a silent chain or, in some passenger cars engines, by a toothed belt. Cam followers (often called valve lifters) of either the roller, solid, or hydraulic type ride on the cams and operate push rods, which in turn operate the rocker arms to open the valves. Valve closing is accomplished by springs surrounding the valve stems. This type of arrangement results in some mechanical lag in valve operation at high speeds; thus, some high speed automotive engines have the camshafts located above the cylinder head so that the cams bear directly on the valve stems or on short rocker arms. This arrangement is called overhead camshaft construction. The cam drive for many of these units utilizes a toothed rubber belt, but a few designs incorporate gear drives for the overhead cams. Some large, medium, and low speed diesel engines now are equipped for direct operation of the valves in a somewhat similar manner, and fully hydraulic valve actuation is also used on a few engines. The complete valve operating mechanism is often referred to as the valve train.

Loading on the rubbing surfaces in the valve train may be high, particularly in high speed engines, where stiff valve springs must be used to ensure that the valves close rapidly and positively. This high loading can result in lubrication failure unless special care is taken in the formulation of the lubricant.

TWO-STROKE CYCLE

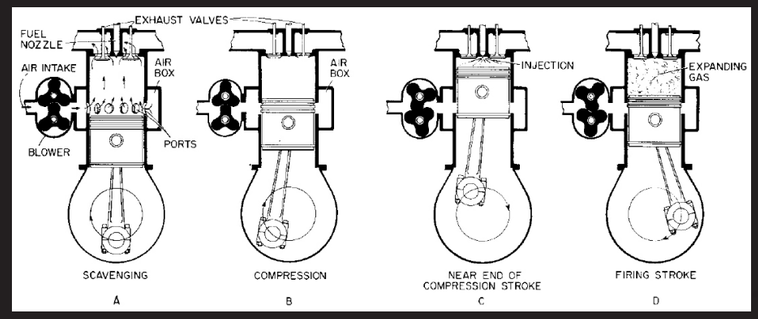


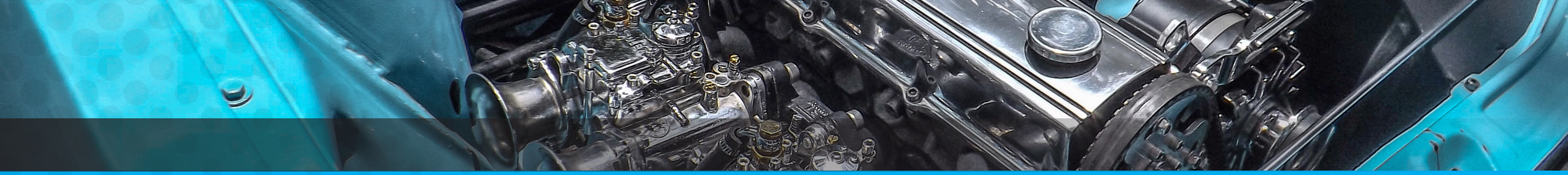
FIGURE 2 - TWO STROKE CYCLE

- A: Air from the blower is driving exhaust gas from the cylinder
- B: The charge of fresh air is trapped in the cylinder and compressed as the piston moves upward
- C: Fuel is injected; the fuel is ignited when the piston is close to the top of its stroke
- D: The hot expanding gases of combustion force the piston down on the power stroke.

The sequence of events in the two-stroke cycle is illustrated in Figure 2. Near the bottom of the stroke, the exhaust valves open and the piston uncovers the intake ports, allowing the scavenge air to force the exhaust gases from the cylinder. As the piston starts on the upstroke (Figure 2), the exhaust valves close and the piston covers the intake ports so that air (or charge) is trapped in the cylinder and compressed. Near the end of this compression stroke, the fuel is injected and begins to burn (or the charge is ignited). The expanding gases then force the piston down on the power stroke.

Two-cycle engines are usually built either with ports for intake and valves for exhaust, or with ports for both intake and exhaust. With the combination of ports and valves (see Figure 10.2), the scavenge air and exhaust gases flow more or less straight through the cylinder, so this arrangement is referred to as uniflow scavenged. With ports for both intake and exhaust, if the intake ports are on one side of the cylinder and the exhaust ports are on the other side, the engine is referred to as cross-scavenged. The scavenge air flows more or less directly across the cylinder. Where the exhaust ports are located on the same side of the cylinder as the intake ports, the engine is referred to as loop-scavenged. The scavenge air must flow in a loop into the cylinder and then back to the exhaust ports. Most small, two-cycle gasoline engines are of the cross-scavenged type, while all three types of scavenging are used for two-cycle diesel engines. In large engines, the type of scavenging has some influence on piston temperatures and the type of piston cooling (oil or water) that can be used; therefore, indirectly, it has an influence on lubricant selection.

Since the two-stroke cycle does not have a full positive exhaust stroke to rid the cylinder of combustion gases, the scavenging process must be assisted by pressure developed outside the cylinder. This can be accomplished by means of a separate blower or compressor, driven either by the engine or an outside source, or by what is known as crankcase scavenging. With crankcase scavenging, the section of the crankcase under each cylinder is sealed, except for a check valve to admit air (or charge) on the upstroke of the piston, and a transfer passage to permit the air (or charge) to be delivered to the intake ports as the piston approaches and goes through its bottom dead center position. A variation



of this principle is used on some large crosshead diesel engines. The lower end of the cylinder is closed and a packing gland installed where the piston rod passes through. With the addition of a check valve and transfer piping to carry the air to the intake ports, the piston then will pump air for scavenging or supercharging purposes. This may be referred to as pulse charging.

In theory—for the same bore, stroke, and rational speed—a two-stroke-cycle engine will develop twice the power of a four-stroke-cycle engine. As a result, more fuel is consumed per unit of time, the cylinder and average temperatures tend to be higher, and more contaminants may find their way into the oil. On many two-stroke-cycle engines, the oil is mixed with the fuel.

MECHANICAL CONSTRUCTION

Most piston engines, including all automotive engines, are of the trunk piston type. Large, low speed diesel engines for marine propulsion and industrial applications are usually of the crosshead type.

In a trunk piston engine, the piston is connected directly to the connecting rod by a piston pin or wrist pin. Thus, the side thrust from the crankpin and connecting rod must be carried through the piston and rings to the cylinder wall. This may result in high rubbing pressures on one side of the piston (thrust side) and on the mating section of cylinder wall.

In a crosshead type of engine, the piston is connected rigidly to a piston rod, which is connected to the crosshead containing the wrist pin. The crosshead also has a sliding guide bearing to absorb the side thrust from the crankshaft and connecting rod. This bearing is usually generously proportioned so that these thrust loads are readily carried by the lubricating films. No side thrust is carried by the piston. The cylinder assembly is usually completely separated from the crankcase, whether by means of a diaphragm containing a packing gland or by having the lower end of the cylinder closed which can be used for pulse charging.

Crosshead-type engines are also built with double-acting pistons, or with two pistons acting in opposite directions in the same cylinder—engines having this configuration are said to be opposed-piston engines. One of the chief disadvantages of crosshead construction is that it results in an engine that has a greater overall height than a trunk piston engine of the same horsepower. However, most engines with bores above 600 mm (24 in.) are of the crosshead type.

SUPERCHARGING

One of the factors that limits the power developed by an internal combustion engine is the amount of air it can “breathe.” It would be easy to supply more liquid fuel, but it would be undesirable to exceed the quantity the available air can burn more or less completely. Supercharging is a method of increasing the available combustion air by supplying air at higher pressure, thus making it possible to burn more fuel and produce more power.

The air for supercharging is provided by a supercharger, turbocharger, or blower, which may be driven by an engine, a motor, or an exhaust gas turbine. The latter is probably most frequently used now. With some large engines, supercharging by the blower may be supplemented by pulse charging.

Since supercharging increases the amount of air in the cylinders, and thus the amount of fuel that can be burned, it tends to raise combustion temperatures and pressures, and to increase the deteriorating influences on the lubricating oil. To increase supercharging efficiency, the compressed air is sometimes cooled between compression and engine intake.

METHODS OF LUBRICANT APPLICATION

Small and medium-sized trunk piston engines usually are lubricated by a combination of pressure and splash. Oil under pressure is fed to the main and crankpin bearings and, from the crankpin bearings, through drilled passages to the wrist pin bearings. Oil under pressure is also fed to an oil gallery, from which it is distributed to the camshafts, valve lifters, and rocker arms. Oil is splashed to the lower cylinder walls to lubricate the rings and cylinders and to the undersides of the pistons for cooling. In some larger engines, oil is sprayed under pressure to cool piston undersides. Eventually, all this oil, neglecting the small amount that finds its way into the combustion chambers and is burned, drains back to the crankcase and is reused.

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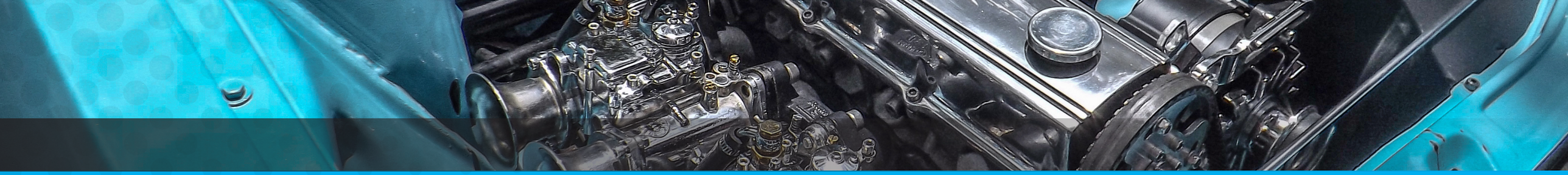
In some cases, the crankcase is arranged for dry sump operation with a reservoir, and possibly an oil cooler for the main supply. Where this arrangement is used, cylinder lubricant is supplied from the wrist pin supply.

Trunk piston engines with bores approximating 250 mm (10 in.) usually have separate cylinder lubricators of the mechanical force-feed type. Any excess cylinder lubricant then drains back into the crankcase supply, carrying contaminants with it. Crosshead engines are equipped with at least two separate lubrication systems. One system supplies the lubricant for the cylinders, while a second system supplies the main and crankpin bearings and crossheads, and usually the piston rod packing glands. A third system may be provided to lubricate the supercharger, or the supercharger may be lubricated from the crankcase system. Piston co ling oil is also supplied from the crankcase system in engines with oil cooled pistons. There is little or no contamination of the crankcase oil of trunk piston engines by excess cylinder oil, other than the minor amounts that may leak past the packing glands. However, any used cylinder oil that is collected above the diaphragms may present a disposal problem because it is generally unsuitable for further use and is extremely difficult to recondition satisfactorily.

A complicating factor in high output, late model, crosshead engines with oil-cooled pistons is that piston temperatures may be high enough to cause thermal cracking of the oil while it is in the piston cooling spaces. This can lead to buildup of deposits in the piston cooling spaces, overheating of the pistons, and eventual cracking or other mechanical failure.

Most small two-cycle gasoline engines, such as are used for marine outboard and utility purposes, are arranged for crankcase scavenging. To control the amount of oil carried into the cylinders with the charge, these engines are designed for dry sump operation. A small proportion of oil is premixed with the fuel, or injected, so the charge consists of a mixture of air, fuel, and oil. Some of the oil condenses on the crankcase surfaces, where it provides lubrication of the main, crankpin, and wrist pin bearings. Also, some of it is carried into the combustion chambers, where it is burned with the fuel. Incomplete combustion of this oil, or the use of the wrong type of oil, can cause spark plug fouling and combustion chamber and port deposit buildup.

An important consideration with any internal combustion engine is the volume of oil in the system in proportion to the amount of contaminants that must be carried by the oil. Generally, large engines in marine and stationary applications can be arranged so that the volume of oil is large, and since operation is at essentially constant speed, combustion efficiency can be kept high. The rate of contaminant buildup is then quite low and usually can be controlled to some extent by means of sophisticated purification equipment. With automotive engines, the amount of oil that can be carried into the system is proportionally much lower, for a variety of reasons. With automotive gasoline engines, particularly, it is desirable to restrict the volume of oil to promote more rapid warm-up. In addition, the lower oil volume is more economical when frequent periodic changes must be performed. Having a lower oil volume helps to evaporate both the water of condensation and that diluting fuel, which result from start–stop operations and cold starting. However, the variable speed conditions under which automotive engines operate, along with frequent starts and stops, tend to reduce combustion efficiency, with the result that the rate of contaminant buildup in the oil is relatively high. The newer, more fuel-efficient engine designs incorporating fuel injection systems are helping reduce contaminant levels in the oils by providing cleaner, more efficient combustion even in start–stop operation. Use of smaller oil quantities also leads to higher operating temperatures for the oil under extended operation, which in turn means that the exposure of the oil to oxidizing conditions may be more severe.



1 1 B. FUEL AND COMBUSTION CONSIDERATIONS

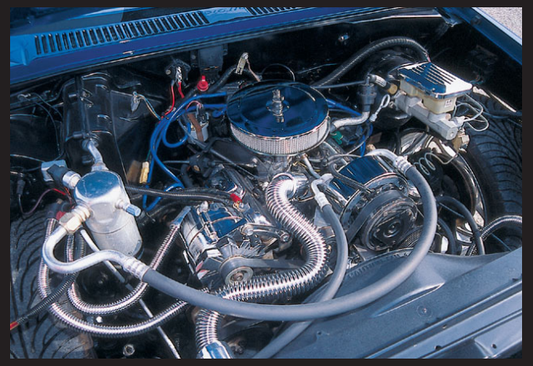
When a hydrocarbon fuel is burned, certain products and residues are formed. One of the most important of these is water. In the case of liquid fuels, the volume formed is slightly greater than the volume of fuel burned. If the engine is fully warmed up, virtually all this water passes out of the exhaust as vapor. If the engine is relatively cold, or under certain pressure and temperatures conditions in the cylinders, some of the water may condense and eventually find its way into the crankcase, where it will mix with the engine oil. The amount of condensation that occurs and the other residues that are formed are largely dependent on the type of fuel and the operating conditions of the engines it is burned in. High temperature thermostats in the cooling system both help reduce the levels of moisture and improve combustion conditions.

GASOLINE ENGINES

Most of the four-cycle gasoline engines have automotive or similar applications. In these applications, the engine is generally started cold and may operate much of the time at below-normal temperatures, either in stop-and-go conditions or when carrying a light load. Under these conditions, a significant amount of the water formed from combustion of the gasoline may condense on the cylinder walls and eventually reach the crankcase by way of blowby past the pistons and rings. In doing so, it tends to wash the lubricant films off the cylinder walls and promote rusting or corrosion. The rust formed is scuffed off almost immediately, but in the process metal is removed, and what appears to be mechanical wear occurs. In the crankcase and in other areas where temperatures are low, the water can combine with the oil and other contaminants to form sludge that is usually of a soft, sticky consistency.

When a gasoline engine is cold, the air–fuel mixture must be enriched by choking to provide enough vaporized fuel for starting. Some of the excess liquid fuel is blown out the exhaust, but a proportion of it drains past the pistons and into the crankcase, usually carrying with it some partially burned components and fuel soot. As the engine warms up, much of the gasoline is evaporated off, but some of the heavier ends, some of the partially decomposed materials, and any solid residues remain in the oil. Even when the engine is fully warmed up, some of these fuel decomposition products blow by into the oil.

Fuel soot and partially burned fuel and water, when present in the oil, can lead to the formation of varnish, sludge, and deposits. Rusting of ferrous surfaces and corrosion of bearings



can be promoted, particularly by the residues. Upon combination with small amounts of oil residue burned or partially burned in the combustion chambers, the solid residues, such as fuel soot, can form deposits that adhere to piston tops and combustion chamber surfaces. Deposits of this type can significantly increase the fuel octane number requirement of an engine by reducing the combustion chamber volume (increased compression ratio).

The use of unleaded gasolines required for engines equipped with catalytic converters may have the effect of reducing the amount of rust and corrosion that occurs. In some older engines, the absence of the lead antiknock additives in the gasoline may result in accelerated valve wear, called valve recession. Generally, this relates more to metallurgy than to lubrication. Somewhat higher operating temperatures result from the emission controls, but these have not presented a major problem from the lubrication point of view. The use of exhaust gas recirculation (EGR) to control emissions of nitrogen oxides (NOx), along with other emission control changes, may result in a greater tendency to form valve stem and engine deposits.

Two-stroke-cycle gasoline engines have such applications as outboard motors and motors for snowmobiles, chain saws, and utility purposes such as pumps and lighting plants. These engines are lubricated by oil mixed with the fuel, so some oil is always present in the charge. Under low speed, low load conditions, such as trolling in a boat, poor combustion can result in heavy buildup of port and piston crown deposits. Ashless and low ash oils tend to help control the level of deposit formation that is attributable to the ash-containing additives in the formulation.

DIESEL ENGINES

Diesel engines in trucks generally operate at more nearly constant speed and higher load factors than gasoline engines. Thus, combustion conditions are more nearly optimum, and water condensation and fuel dilution are not as serious problems. Where excessive fuel dilution occurs, it is usually the result of a mechanical problem, such as a faulty injector or defective turbocharger. Diesel fuel is not as readily evaporated from the engine oil as is gasoline; thus, if a problem exists, the concentration of diesel fuel will tend to increase steadily. This can lead to deposits and a reduction of the oil viscosity sufficient to promote mechanical wear.

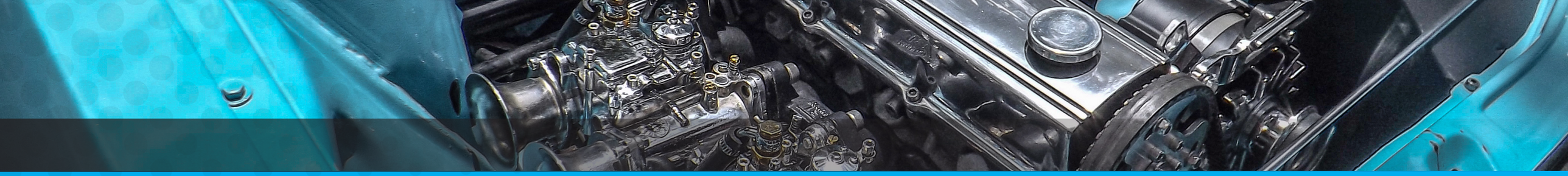
One of the major problems with diesel engines used to be the level of sulfur in the fuel. Sulfur can be present in diesel fuels in a considerably higher concentration than in gasolines, and although some current regulations require sulfur levels in diesel fuels to be below 500 ppm, in many areas sulfur levels are higher. When sulfur burns, it forms sulfur dioxide, part of which may be further oxidized to sulfur trioxide. In combination with water, these sulfur oxides form strong acids that not only are corrosive in themselves but also have a strong catalytic effect on oil degradation. Since piston temperatures are also high, this may result in heavy deposits of carbon and varnish on the pistons and in the ring grooves. Under severe conditions, deposits may build up in the piston ring grooves until the rings cannot function properly and may even stick, causing higher oil consumption, high wear, blowby, and loss of power. Manufacturers of diesel engine passenger cars are particularly concerned about soot deposits and recommend more frequent oil drains—more than twice as many as an required for gasoline-fueled car engines.

Many large diesel engines in marine and stationary industrial service are operated on residual-type fuels with sulfur content in the 2–4% range. The strong acids formed from the combustion of these high sulfur content fuels can be extremely corrosive to rings and cylinder liners, with the result that metal removal may be rapid and wear rates excessive. Oil selection becomes more critical as fuel sulfur levels rise.

GASEOUS FUELED ENGINES

Engines burning clean gaseous fuels, such as liquefied petroleum gas (LPG: propane, butane, etc.) or natural gas, are comparatively free of the contaminating influences encountered in liquid-fueled engines. Although water is formed from combustion, most of it passes out the exhaust as vapor. Products of partial combustion that blow by to the crankcase tend to polymerize with the engine oil and cause an increase in viscosity; eventually, these may result in varnish and lacquer formation.

FIGURE 1 - LPG TAXI IN HONG KONG



11C. OPERATING CONSIDERATIONS

The operating conditions in an engine have a major influence on the severity of the service the lubricating oil is exposed to in the process of performing its functions of minimizing wear, reducing corrosion, reducing friction, assisting in cooling and sealing, and controlling deposits.

METAL WEAR

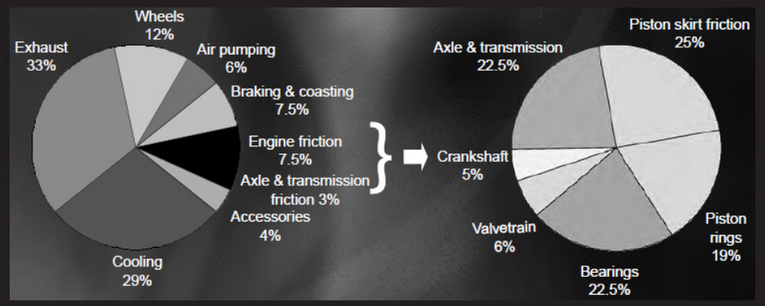


FIGURE 1 - TYPICAL VALUES FOR ENERGY LOSS IN A LIGHT-DUTY VEHICLE

- Engine friction and Axle & transmission friction contribute to 7.5% and 3 % of total energy lose in a engine
- Piston skirt friction, Axle & transmission and Bearings are the largest sources of friction which lead to energy lose

Normally, most engine wear is that experienced by cylinders, piston rings, and pistons. Less frequently, wear may be experienced in bearings and on camshafts. The three principal causes are abrasion, metal-to-metal contact, and corrosion.

Much of the dust and dirt carried into the cylinders with the intake air is hard and abrasive. Some diesel fuels (particularly the residual fuels used in many large engines) may also contain abrasive materials. Abrasive particles carried by the oil onto load-supporting surfaces of the cylinder walls and other areas can cause wear to the rings and cylinder, no matter how persistent the lubricating oil films. Fortunately, wear due to abrasives can be held to almost negligible values by the use of effective air, fuel, and oil filters. Proper maintenance of these filters is important, since a ruptured or damaged filter can allow free passage of abrasive materials.

As a result of the conditions of boundary lubrication that exist on the upper cylinder walls, metal-to-metal contact cannot be avoided entirely. The rate of wear from this cause depends to a large degree on the suitability of the lubricating oil. When the oil is of the correct viscosity and has adequate antiwear characteristics, wear due to metal-to-metal contact is kept at a low rate. However, reduced rates of oil flow and poor oil distribution, caused by deposits, can contribute to increased rates of metallic wear.

In large, highly supercharged, trunk piston engines, the side thrust on the cylinder walls is high. It has been found that some of these engines require oils with high loadcarrying ability to keep metallic wear rates to an acceptable level.

Corrosion and corrosive wear result from water or a combination of water, severe oil degradation products, and corrosive end products of combustion. When operating temperatures are low, either during the warm-up period or as a result of low load or stopand-go operation, condensation is increased and corrosive wear may be rapid. Where the use of high sulfur diesel fuels is unavoidable, the compounds formed from their combustion promotes corrosive wear. Generally, it has been found that the use of alkaline additives in the lubricating oil acts to retard this type of wear. These materials neutralize the acidic substances, reducing their corrosive and catalytic effects.

Some bearings of the hard alloy type are susceptible to corrosive attack by certain oxidation products resulting from oil degradation. Oils for engines where corrosion-susceptible bearings are used are formulated with additives that provide protection against these oil oxyproducts.

Metallic wear may be encountered on highly loaded valve train parts and fuel pump cams of some engines. This problem is most often encountered in passenger car engines. Antiwear agents are incorporated in oils for these engines to minimize wear. With this exception, metallic wear is not generally a problem with engine

bearings as long as sufficient oil of the proper viscosity is available, and there is no interruption of oil flow. Current engine technology using rollerized valve train components and electric fuel pumps will help reduce the wear.

ENGINE COOLING

Engine cooling is necessary to avoid engine damage and failure through overheating and thermal distortion. This is primarily a function of the cooling system, but the engine oil also has an important role to play in cooling, especially in large diesel engines, where forced oil cooling of the pistons is used. Heat picked up by the oil is dissipated by natural radiation from the walls of the crankcase, or by means of an oil cooler if the oil is relied on for substantial engine cooling.

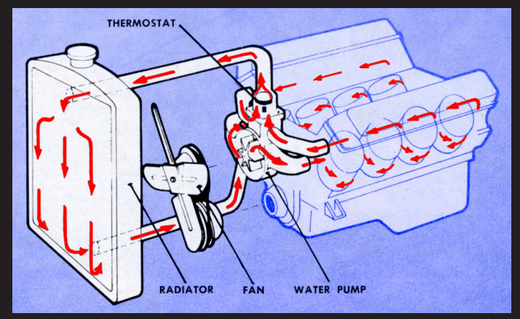
The specific heat of all-petroleum oils is essentially the same and, of itself, has no relevance in the choice of a lubricant. Of importance is chemical stability and ability to resist the formation of deposits that might interfere with heat transfer, either from the engine parts to the oil or from the oil to its cooling medium. Under the severe conditions encountered in large diesel engines with oil-cooled pistons, thermal stability—that is, the ability to resist cracking of oil and deposit formation at high temperatures—is also important.

ENGINE CYLINDER SEALING

Effective cylinder sealing is necessary to minimize blowby and thereby maintain power and economy. Blowby, which cannot be entirely prevented, is a function of engine design (speed, ring, and cylinder conformity, and provision for cylinder lubrication) and oil. The greater responsibility lies with the rings and their

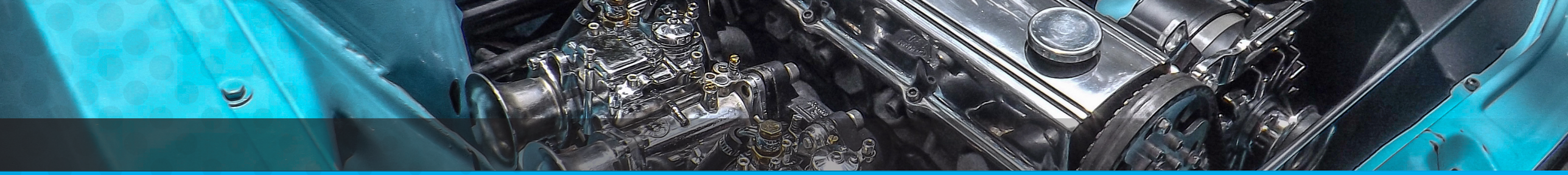
FIGURE 2 (LEFT) - PISTON WEAR DUE TO LACK OF LUBRICATIONS

FIGURE 3 (RIGHT) - ENGINE COOLING SYSTEM



ability to adjust themselves to the varying cylinder contours throughout the length of ring travel, but the oil has an important complementary role. Generally, as far as the oil is concerned, there will be maximum contribution if the ring grooves are clean and unobstructed so that the rings are free to move as required, and if there is no excessive removal of oil from the cylinder walls by the oil control rings. Too little oil on the cylinder walls not only will result in poor sealing but may result in rapid wear. This, in turn, leads to even poorer sealing. Too much oil on the cylinder walls, on the other hand, results in the exposure of more of the oil to combustion conditions, and in turn, oil consumption and rate of contaminant buildup in the oil may be high.

FIGURE 4 - PISTON SEAL



DEPOSITS

Control of deposits in an engine is a fundamental need if long life and efficient engine performance are to be realized. Deposit formation is affected by engine design, operating conditions, maintenance, fuel combustion, and the performance of the oil. In turns, deposits affect engine power output, noise, smoothness, economy, life, and maintenance cost.

Two important sources of engine deposits have been discussed briefly, namely, dirt entering with the fuel and combustion air, and the fuel combustion process. Dirt in air or fuel causes abrasive wear, as already noted. In addition, it contributes to deposits on piston crowns, in ring grooves, and on valves. Deposits in these areas are often referred to as “carbon”, but this is a loose term. Usually, analysis will show that the deposits consist of dirt, solid combustion residues such as fuel soot, lubricating oil in various stages of decomposition, and residues from lubricating oil additives. It is important to note that any analysis of an engine deposit will show additive metals. This does not necessarily mean that an “oil” problem exists.

Temperatures in the combustion zone are high; thus, continued exposure of oil reaching this area causes it to oxidize, crack, and polymerize to heavier hydrocarbons. Large amounts of deposits in the combustion zone may be caused by excess amounts of oil reaching the upper cylinder area. Other possible causes are maladjustments in the fuel system, improper fuels that cause smoky combustion, poor ignition, faulty or worn valve guides, or worn cylinders and rings.

Diesel engines are not particularly sensitive to deposits in the combustion zone, but gasoline engines are, especially those with high compression ratios. Depending on the character of the deposits, continued exposure to the combustion process may cause them to glow, which may provide an unwanted source of ignition. Undesirable combustion phenomena such as knock, preignition, rumble, and run-on can result. Use of a higher octane fuel is usually beneficial in alleviating these problems, as is use of an oil that has less tendency to form adhering deposits in the combustion chambers.

Deposits in ring grooves are similar in origin to those in combustion chambers, but since they are not exposed to the direct flame of combustion, they may be more carbonaceous. Toward the bottoms of the pistons (cooler areas), they also tend to have a higher oil content. In severe cases, groove deposits can be packed so tightly in the clearance spaces behind the compression rings that the rings cannot operate freely. Compression pressure cannot then be maintained, and blow by becomes excessive. Also, oil control ring slots may become plugged; thus, oil control is lost.

Piston varnish is also formed from fuel and oil decomposition products. It may vary from a smooth, shiny, almost transparent coating often called lacquer to a dark, opaque coating that becomes progressively more carbonaceous with continued operation.

Valve deposits (Figure 6) are sometimes observed. These are generally the decomposition products of both fuel and oil, formed somewhat in the same manner as combustion chamber deposits. Intake valves may show more deposits than exhaust valves, particularly when they run cool because of low load operation. Under this condition, there is a greater opportunity for droplets of gasoline to form gums on the valve stems. Dirt and solid residues will then adhere to these gum deposits. In some designs of overhead valve engines, oil flow down the valve stems is excessive, and this speeds up deposit formation, as well as being wasteful of oil.

The other major type of deposit is the emulsion or sludge formed by water, fuel decomposition residues, and solid residues. Sludge generally deposits on cooler engine surfaces, such as the bottom of the crankcase pan, the valve chambers, and the top decks (Figure 5). The main problem with this type of deposit is that it can be picked up by the oil and carried to areas such as the oil pump inlet screen or oil passages, where it can obstruct oil flow and cause lubrication failure.

Although the physical appearance of deposits varies greatly throughout an engine, basically these deposits result from the combustion process and lubrication oil deterioration. The exact chemical and physical nature of deposits depends on the area where they are formed, the duration of exposure, and any relative motion present. In the case of sludge, water is an essential factor, and any condition that encourages the entrance and retention of water in an engine oil promotes sludge formation.

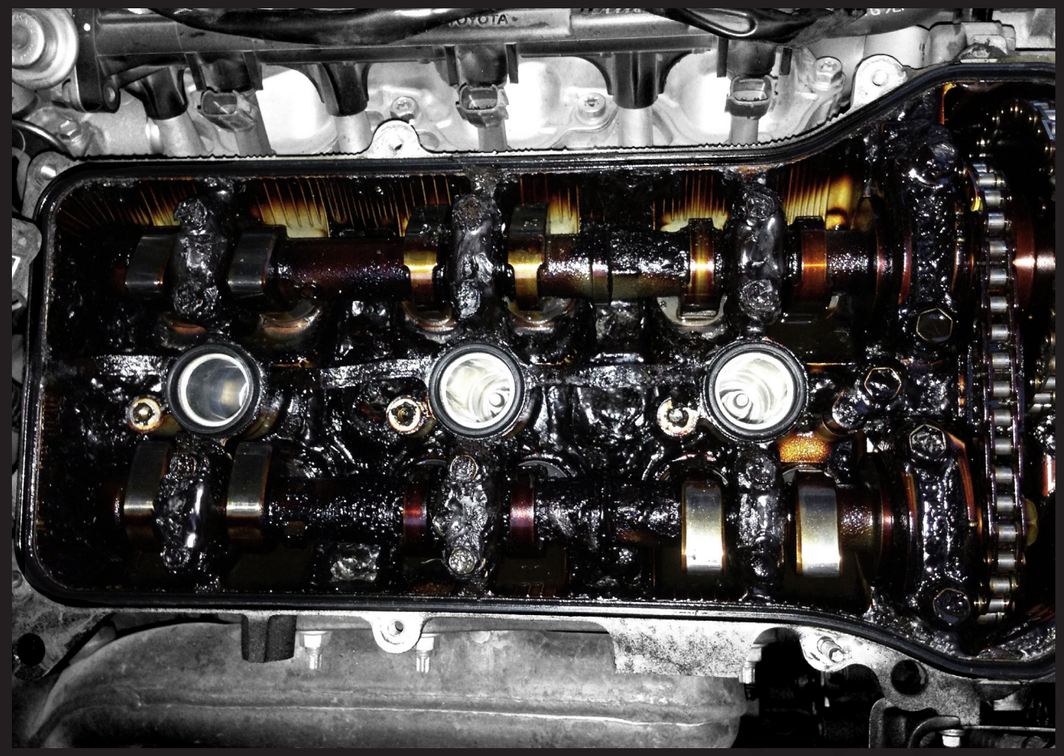
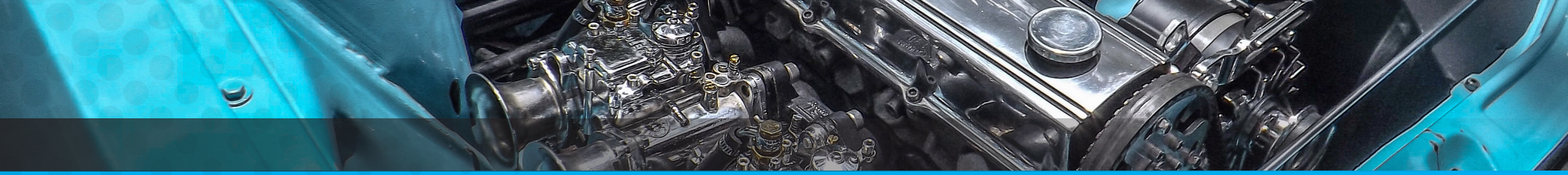


FIGURE 5 (UPPER) - TOP DECK (CYLINDER HEAD) SLUDGING

- Heavy sludge buildup resulting from cold engine operation combined with an oil of inadequate quality

FIGURE 6 (LEFT) - ENGINE VALVE DEPOSITS

- The valve on the right hand side suffers from heavy deposits due to combustion and carbon formations



I I D. MAINTENANCE CONSIDERATIONS

The quality of maintenance of engine components that affect the lubrication process is of considerable importance. It is of course necessary to have clean combustion and crankcase ventilation air, which means that air cleaners and the positive crankcase ventilation (PCV) system must be serviced regularly. A clogged air cleaner, while it may be effective in cleaning the air, can restrict the volume of air reaching the engine enough to reduce power output significantly. To maintain power, the natural tendency is to open the throttle, which only adds to the difficulty (since the extra fuel is not burned). Diesel engines are quite sensitive to such a condition and react by smoking and rapid buildup of engine deposits and lubricating oil contamination (soot). In addition to keeping the filters serviced, it is important that the piping connecting the filter to the engine be unobstructed and leak free. This is particularly important in installations having the air filter located a considerable distance from the engine.

The carburetor and ignition systems of spark ignition engines and the fuel injection systems of both gasoline and diesel engines should be in good working order and properly adjusted to assure the cleanest, most complete combustion possible. Malfunction or incorrect adjustment of these systems can result in increased amounts of unburned fuel in the cylinders, and dilution or more rapid buildup of contaminants in the oil, as well as increased emissions.

Proper engine oil drain schedules should be followed, to ensure that oil is drained before the contaminant load becomes so great that the oil's lubricating function is impaired, or heavy deposition of suspended contaminants occurs. In principle, the correct drain interval for a given engine in a given service is best established by means of a series of used-oil analyses and inspections of engine condition. As a practical matter, this is an economical approach only for very large engines or fleets of similar engines in similar service. For most smaller engines, such as those used in passenger cars, drain intervals are usually established by the manufacturer on the basis of experience accumulated over the years with similar engines operating under typical conditions.

Drain intervals can vary considerably depending on the engine and service. For example, a large diesel engine in central station use, with a relatively large crankcase oil supply, may operate for thousands of hours between oil changes. Such engines are usually in good adjustment, temperatures are moderate, and the contamination rate is low in comparison to the volume of oil in the system. On the other hand, a passenger car engine may require an oil change every few thousand miles. Such engines are physically small with relatively small crankcase capacity, and operate under conditions conducive to rapid oil contamination. Not only are load factors often low, but these engines may be engaged mostly in short runs and start–stop service, as well operating over wide ranges of ambient temperature, all of which favor the accumulation of oil contaminants and the risk of deposits.

The presence of an oil filter does not necessarily permit an extension of the oil drain interval. Filters do not remove oil-soluble contaminants and water, which are important factors in deposit formation. Regular filter changes are, however, important in keeping the filter operable so that it can perform its function of removing insoluble contaminants from the oil.

I I E. ENGINE OIL CHARACTERISTICS

VISCOSITY, VISCOSITY INDEX

In reciprocating engines, viscosity of the engine oil is extremely important. It has a bearing on wear prevention, sealing, oil economy, frictional power losses (fuel economy), and deposit formation. For some engines, particularly vehicle engines, it also is a factor in cranking speed and starting ease. Too high a viscosity may cause excessive viscous drag, reduction in cranking speed, and increased fuel consumption after the engine is started.

The viscosities of engine oils are usually reported according to the SAE J300 (Engine Oil Viscosity Classification), as discussed in Chapter 3. While this system was originally intended for automotive engine oils only, its use has now been extended to include most oils for internal combustion engines. Engine manufacturers normally specify the viscosities of oils for their engines, according to ambient temperature and operating conditions, by SAE grade.

Viscosity index (VI) is important in engines that must be started and operated over a wide temperature range. In these cases, all other factors being equal, oils with higher viscosity indexes give less viscous drag during starting and provide thicker oil films for better sealing and wear prevention; moreover, oil consumption, at operating temperatures is lower.

In past years, the viscosity index of an oil was of limited importance for an oil that was used for engines not subject to frequent cold starts. This remains partially true today except that engine manufacturers are recommending the high VI oils for year-round service, primarily because the viscous drag of an oil is proportional to its viscosity, and higher viscosities at start-up or during operation will reduce efficiency (fuel economy). Other materials such as friction modifiers can be added to the oil to help reduce friction. At present, however, the single oil characteristic that has the biggest effect on fuel economy is viscosity.

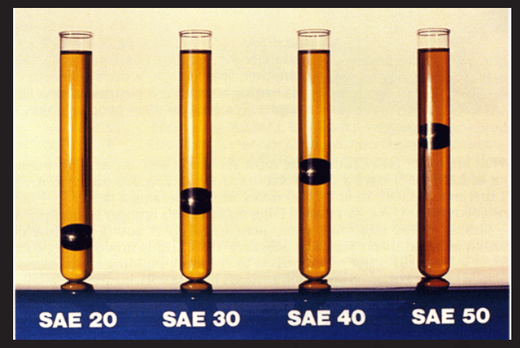


FIGURE I - VISCOSITY

- Steel balls of equal weight dropped into test tubes filled with motor oils fall at different rates. Their rate of fall depends on the viscosity of the oil.
- The ball travelling through the light SAE 20 oil has travelled farthest, while the ball in the heavy SAE 50 has travelled least.

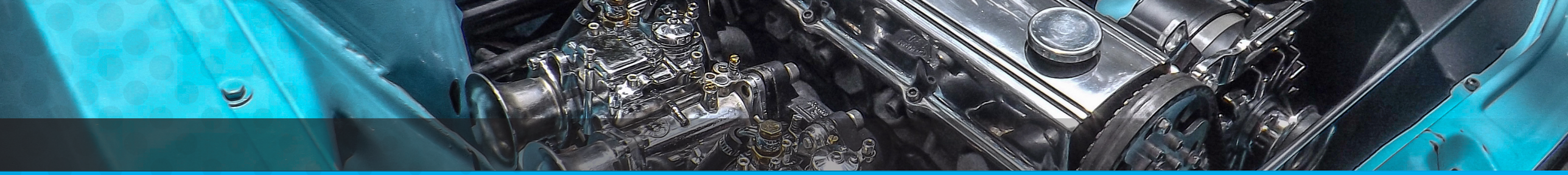
LOW TEMPERATURE FLUIDITY

When an oil is to be used in engines operating at low ambient temperatures, the oil must have low temperature fluidity adequate to permit immediate flow to the oil pump suction when the engine is started. The pour point of an oil is an adequate indication of whether the oil will flow to the pump suction. Most conventional oils will flow to the pump suction at temperatures below their pour points because the pump suction creates a considerably greater pressure head than is present in the pour point test. However, many multigrade oils will not circulate adequately at temperatures considerably above their pour points. The correlation between pour point and flow in instrumented engines is poor, and at best, pour point is only a rough guide to the minimum temperature at which an oil may be used safely.

ASTM has introduced two tests that measure the low temperature performance of an oil. The test that simulates cold cranking of an engine is the cold cranking simulator (CCS), and the test for measuring low temperature pumping is the mini rotary viscosimeter (MRV). Both the CCS and MRV show good correlation to low temperature performance. The maximum values for these tests are listed for the "W" grades in the SAE engine oil viscosity classification. The CCS is designed to reproduce the elements of viscous drag that effects cranking speed. The MRV is designed to predict the low temperature pumpability and therefore the ability of the oil to reach critical components under low temperature starting conditions. For example, a SAE grade oil:

SAE 5W40

- Means this oil ensures the fluidity at -25°C
- Cold start fluidity = 5°C-30°C = -25°C



OXIDATION STABILITY (CHEMICAL STABILITY)

High resistance to oxidation is an important requirement of a good engine oil in view of the high temperatures the oil is exposed to and, in the crankcase, the agitation of the oil in the presence of air. Deterioration of an engine oil by oxidation tends to increase viscosity, create deposit-forming materials, and promote corrosive attack on some hard alloy bearings. Where the engine oil capacity is relatively small, the rate of deterioration tends to be higher, other factors being equal.

An oil's natural oxidation stability is determined in part by the crude oil from which it is made and the refining processes to which it is subjected. Where engine design or operating conditions require a high degree of oxidation stability, oxidation inhibitors are used. As a general rule, the need for greater oxidation stability increases as oil service temperatures and drain intervals increase. Among the principal factors that make enhanced oxidation stability necessary are high engine specific power output (high horsepower per unit of displacement), small crankcase charge volume, long oil drain intervals, and modifications and devices to control emissions that result in high operating temperatures. For example, a heavily loaded truck engine requires an oil with excellent oxidation stability because of the high operating temperatures involved, while a large, low speed diesel engine in central station (stationary) service, with a large crankcase oil supply at a moderate temperature, requires an oil with good stability because the oil is expected to remain in service for thousands of hours. Regardless of the necessity for it, good stability is always desirable in view of its helpful influence on engine cleanliness.

Oxidation stability plays only a minor role in the process by which combustion chamber deposits are formed. Under the conditions just described, however, combustion of the lubricating oil to such deposits can be controlled partly by base stock refining and selection.

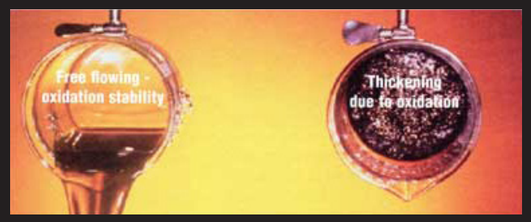


FIGURE 2 - ENGINE OIL OXIDIATION
- Left: Free flowing due to oxidiation stability of oil
- Right: Thickening due to oxidiation of oil

THERMAL STABILITY

Thermal stability, or resistance to cracking and decomposition under high temperature conditions, is a fundamental characteristic of the lubricating base oil that cannot be substantially improved by means of additives. However, careful selection of additives is important in formulating thermally stable oils, since decomposition of the additives can contribute to the formation of deposits under operating conditions that promote thermal cracking of the oil.

As noted earlier, thermal stability of the engine oil is of special concern in certain large, highly supercharged, two-cycle diesel engines used for marine propulsion. Thermal cracking of the system oil, experienced in the piston cooling spaces, has resulted in deposits that interfere with heat transfer. Oils for these applications must be manufactured from base stocks made from selected crudes by carefully chosen refining processes.

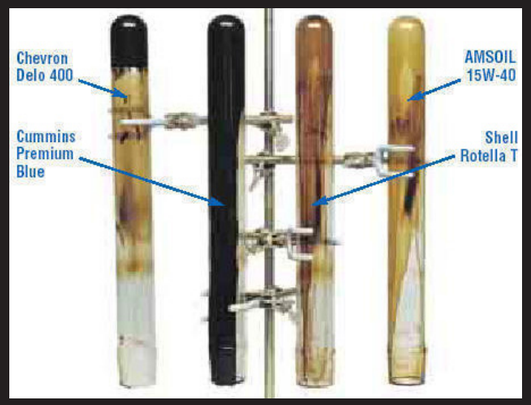


FIGURE 3 - THERMAL STABILITY OF OIL
- From left to right: Solid deposits, Heavy deposits, Medium deposits and Very light deposits
- The high temperature stability of engine oil keeps engine cleaner and performs longer

DETERGENCY AND DISPERSANCY

The natural detergent and dispersant properties of most oils is slight, and where these characteristics are important, they are obtained through the use of additives.

In nearly all current internal combustion engine applications, oils with enhanced detergency and dispersancy are necessary to control engine deposits and maintain engine performance. The levels of detergency and dispersancy required depend on a number of factors such as engine design, operating temperatures, type of fuel, continuity of operation, and exposure to low ambient temperatures. In general, conditions that tend to promote oil oxidation, such as supercharging or the use of high sulfur fuels, dictate the use of oils with higher levels of detergency. Conditions that promote condensation of water and unburned or partially burned fuel in the engine require the use of oils with higher dispersancy.

As noted in the preceding discussion, detergency and dispersancy are not clearly differentiated properties. There is a trend in additive development to improve the dispersancy of the so-called detergents and the detergency of the "dispersants." Thus, some oils formulated with dispersants but not detergents may give entirely adequate control of high temperature deposits in some services, while other oils formulated with detergents only may give good control of low temperature emulsions and sludges in some services. In general, however, most engine oils contain a mixture of the two types of material, with the concentrations and relative proportions depending on the type of engine service an oil is designed for.

One of the main functions of both detergents and dispersants is to suspend potential deposit-forming materials in the oil. In suspended form, these materials are relatively harmless and may be removed from the system by draining the oil. Regular oil drains for this purpose are important, particularly for engines with a relatively small oil capacity. If the oil drain intervals are too long, the ability of the additives to suspend the depositforming materials may be exceeded, whereupon deposits will begin to form on engine surfaces and engine performance will deteriorate. This is why manufacturers specify more frequent oil drains for "severe service" such as short trips, sustained high speeds, and trailer towing.

There are no absolute measures of detergency and dispersancy. It is now customary to describe engine oils on the basis of performance testing. While this description includes an evaluation of detergency and dispersancy, the intent is to provide a more comprehensive description that includes all the factors that make a particular oil suitable for a particular type of engine service.

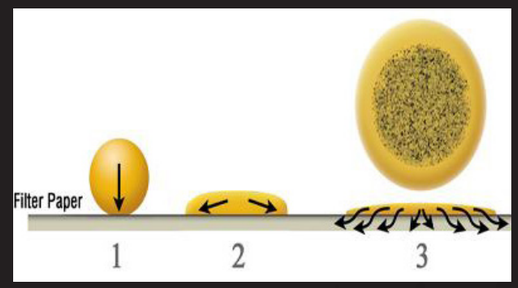


FIGURE 4 - DISPERSANCY OF OIL
- Oil sport test can be used to test oil dispersancy

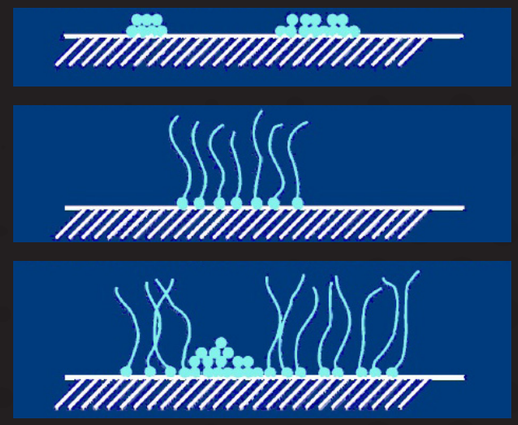
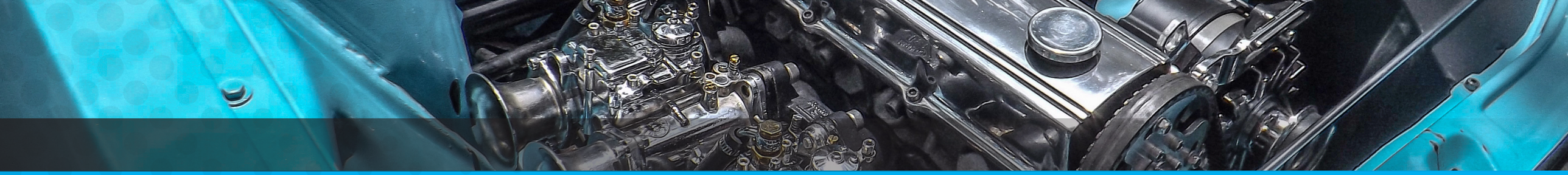


FIGURE 5 - DETERGENCY OF OIL
- Top: Gum on the metal surface (e.g. engine piston) being polar, sticks on polar surface
- Middle: The polar ends of detergents also stick to polar surface
- Bottom: An effective detergent displaces gum (deposits)



ALKALINITY

Most detergents, and to a lesser extent many dispersants, have some ability to neutralize the acidic end products of fuel combustion and oil oxidation. When a considerable ability to neutralize acids is required, as in oils for diesel engines burning high sulfur fuels, however, highly alkaline (overbased) detergent-type materials are used. The concentration of these materials in an oil, and an indication of the oil's ability to neutralize acids, is given by the total base number (TBN), also called the alkalinity value. There is only a general relationship between TBN and the ability of an oil to control wear and corrosion caused by strong acids, since it has been found that some newer additive systems are more effective in this respect than would be predicted by consideration of the TBN level alone.

Many of the highly alkaline oils serve as cylinder oils in large engines, which is a once-through use. In these cases, the changes in the oil in service are of little or no concern. In engines in which the same oil serves as both the cylinder and crankcase oil, it is desired to monitor the alkalinity of the oil as a method of determining whether it is still capable of performing its neutralization function, particularly if high sulfur or other acid-producing constituents are present in the fuel.

ANTIWEAR

In addition to the corrosive wear caused by acidic products of combustion, metallic wear may occur in areas where loads or operating conditions prevent the maintenance of effective lubricating films. The main areas of concern is this respect are cylinder walls and rings, particularly of large, high output trunk piston engines, and the valve train mechanisms of small, high speed engines. In these cases, it is usually necessary to use oils that are formulated with additives that provide enhanced protection against wear and scuffing under boundary lubrication conditions.

RUST AND CORROSION PROTECTION

All petroleum oils have some ability to prevent rusting and corrosion of engine metals. However, in most cases, this natural ability is not sufficient to do the following:

1. Protect hard alloy bearings from corrosion caused by oil oxyacids
2. Prevent rusting and corrosion due to condensation of water and combustion products in low temperature or stop-and-go service
3. Control the corrosive wear caused by acidic end products of combustion

Since one or more of these conditions, which can cause troublesome corrosion, are encountered to some extent in nearly all internal combustion engine service, most oils for internal combustion engines are formulated to provide additional protection against corrosion.

FIGURE 6 - ENGINE CORROSION

- Engine oil with stable alkalinity can neutralize acid, and thus prevent corrosion
- Engine oil with rust prevention water seperation formula can prevent rusting of metal surface

Automotive engine oils usually are formulated to provide protection against corrosion and particularly corrosion of hard alloy bearings. In the case of oils intended for gasoline engine service, protection against corrosion and rusting due to condensation of water and unburned or partially burned fuel components is emphasized. Diesel engine oils are usually formulated to provide protection against corrosion due to acidic end products of combustion. As stated earlier, in these latter oils, the function of corrosion protection is closely related to detergency and alkalinity.

Special preservative oils are available for the protection of engines that are to be laid up seasonally or stored for extended periods. These oils are formulated to provide protection against rust and corrosion due to atmospheric conditions and, usually, are also formulated to be suitable for short-term use in the engines under moderate operating conditions. As a result, an engine can be run safely on the preservative oil prior to being laid up to distribute the oil over the internal engine surfaces. Also, an engine can be run for a reasonable period after being taken out of storage before the preservative oil is drained and replaced by the normally recommended type of oil. This assumes that excessive contamination has not entered the engine or oil during storage.

FOAM RESISTANCE

All oils will foam to some extent when agitated. If excessive foaming occurs in an internal combustion engine, several problems may result. Overflow and spillage of oil is, of course, one of the most obvious, but foaming can also result in starvation at the oil pump inlet, or slugs of foam being drawn into the pump with the oil. Foam entrained in the oil can cause failure of lubricating films, and noisy, erratic operation of hydraulic valve lifters. To reduce foaming, particularly of oils intended for small, high speed engines where agitation is severe, a defoamant is often included in the formulation. Overfilling the crankcase can cause foaming even with defoamants.

EFFECT ON GASOLINE ENGINE OCTANE NUMBER REQUIREMENT (ONR)

Although ONR is not classed as a lubricating function directly, the characteristics of the lubricating oil in fact have a considerable influence on the octane number requirement for gasoline engines. Some oil always finds its way past the rings into the combustion chambers, where it is partially burned to form deposits that adhere to the piston tops and combustion chamber surfaces. As these deposits build up, the ONR of the engine gradually increases. The increase in ONR is a function of both the quantity and nature of the deposits. Heavy, ragged deposits (Figure 7) cause the octane number requirement to increase more than smooth, even deposits (Figure 10.5, right), primarily because the sharp projections on the ragged deposits can be more easily heated to incandescence. In this condition, the deposits may ignite the fuel charge, either before the spark plug fires or before the normal flame front reaches portions of the charge. In either case, knock and power loss result.

It has been found that the contribution of the lubricating oil to the increase in engine ONR may be reduced considerably by careful attention to such factors as crude oil source, refining processes, and the use of base stocks having a minimum of heavy hydrocarbons. One of the major factors in accomplishing the latter is the use of all-distillate base stocks, rather than the older practice of incorporating some bright stock in the blends. Many multiviscosity automotive engine oils are manufactured to provide maximum benefits in the control of octane number requirement increase.

Although oil formulation can help control combustion chamber deposits, the type of service, operating conditions, engine conditions, and maintenance practices generally are the major contributors to combustion chamber deposits. These conditions also affect engine emissions and fuel economy.

FIGURE 7 - COMBUSTION CHAMBER DEPOSITS

- The heavy, ragged deposits on the top, formed when a conventional oil was used, generally contribute significantly more to the engine octane number requirement than the smooth deposits at the bottom.

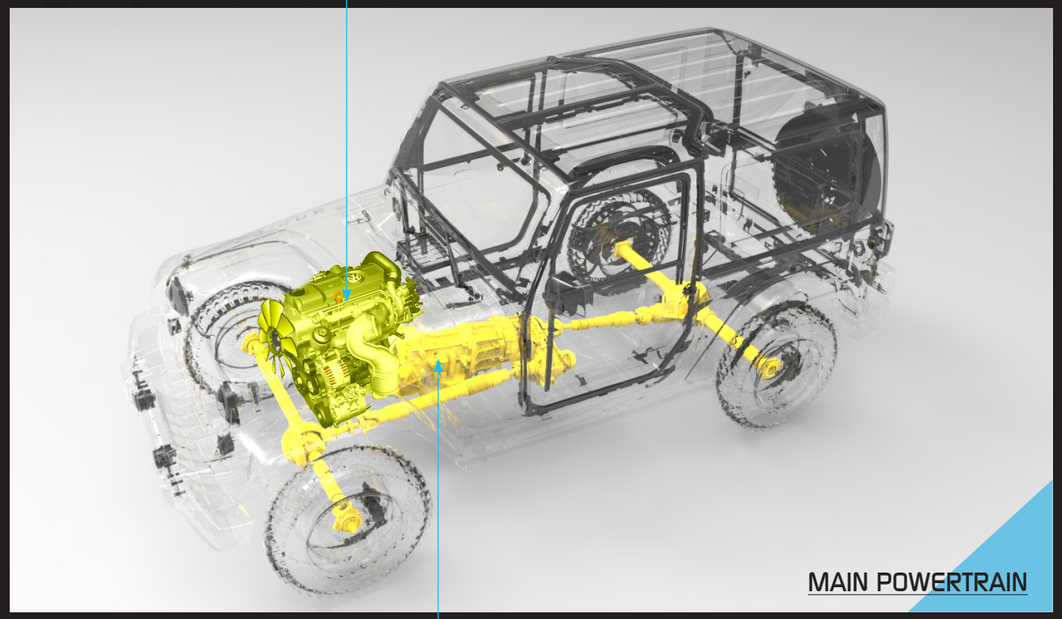
12. STEEL SHIELD AUTOMOBILE APPLICATIONS & BENEFITS

"SEEL SHIELD lubricants have a wide range of applications in the automobile industry. Its unique ABF Technology will improve the function and reliability of all metal components of an engine without changing its integrity or causing any undesirable effects. SwRI test reports proved that STEEL SHIELD lubricants are superior to the premium brands such as Mobil, Shell and Caltex etc."

I 2A. ENGINE & TRANSMISSION SYSTEM

ENGINE

- Dramatically increase engine power
- Dramatically extended engine life
- Increased lubricants life
- Excellent cold start ability (max. 90 days)
- Keeps engine cool
- Cleans the engine system and prevents debris formation
- Fuel economy
- and much more



TRANSMISSION SYSTEM

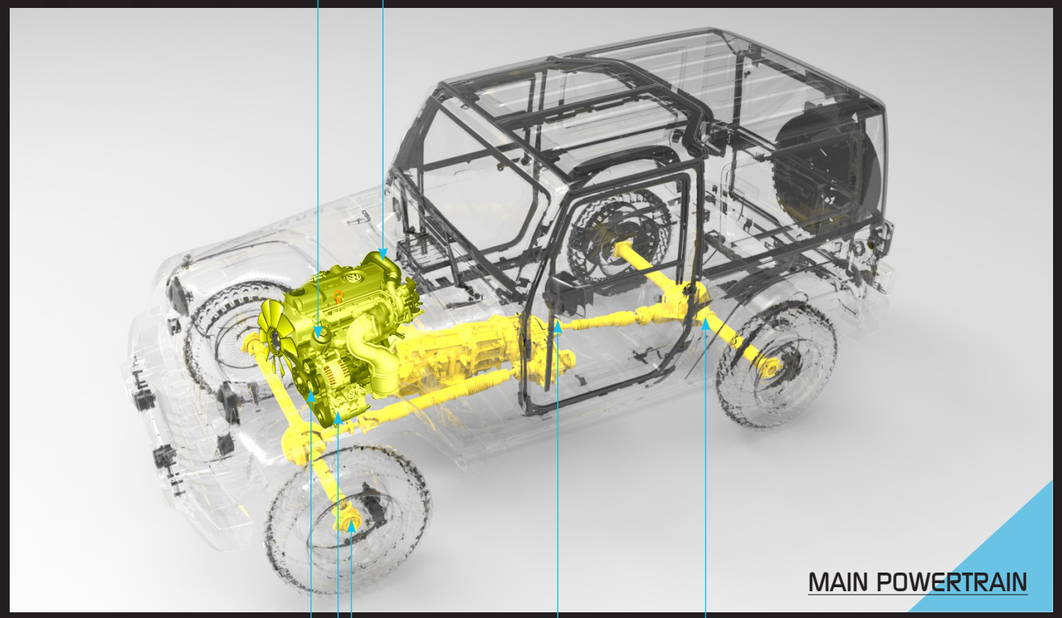
- Ultra smooth, reliable and stable transmissions
- Greatly extended gear and bearing life
- Reduces maintenance
- Slience operations
- Increased transmission efficiency
- and much more

Lube Point	STEEL SHIELD Products	
Engine	Additives	Fuel Shield (Increase Octane of gasoline and Cetane of diesel fuel)
		Injector Shield
		Engine Shield
		Truck Shield
	Full Synthetic Made in USA	Original USA STEEL SHIELD Series Lubricants
	Full Synthetic Made in Singapore	ABF ECI M7
		ABF ECI F1 M13
		ABF ECI M53
		ABF LITE E3
		ABF LITE E3 SPECIAL
		SST BASIC
		SST BASIC SPECIAL
Transmission	Additives	Transmission Shield
		Truck Shield

12B. POWER TRAIN

ELECTRONIC WASTE GATE
- Resistant to waste heat

VARIABLE INTAKE MANIFOLDS
- Reliable lubrication even within blow-by



WATER PUMP BEARING
- Resistance to water
- Smooth operations

START-STOP STARTER
- Low wear during constant operation

SPLINE SHAFTS
- Minimises tribocorrosion

GEAR SHIFT SELECTOR
- Good haptics even at very low temperatures

CONSTANT VELOCITY JOINTS
- Long service life even at high torques

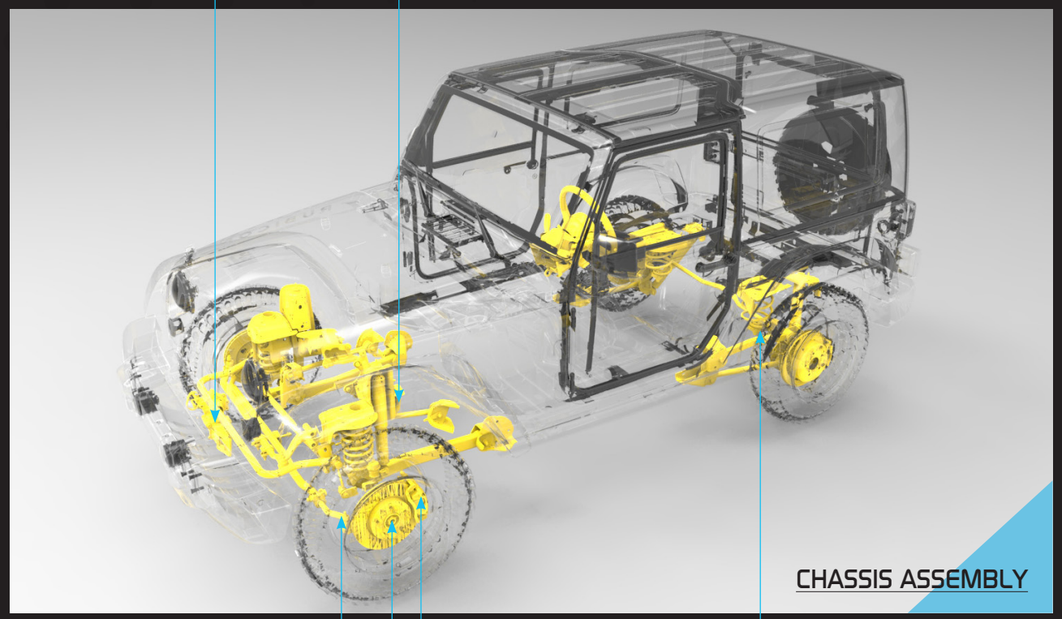
Powertrain	Compontent Requirements / Lube Point	Lifetime lubrication	compatibility with polymers	Resistance to water	Resistance to fuel / blow-by condensates	Dust & dirt capacity	No fretting / no tribocorrosion	Wear protection & load carrying apacities	Corrosion protection	Wide temperature range	Low friction & high efficiency	Low break away & running torques	Anti squeak & anti stick-slip	No hootnoise	STEEL SHIELD Products
Drive shafts / Constant Velocity Joints	U-Joints	√√	√					√√			√				Lithi Shield, Reel Shield Grease
	CVJ - Tripode Joint	√√	√					√√		√√	√				Lithi Shield, Reel Shield Grease
	CVJ - Plunging Ball Joint	√√	√					√√		√√	√				Lithi Shield, Reel Shield Grease
	CVJ - Fixed Ball Joint	√√	√					√√		√√	√√				Lithi Shield, Reel Shield Grease
	Drive Shaft Spline	√√		√			√√	√	√						Lithi Shield
Engine	Starter - Gear & Helical Spline	√√	√	√		√√		√√	√	√√					Lithi Shield
	Starter - Overrunning Clutch (ORC)	√√		√				√√		√√					Lithi Shield
	Starter - Solenoid Switch	√√				√			√√	√√		√√			Lithi Shield
	Throttle / Throttle Control	√√			√			√	√	√√	√√	√√			Lithi Shield
	Idle Speed Actuator	√√								√√	√√		√		Lithi Shield
	Alternator - Bearing		√√					√√						√√	Lithi Shield, Reel Shield Grease
	Belt Tensioner - Bushing	√√	√	√		√		√√		√			√		Lithi Shield
	Pulleys - Bearing	√√	√√											√√	Lithi Shield, Reel Shield Grease
	Turbocharger Bolts / VTG Actuator	√					√√			√√	√	√			Lithi Shield
	EGR Actuator	√√	√		√√					√√	√	√			Lithi Shield
	Waste Gate Actuator	√√			√√					√√	√	√			Lithi Shield
	Intake Manifold Shaft - Seals / Actuator				√√					√			√√		Lithi Shield
	Water Pump Bearing		√	√√										√	Lithi Shield, Reel Shield Grease
	Fuel Line Connectors				√√				√						
	Cooling Fluid Connectors			√√					√	√	√√				
Transmission & Clutch	Gear Shift Cable - Linkage	√√	√√							√	√√				Lithi Shield
	Spline Shaft						√√		√√	√					Lithi Shield
	E-Clutch - Actuator	√√	√							√√	√√	√			Lithi Shield
	H-Clutch - Master / Slave Cylinder Seals	√	√√								√	√			Lithi Shield
	H-Clutch - Linkage Joints	√√	√	√		√				√√	√√	√√	√√		Reel Shield Grease
	Clutch Release Bearing	√√	√					√√	√√			√√		√√	Lithi Shield
	Dual Mass Flywheel	√√	√				√√	√√	√	√√	√√		√		Lithi Shield

√√ = Major requirement; √ = Secondary requirement

12C. CHASSIS

EPS
- No stick-slip and reduced static friction

BRAKE BOOSTER
- Lifetime lubrication for vacuum seals



BALL JOINTS
- Reduction of breakaway torques

HUB UNIT BEARING
- Longer service life due to wear protection

PARKING BRAKE BOWDEN CABLE
- High effi ciency and high thermal stability

BRAKE CALIPERS
- Longer life of guide pins

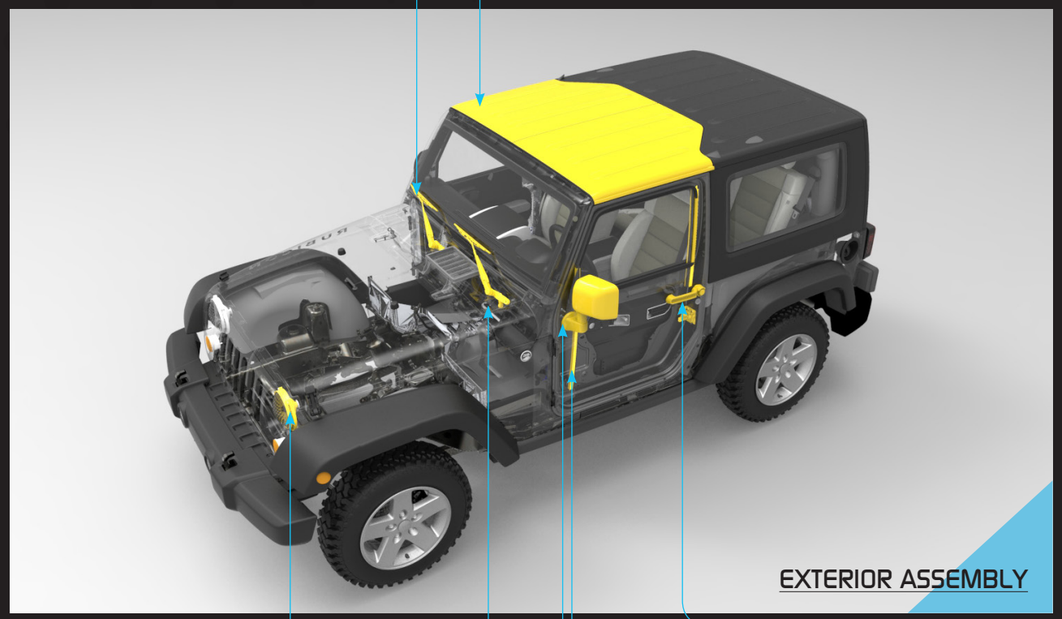
Chassis	Compontent Requirements / Lube Point	Lifetime lubrication	Reliability in regard to safety criticality	Compatibility with polymers	Miscable with brake fluids	EPDM compatibity	Resistance to water & detergents	No false brinelling	No fretting / no tribocorrosion	Wear protection & load carrying capacities	Corrosion protection	Wide temperature range	Low friction & high efficiency	Low break away & running torques	Anti squeak & anti stick-slip	Good adhesion	STEEL SHIELD Products
Brakes	Master Brake Cylinder	√√	√√	√√	√√	√√				√	√	√√	√	√	√	√√	Lithi Shield
	Slave Cylinder Disc	√√	√√	√√	√√	√√	√			√	√	√√	√	√	√	√√	Lithi Shield
	Disc Brake Pads					√√	√								√√	√√	Lithi Shield
	Disc Brake Caliper - Guide Pins	√√	√√	√√		√√		√	√√	√	√	√√		√	√√		Lithi Shield
	Slave Cylinder Drum	√√	√√	√√	√√	√√	√			√	√	√√	√	√	√	√√	Lithi Shield
	Drum Brake Backing Plate		√√			√	√		√√			√			√√	√√	Lithi Shield
	Drum Brake Adjustment	√			√√	√			√√							√	Lithi Shield
	Park Brake Cable - Linkage	√√	√√	√√		√	√					√√	√√		√		Lithi Shield, Reel Shield Grease
	Park Brake Electronic	√√	√√		√	√				√		√√					Lithi Shield, Reel Shield Grease
	ABS Actuator	√√	√√	√√		√√		√		√	√	√√		√√		√	Lithi Shield
	Brake Booster	√√	√√	√√		√√				√		√	√√	√√	√√		Lithi Shield
	Air Brake Pneumatic Valves	√√	√√	√√								√	√√	√√			Lithi Shield
Steering System	Steering Wheel Adjustment - Height / Length	√√	√	√						√			√√	√√	√√		Lithi Shield
	Intermediate Telescope Shaft	√√		√						√			√√	√√	√√		Lithi Shield
	Steering Column - U-Joint	√√	√√							√√	√	√		√			Lithi Shield
	Rack / Pinion / Slide Yoke	√√		√				√√	√√	√√			√	√√	√√	√√	Lithi Shield
	Ball Joints - Inner / Outer Tie Rod End	√√	√	√√			√√			√√	√		√√	√√	√√	√√	Lithi Shield
	Rear Axle Steering Actuator	√√		√						√√							Lithi Shield
	EPS Column - Worm Gear	√√		√						√√			√√	√√	√√		Lithi Shield
	EPS Pinion / DP - Worm Gear	√√		√						√√		√√	√√	√√	√√		Lithi Shield
	EPS Parallel - Ball Screw	√√						√√	√√	√√		√√	√√	√√	√√		Lithi Shield
	EPS Parallel - Supporting Bearing	√√						√√	√√	√√		√√	√√	√√	√√		Lithi Shield
	Steering Angle Sensor	√√	√√									√	√√	√√		√	Lithi Shield
Axle	Ball Joints - King Pin / Control Arm / Stabilizer	√√	√	√√			√√			√√	√		√√	√√	√√	√√	Lithi Shield
	Hub Unit Bearing	√√		√				√√			√	√		√√			Lithi Shield
	Shock Absorber Sealing	√		√			√						√√	√√	√√	√	Lithi Shield
	Strut Bearing	√√					√		√	√√	√√					√	Lithi Shield
	Rubber-Metal Compounds	√		√√						√					√√	√	Lithi Shield

√√ = Major requirement; √ = Secondary requirement

12D. BODY & EXTERIOR

WINDSHIELD WIPER BLADES
- Water-miscible dispersion reducing stick-slip

SLIDING ROOF - GUIDE RAILS
- Low breakaway torques and high water resistance



EXTERIOR ASSEMBLY

ADAPTIVE FRONTLIGHT AND WASHER SYSTEM
- Chemical resistance and high service temperatures

WIPER MOTOR PLANETARY GEAR
- High performance at low temperatures protection

CENTRAL LOCKING SYSTEM
- Grease have excellent low temperature property

WINDOW LIFTER GUIDE RAILS
- Grease providing resistance against dust at low temperature

EXTERIOR MIRROR CATCH
- High corrosion protection even in salty environment

Body & Exterior	Compontent Requirements / Lube Point	Lifetime lubrication	Compatibility with polymers	Resistance to water & detergents	Dust & dirt capacity	Wear protection & load carrying capacities	Corrosion protection	Low temperature performance	Freeze release	Low friction & high efficiency	Low break away & running torques	Anti squeak & anti stick-slip	Good adhesion	Wide temperature range	Dmping of haptics	Self locking	STEEL SHIELD Products
Wind-shield Wiper & Wash Water System	Wiper Motor - Sinter Bearings	√√				√	√√	√√		√	√√						Lithi Shield
	Wiper Motor - Gear System	√√	√			√	√	√√		√√	√√						Lithi Shield
	Wiper Linkage	√		√		√√	√	√									Lithi Shield
	Wash Water Pump Seals	√	√√	√√				√		√	√		√				Lithi Shield
	Head Light Telescope Washer - Seal	√	√√	√√	√√			√		√	√√	√	√				Lithi Shield
	Wiper Blades									√		√√	√√				Lithi Shield
Doors & Lock Systems	Door handle	√	√	√√	√√	√	√						√		√		Lithi Shield
	Tail Gate Lifter	√√				√√		√			√	√					Lithi Shield
	Latch / Pawls	√	√	√	√	√	√	√√		√√	√√				√		Lithi Shield
	Lock Mechanisms	√	√	√	√		√	√√		√√	√√		√		√		Lithi Shield
	Lock Cylinder			√√	√		√	√	√√								Lithi Shield
	Catch		√	√	√√	√√	√	√					√√		√		Lithi Shield
	Sliding Door - Spindle Drive	√√	√			√√	√	√		√√	√						Lithi Shield
	Sliding Door - Guide	√		√	√√	√		√					√√				Lithi Shield
Window Lifters	Cable Drive - Guides	√	√	√√	√√			√√		√√	√√	√√	√√				Lithi Shield
	Cable Drive - Rollers	√	√	√	√	√	√	√√		√√	√√	√√					Lithi Shield
	Cross Arm - Guides	√	√	√	√√	√√	√	√√		√√	√√	√√			√		Lithi Shield
	Cross Arm - Tooth Segment	√		√	√	√√	√	√					√√				Lithi Shield
	Manual WL - Clutch	√			√	√√	√						√		√	√	Lithi Shield
	Gearmotors - Worm Gear	√√	√			√	√	√√		√√	√√					√√	Lithi Shield
Sliding Roofs	Kinematics / Mechanics	√												√			Lithi Shield
	Manual Roof - Lock System	√√			√		√						√		√		Lithi Shield
	Guide Rails		√√	√√	√√			√√		√	√√	√√	√√				Lithi Shield
	Flocked Flex Cables	√						√	√	√√	√	√√					Lithi Shield
	Elastomer Profiles - flocked / non-flocked		√√	√√	√							√√	√√				Lithi Shield
	Gearmotors - Worm Gear	√√	√			√	√	√√		√√	√√			√			Lithi Shield
	Roller Shade - Axle & Guides	√	√√		√			√		√		√√			√		Lithi Shield
Exterior Mirrors	Catch	√		√√	√√	√	√√	√					√		√		Lithi Shield
	Gearmotors - Plastic Gear	√√	√	√	√	√	√	√√		√√	√√		√			√	Lithi Shield
Front Lights	AFS Actuator - Gear	√√	√	√				√√		√	√√			√√			Lithi Shield
	AFS Actuator - Linkage		√	√	√							√√					Lithi Shield
	AFS Actuator - Bearings	√√		√				√√		√	√√			√√			Lithi Shield
Bonded Coat-ings for Elas-tomer	Weatherstrips	√√										√√	√√				Lithi Shield
	Wiper Blades									√		√√	√√				Lithi Shield
	Flocked Profiles	√							√√			√√	√√				Lithi Shield

√√ = Major requirement; √ = Secondary requirement

13. STEEL SHIELD USA ORIGIN ADDITIVES FOR AUTOMOTIVE

ENGINE SHIELD

TRUCK SHIELD

V-TWIN SHIELD

TRANS SHIELD

TRANSMISSION SHIELD

STEEL SHIELD EPA

FUEL SHIELD

TOOL SHIELD

LITHI SHIELD

REEL SHIELD GREASE

STRIKE SHIELD

SPRAY SHIELD

Not Just Oil... IT'S TECHNOLOGY

ENGINE SHIELD

ENGINE SHIELD™ is the ultimate protection for the moving metal parts in your engine. Utilizing the most Advanced Boundary Film (ABF) Technology, it protects moving metal parts from wear and damage due to boundary conditions of frictional abrasion, extreme pressure torque, dry startup and engine shutdown. Other benefits include increased fuel savings due to reduced friction and increased oil flow, reduced maintenance and downtime, extended engine parts longevity and reduced operating temperatures an average of 30 to 50 Fahrenheit degrees.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages

- Protects Moving Metal Parts
- Extends Engine And Parts Life
- Dramatically Reduces Wear
- Improves Fuel Mileage
- Increases Horsepower
- Reduces Maintenance
- Reduces Friction
- Improves Oil Flow
- Protects Gasoline or Diesel Engine
- Reduces Operating Temperatures
- Reduces Metal Debris In Oil

Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling Point		˚C	238
Evaporation Rate			<0.01
Vapor Pressure			<1@25 ˚C
Specific Gravity			1.07

Applications

Any engine, transmissions, gears or other mechanical systems

Directions of Usage

- Remove the oil filler cap and add one 8 ounce bottle of Engine Shield™ to engine while running.
- For larger engines, add 2 ounces of Engine Shield™ per quart of oil.
- Use at every oil change for maximum performance.
- Contains no volatiles or solvents. Contains synthetic hydrocarbons and advanced chemical additive technology. Non-toxic and environmentally friendly.

TRUCK SHIELD

TRUCK SHIELD™ is the ultimate protection for the moving metal parts for trucks. Utilizing the Advanced Boundary Film (ABF)Technology, it protects moving metal parts from wear and damage due to boundary conditions of frictional abrasion and extreme pressure. Other benefits are increased fuel savings, increased performance, reduced maintenance costs and downtime due to lowering operating temperatures that extends component life from light trucks to heavy trucks and equipment.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages

- Extends Parts & Engine Life and Truck Component Reliability
- Improves Lubrication & Oil Flow
- Increases Fuel Savings
- Increases Horsepower
- Practical Elimination of Metal-To-Metal Wear (Cold Start)
- Reduces Friction
- Reduces Maintenance and Downtime
- Reduces Metal Debris In Oil
- Reduces Operating Temperatures
- Smoother and Quieter Operation

Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling Point		˚C	238
Evaporation Rate			<0.01
Vapor Pressure			<1@25 ˚C
Specific Gravity			1.07

Applications

Any truck engines or other heavy mechanical systems

Directions of Usage

- Diesel and Gasoline Engines: Add 2 oz. per quart of oil initially; 1 - 2 oz. per quart of oil every oil change
- Automatic Transmissions: Add 1 oz. per quart automatic transmission fluid
- Manual Transmissions & Differentials: Add 2 oz. per quart of gear lube / fluid
- Hydraulics: Add 1 oz. per quart of fluid
- Power Steering: Add 1 oz. per quart of fluid

V-TWIN SHIELD

V-TWIN SHIELD™ is the ultimate protection for the moving metal parts in your motorcycle engine. Utilizing the most Advanced Boundary Film (ABF) Technology, it protects moving metal parts from wear and damage due to boundary conditions of frictional abrasion, extreme pressure torque, dry startup and engine shutdown. Other benefits include increased fuel savings due to reduced friction and increased oil flow, reduced maintenance and downtime, extended engine parts longevity and reduced operating temperatures an average of 30˚F to 50˚F.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages

- Dramatically Reduces Wear
- Improve Lubrication
- Improves Oil Flow
- Increases Fuel Savings
- Increases Horsepower
- Increases Engine Life
- Protects Moving Parts
- Reduces Operating Temperatures
- Reduces Costly Repairs & Maintenance
- Reduces Friction
- Reduces Metal Debris In Oil
- Smoother Shifting

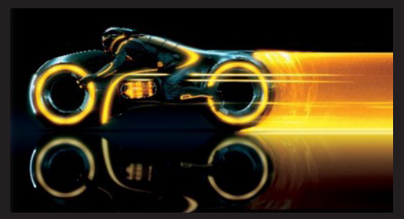
Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling Point		˚C	238
Evaporation Rate			<0.01
Vapor Pressure			<1@25 ˚C
Specific Gravity			1.07

Applications

Any motorcycle engines

Directions of Usage

- Remove the oil filler cap and add one 8 ounce bottle of V-Twin Shield™ to engine while running. Use at every oil change for maximum performance.
- Contains no volatiles or solvents. Contains synthetic hydrocarbons and advanced chemical additive technology. Non-toxic and environmentally friendly.



ORIGINAL USA ADDITIVES

TRANS SHIELD

TRANS SHIELD™ is the ultimate protection for the moving metal parts in your motorcycle transmission. Utilizing the most Advanced Boundary Film (ABF) Technology, it protects moving metal parts from wear and damage due to boundary conditions of frictional abrasion, extreme pressure torque, dry startup and engine shutdown. Other benefits include smoother shifting and quieter operation, increased fuel savings due to reduced friction, reduced maintenance and downtime, extended transmission parts longevity and reduced operating temperatures an average of 30˚F to 50˚F.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages

- Dramatically Reduces Wear
- Improve Lubrication & Oil Flow
- Increases Fuel Savings
- Increases Horsepower
- Increases Parts & Transmission Life
- Protects Moving Parts
- Reduce Temperatures An Average Of 30
- Reduces Chain Stretching
- Reduces Costly Repairs & Maintenance
- Reduces Friction
- Reduces Metal Debris In Oil
- Smoother Shifting

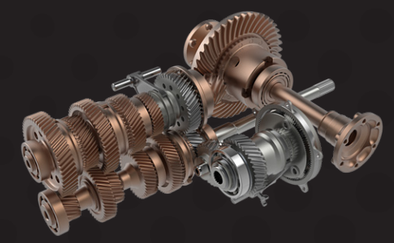
Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling Point		˚C	238
Evaporation Rate			<0.01
Vapor Pressure			<1@25 ˚C
Specific Gravity			1.07

Applications

Any motorcycle transmission systems

Directions of Usage

- Demove the oil filler cap and add 4 ounces of Trans Shield™ to the transmission, and 4 ounces to primary. Use at every oil change for maximum performance.
- Contains no volatiles or solvents. Contains synthetic hydrocarbons and advanced chemical additive technology. Non-toxic and environmentally friendly.



TRANSMISSION SHIELD

TRANSMISSION SHIELD™ is the ultimate protection for the moving metal parts in your automatic and manual transmission. Utilizing the most Advanced Boundary Film (ABF) Technology, it protects moving metal parts from wear and damage due to boundary conditions of frictional abrasion, extreme pressure torque, dry startup and abrasive shutdown. Other benefits include smoother shifting, reduced friction and increased oil flow, reduced maintenance and downtime, extended transmission parts longevity and reduced operating temperatures an average of 30 to 50 Fahrenheit degrees.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages

- Protects Moving Metal Parts
- Extends Parts & Transmission Life
- Dramatically Reduces Wear
- Smoother Shifting
- Reduces Maintenance
- Reduces Friction
- Reduces Operating Temperatures (Average Of 30)
- Reduces Metal Debris In Oil
- Reduces Chain Stretching
- Improves Lubrication & Oil Flow
- Increases Horsepower
- Increases Fuel Savings
- Increases Horsepower

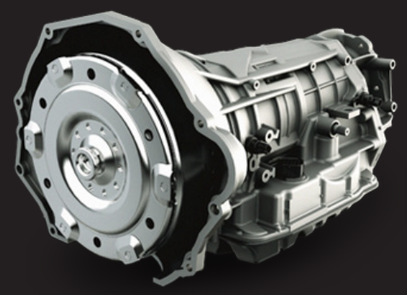
Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling Point		˚C	238
Evaporation Rate			<0.01
Vapor Pressure			<1@25 ˚C
Specific Gravity			1.07

Applications

Any transmission systems

Directions of Usage

- Remove the oil filler cap and add one 8 ounce bottle of Engine Shield™ to engine while running.
- For larger engines, add 2 ounces of Engine Shield™ per quart of oil.
- Use at every oil change for maximum performance.
- Contains no volatiles or solvents. Contains synthetic hydrocarbons and advanced chemical additive technology. Non-toxic and environmentally friendly.



STEEL SHIELD EPA

STEEL SHIELD Extreme Pressure Anti-Wear (EPA)™ is the ultimate protection for the moving metal parts for industry. Utilizing the most Advanced Boundary Film (ABF) Technology, it protects moving metal parts from heat, friction and wear in engines, transmissions, differentials, transfer cases, hydraulic pumps and motors, gear boxes, and other enclosed lubrication systems, due to boundary conditions of frictional abrasion, extreme pressure torque, dry startup and shutdown. Increased performance and greatly reduced maintenance and downtime are the results. These performance goals are achieved through ABF Technology by lowering the operating temperatures, extending the life of component parts and increasing reliability.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages

- Dramatically reduces wear
- Extends parts life and component realibity
- Improves lubrication
- Protects moving metal parts
- Reduces friction
- Reduces maintenance and downtime
- Reduces operating temperatures
- Smoother operation

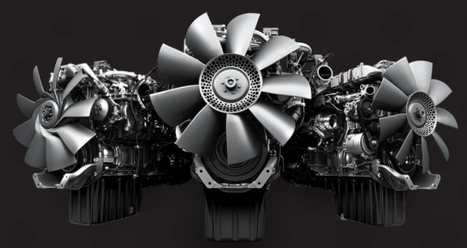
Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling point		˚C	238
Evaporation rate			<0.01
Vapor pressure			<1@25 ˚C
Specific gravity			1.07

Applications

- All Engines, Transmissions & Differentials
- Hydraulic Systems
- Open Gears
- Gear Boxes
- Gear Reducers
- Gear Couplings
- Electric Motors
- Heavy Machinery
- Weapon Systems

Directions of Usage

- Sasoline And Diesel Engines: Add 2 oz. per quart of oil.
- Auto Transmissions: Add 1 oz. per quart of fluid.
- Manual Transmissions & Differentials: Add 2 oz. per quart of gear lube/oil.
- Gear Boxes: Add 2-3 oz. per quart. Hydraulics: Add 1 oz. per quart of fluid.
- Contains no volatiles or solvents. Contains synthetic hydrocarbons and advanced chemical additive technology. Non-toxic and environmentally friendly.



ORIGINAL USA ADDITIVE

FUEL SHIELD

Fuel Shield cleans the entire fuel system while driving, eliminating gums and resins from the carburetor, fuel lines, fuel tank and extends the life of spark plugs, fuel injectors and catalytic systems.

Not Just Oil... IT'S TECHNOLOGY

THE ADDITIVE QUALITY

MADE IN THE USA

Advantages in Gasoline Engines

- Improves Engine Performance
- Cleans Fuel Injectors (and Carburetors)
- Reduces Fuel Consumption
- Disperses Moisture in Fuel
- Prevents Dieseling & Pinging
- Fights Formation of Gums & Resins
- Protects Against Corrosion in Fuel Systems
- Increases Atomization of Fuel

Advantages in Diesel Engines

- Cleans Injectors & Pump Systems
- Removes Soot
- Reduces Gelling and Waxing
- Provides Upper Cylinder Lubrication
- Inhibits Organic Build Up in Fuel
- Reduces Corrosion Formation

Applications

Any fuel system of vehicles

Directions of Usage

- Shake Well First
- GASOLINE OR DIESEL ENGINES – Add 1.5 oz. of Fuel Shield™ to each 10 gallons of fuel.
- TWO CYCLE ENGINES – Add 2oz of Fuel Shield™ to 5 gallons of fuel.
- HIGH PERFORMANCE AND V-TWIN MOTORCYCLE ENGINES – Add 4oz. of Fuel Shield™ to 5 gallons of Fuel.

Properties	Standard	Unit	Result
Flash Point		℃	16.6 PMCC
Boiling Point		℃	87.2
Evaporation Rate			2.1
Vapor Pressure			105@38 ℃
Specific Gravity			0.801

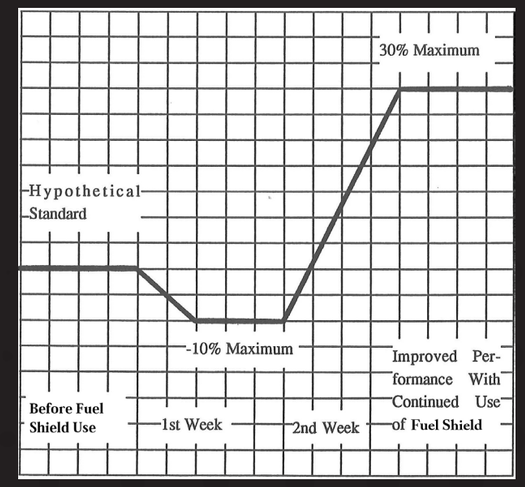
Once the system has been cleaned the addition of Fuel Shield, rough idling and stalling will no longer exist, and fuel consumption will be reduced significantly. A clean carburetor or fuel injection system will perform at optimum due to proper mixing of fuel and gases, with the exception of being a new system already free from dirt and resins.

Fuel Shield breaks down, suspends, and removes water and moisture from the fuel system, eliminating fuel line freeze-ups and stalling due to water and moisture in the lines. Water does not necessarily come from contaminated gas or fuel at the service station. If your tank is not full, a temperature change overnight will cause condensation to form; tiny droplets of water adhering to the inside of your fuel tank will collect and accumulate the fuel itself. Fuel attempting to burn in the engine cylinders will cause rough idling and poor engine performance. Fuel Shield molecularly breaks down and suspends this moisture the fuel so a more efficient burning can be achieved.

Fuel Shield helps protect the environment by increasing the efficiency of fuel burning by providing a high state of oxidation. This, in turn, reduces harmful emissions, such as carbon monoxide, hydrocarbons and dioxins. Independent emissions testing has proven Fuel Shield to be superior in reducing harmful exhaust emissions up to 100%. Fuel Shield works with all grades of gasoline, leaded or unleaded. Fuel Shield is unique in its field. It surpasses all other products in both diesel and gasoline engines.

One of the more serious problems associated with fuel oil is long-term storage. The growth of fungi and bacteria causes serious filtering problems stored fuel oil the home or business (i.e. , oil storage during the summer season). Clogged filters and lines or complete failure Of automatic mechanisms can be eliminated by fuel oil with Fuel Shield.

One of Fuel Shield's many unique characteristics is its powerful ability to remove and extract varnishes, dirt and contaminants from the fuel system. During this process of cleaning the system and restoring it to and optimum condition, a slight loss fuel efficiency may be experienced for a brief time. This effect is brief, as depicted in the graph to the left. The first section on the left entitled "Before Fuel Shield Use" represents a vehicle operating normally without the use of Fuel Shield. The second section entitled "1st week" shows the dip that may occur, some instances, of a loss of efficiency (not more than 10%) for a very brief time (i.e., three to four days), until the upswing of performance and efficiency occurs. The third section entitled "2nd week" represents the continued rise in performance and fuel efficiency until an optimum is reached (as much as 30% or more). Then, through continued use of Fuel Shield, this optimum of fuel efficiency and performance will be maintained.



ORIGINAL USA ADDITIVES

TOOL SHIELD

TOOL SHIELD™ is the ultimate protection for the moving metal parts for automotive and industrial tools. Utilizing the most Advanced Boundary Film (ABF) Technology, it protects moving metal parts from heat, friction and wear due to boundary conditions of frictional abrasion, extreme pressure torque, air line moisture and internal dirt. It works in all piston and rotarytype air tools, stationary and hand-held power tools and many hand tools. Increased power and performance and greatly reduced wear while removing dirt from tool are the results. TOOL SHIELD™ contains ABF (Advanced Boundary Film) for increased lubricity and boundary film lubrication.

ORIGINAL USA ADDITIVE

Advantages

- Cleans & Removes Internal Dirt
- Dramatically Reduces Metal-To-Metal Wear
- Extends Tool Life
- Improves Tool Power & Performance
- Lubricates, Cleans & Protects
- Protects Moving Metal Parts
- Repels Air Line Moisture
- Smooths Tool Operation
- Stops & Inhibits Rust

Properties	Standard	Unit	Result
Flash Point (PMCC)		˚C	61
Boiling point		˚C	186 - 201
Evaporation rate			<0.01
Vapor pressure			<1@25 ˚C
Specific gravity			1.02

Applications

- Air Cutting Tools, Air Drills, Air Grinders, Air Nailers, Air Ratchets, Air Sanders, Air Staplers
- Automatic Oilers
- Hand Tools
- Impact Wrenches
- Piston & Rotary Type Air Tools

Directions of Usage

- Use in accordance with tool manufacturer's instructions.
- Tools may need to be lubricated daily, or several times a day, depending on the frequency and prolonged use of the tool.
- Contains no volatiles or solvents. Contains synthetic hydrocarbons and advanced chemical additive technology. Non-toxic and environmentally friendly.

LITHI SHIELD

LITHI-SHIELD™ is the ultimate in extreme pressure anti-wear lithium complex grease. It exceeds all other lithium complex greases due to the addition of ABF (Advanced Boundary Film)Technology, extreme pressure and antifriction additives added to its formula. LITHI-SHIELD™ treats, seals and smooths metal surfaces to dramatically reduce friction, as well as friction related heat and wear. LITHI-SHIELD's™ unique formulation allows it to exceed the performance of other greases while using smaller quantities. In fact, LITHI-SHIELD™ exhibits great oxidation resistance, over twice that of its nearest competitor.

ORIGINAL USA NLGI No. 2 GREASE

Advantages

- Maximum Protection Against Wear And Extreme Pressure
- Adheres To Metal Exhibiting Top Performance In Roll Stability
- Provides Constant Lubrication To All Areas
- Offers The Maximum In Friction Reduction
- Resists Water Washout

Applications

- All Extreme Pressure Applications
- Axles, Bearings, CV Joints, Universal Joints, Chassis Fittings, Conveyors, Pumps, Rotating Machinery
- Boat Trailers And Marine Applications
- Heavy Equipment, Mining Equipment, Railroad Equipment

Directions of Usage

- Follow the maintenance manuals of the machines

Properties	Standard	Unit	Result
NLGI Grade			No. 2
Penetration, Worked, 60s	D-217		265 - 295
Penetration, Unworked	D-217		265 - 295
Thickener Type	D-217		Lithium Complex
Thickener, %	D128		8 - 11
Color	D128		Light Amber

Properties	Standard	Unit	Result
Texture	D128		Smooth
Dropping point	D-2265	˚C	500
Viscosity @ 40˚C	D-445	cSt	220
Viscosity @ 100˚C	D-445	cSt	19
Viscosity Index	D-2270		95
Flash Point	D-92	˚C	464
Fire Point	D-92	˚C	550
Timken OK load	D-2509	lbs.	60
Rust	D-1743		Pass
Copper Corrosion	D-4048		1B
4-Ball Wear Test	D-2266	mm	0.68
4-Ball EP Weld Test	D-2596	Kg Min.	800 / Pass
Oxidation Induction time @210˚C	D-5483	min	11.47
Water washout @ 79˚C	D-1264		0.027
Mobility at 77˚C	US Steel Mobility Test	g/min	576
Mobility at 60˚C	US Steel Mobility Test	g/min	275.4
Mobility at 40˚C	US Steel Mobility Test	g/min	86.6
Mobility at 20˚C	US Steel Mobility Test	g/min	15.3
Mobility at 0˚C	US Steel Mobility Test	g/min	1.6

REEL SHIELD GREASE

The ultimate lubricant, cleaner, penetrant, and saltwater protectant, has been aggressively designed and formulated for the Sport Fishing Industry. Reel Shield Grease™ lubricates and protects against extreme pressure and wear in all moving metal-to-metal parts, in all types of fishing reel and drag systems. Reel Shield Grease™ penetrates to the internal moving parts and shields against corrosion in extreme saltwater environments better than any other product to date. This distinguishes Reel Shield™ as the ultimate tool in the total care and maintenance of all fishing tackle in both fresh and saltwater fishing. Reel Shield Grease™ has been tournament tested in harsh saltwater conditions and proved to be superior in its performance.

Additional testing has proven Reel Shield Grease™ improves casting distances due to its Advanced Boundary Film (ABF) Technology, which reduces coefficients of friction between the gears and other moving metal parts in the reel and roller guides of the rod allowing for smoother casting and overall performance and operation.

ORIGINAL USA NLGI No. I GREASE

Not Just Oil... IT'S TECHNOLOGY

100% GREASE QUALITY

MADE IN THE USA

Advantages

- Dramatically Reduce Gear Water
- Extends Life Of Fishing Pliers, Tools And Equipment
- Extends Reel Life
- Gears Run Smooth & Quiet
- Longer Conventional Casts
- Protects Against Salt Water, Rust & Corrosions
- Smoother Reel Operation

Applications

- All High Temperature Applications
- All Extreme Pressure Applications
- Axles
- Bearings
- Boat Trailers And Marine Applications
- Chassis Fittings
- Conveyors
- CV Joints
- Heavy Equipment
- Mining Equipment
- Pumps
- Railroad Equipment
- Reel, Ship Equipments
- Rotating Machinery
- Universal Joints

Directions of Usage

- Use in accordance with machine / tool manufacturer's instructions.
- Apply to bearings and moving parts. Coat metal surfaces lightly and wipe excess off.
- Contains synthetic hydrocarbons. Non-Toxic. Contains no volatiles. If swallowed, do not induce vomiting due to aspiration in lungs.

Properties	Standard	Unit	Result
NLGI Grade			No. 1
Penetration, Worked, 60s	D-217		310 - 340
Penetration, Unworked	D-217		310 - 340
Thickener Type	D-217		Lithium Complex
Thickener, %	D-128		6 - 8
Color	D-128		Light Amber
Texture	D-128		Smooth
Dropping point	D-2265	˚C	500
Viscosity @ 40 ˚C	D-445	cSt	220
Viscosity @ 100 ˚C	D-445	cSt	19
Viscosity Index	D-2270		95
Flash Point	D-92	˚C	464
Fire Point	D-92	˚C	550
Timken OK load	D-2509	lbs.	60+
Rust	D-1743		Pass
Copper Corrosion	D-4048		1B
4-Ball Wear Test	D-2266	mm	0.7
4-Ball EP Weld Test	D-2596	Kg Min.	800 / Pass

Properties	Standard	Unit	Result
Oxidation Induction time @210˚C	D-5483	min	95
Water washout @ 79 ˚C	D-1264		0.027
Mobility at 77 ˚C	US Steel Mobility Test	g/min	
Mobility at 60 ˚C	US Steel Mobility Test	g/min	515
Mobility at 40 ˚C	US Steel Mobility Test	g/min	257.1
Mobility at 20 ˚C	US Steel Mobility Test	g/min	78.9
Mobility at 0 ˚C	US Steel Mobility Test	g/min	5.4

STRIKE SHIELD

STRIKE SHIELD™ is the ultimate penetrant to rapidly pierce rusted and corroded metal surfaces using a distinctive spreading action to break lose frozen mechanisms while at the same time applying an advanced lubricating film to the surfaces of the metal delivering the highest quality lubrication available in penetrating oil. STRIKE SHIELD™ leaves a unique layer of film on surfaces that helps prevent rust and corrosion along with driving out and dispersing moisture on ignition wires, electrical contacts, circuit boards and other electrical connections to provide protection against future corrosion in extremely tough conditions.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

100% Quality SPRAY

MADE IN THE USA

Advantages

- Offers extremely fast penetration and lubrication into remote rusted /corroded areas especially for industrial and marine applications that have seized metal mechanisms
- Provides a quick durable long lasting lubricating film to a variety of different areas including mechanisms in extreme salt water environments
- Inhibits rust and oxidation on metal contacts and surfaces in all weather conditions
- Maximum performance as a moisture displacement on wet electrical switches/boards and electronic systems
- Helps start damp engines by dispersing moisture on ignition wires and electrical systems
- Protects circuit boards from corrosion in all weather conditions including salt spray
- Repels dirt and dust build-up
- Mild and pleasant fragrance

Applications

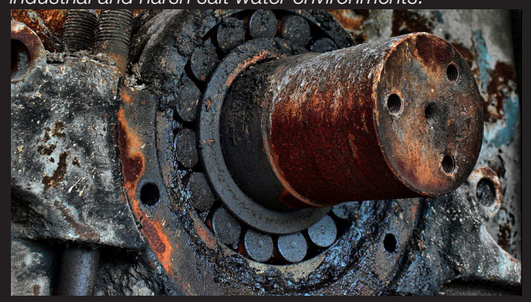
- Frozen or scaled nuts and bolts
- Sticky locks
- Squeaky hinges
- Sliding doors
- Wheels
- Conveyors
- Cables
- Linkages, Shafts, Bushings
- Sliding parts and mechanisms
- Any automotive, marine, farming industrial or commercial application that requires a fast acting penetrate, lubricant and moisture displacement all combined in one product

Directions of Usage

- Spray to any frozen mechanisms

Properties	Standard	Unit	Result
Flash Point (PMCC)		˚C	61
Boiling point		˚C	186 - 201
Evaporation rate			<0.01
Vapor pressure			<1@25 ˚C
Specific gravity			1.02

"STRIKE SHIELD delivers an all in one product that is a fast acting penetrant, extremely durable lubricant and long-lasting rust and corrosion protectant even in tough industrial and harsh salt water environments."



SPRAY SHIELD

SPRAY SHIELD™ is the ultimate multi-purpose lubricant that also penetrates metal surfaces while maintaining highest qualities in corrosive and extreme humidity environments. SPRAY SHIELD™ penetrates into remote areas and delivers long-lasting lubrication in many different applications. SPRAY SHIELD™ works quickly to provide excellent protection and long-lasting lubrication.

ORIGINAL USA ADDITIVE

Not Just Oil... IT'S TECHNOLOGY

100% Quality SPRAY

MADE IN THE USA

Advantages

- Creeps Into Remote, Inaccessible Areas
- Offers Quick, Long-Lasting Lubrication
- Penetrates To Loosen Seized & Corroded Metal Mechanisms
- Provides Free-Flowing Protection
- Provides Protection Against Rust & Corrosion

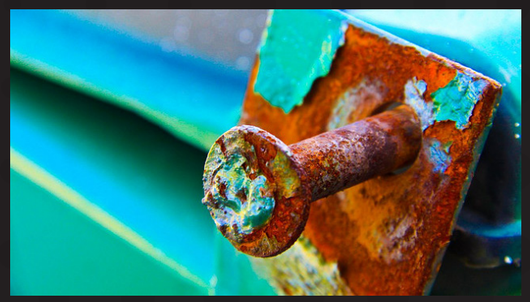
Applications

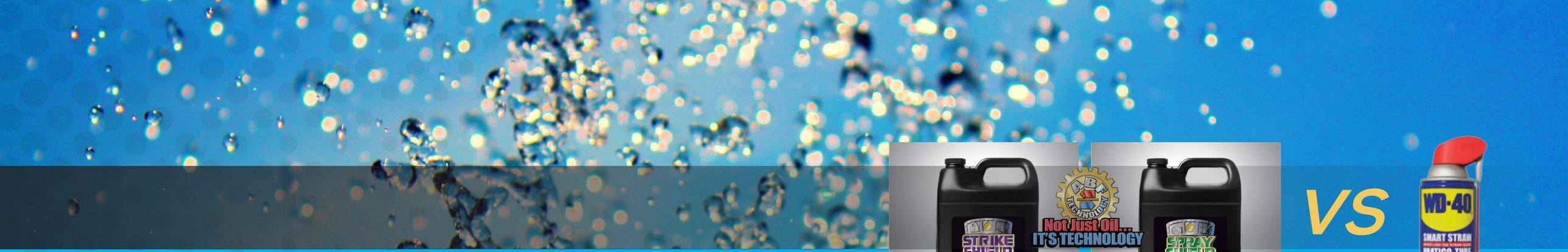
- Metal Mechanisms
- Metal-To-Metal Surfaces
- Chain Drives
- Drag Lines
- Bushings
- Pulleys
- Hinges
- Tools
- Sleeve Bearings
- Open Gears
- Steel Cables
- Couplings
- Linkages
- Wheels
- Augers
- Rusty Nuts & Bolts
- Any Automotive, Industrial or Commercial Areas Of Lubrication That Require An External Heavy-Duty Spray Lubricant For Accessible And Hard-To-Reach Areas

Directions of Usage

- Spray to any frozen mechanisms

Properties	Standard	Unit	Result
Flash Point		˚C	226
Boiling point		˚C	238
Evaporation rate			<0.01
Vapor pressure			<1@25 ˚C
Specific gravity			1.07





13A. STRIKE-SHIELD, SPRAY-SHIELD & WD-40 COMPARISON

VS

When comparing the characteristics of SPRAY-SHIELD (SS) & STRIKE-SHIELD (STKS) to those of WD-40, there are profound differences in product features and benefits.

WD-40 CLAIMS FIVE BASIC FUNCTIONS

CLEANS: WD-40 gets under dirt, grime and grease to clean. It also dissolves adhesives, allowing easy removal of labels, tape, stickers, and excess bonding material.

DISPLACES MOISTURE: Because WD-40 displaces moisture, it quickly dries out electrical systems to eliminate moisture-induced short circuits.

PENETRATES: WD-40 loosens rust-to-metal bonds and frees stuck, frozen or rusted metal parts.

LUBRICATES: WD-40's lubricating ingredients are widely dispersed and hold firmly to all moving parts.

PROTECTS: WD-40 protects metal surfaces with corrosion-resistant ingredients to shield against moisture and other corrosive elements.

SPRAY-SHIELD & STRIKE-SHIELD PROVIDE THE ABOVE FUNCTIONS PLUS MORE

CLEAN: SS & STKS lift and remove dirt, grime and grease from surfaces, including adhesive compounds and bonding agents.

SS & STKS keep surfaces clean by rejecting airborne contaminants, such as dust and smoke, due to its electrochemical surface bonding technique by causing a dipole-dipole interaction and cation exchange on the metal surfaces. This, in effect, creates a greater positive charge on the metal surfaces which react with positive charged airborne contaminants (+ ions) in causing a repulsion between the two.

DISPLACE MOISTURE: SS & STKS are a fast-acting drying agent for quick and thorough moisture displacement in damp or soaked electrical or electronic systems. A migrating film burrows under condensation and moisture, driving it to the surface where they dry or can be wiped off to reactivate circuits. After moisture is displaced, an ultra-thin residual film resists rust and corrosion. SS & STKS do not contain carbon tetrachloride and will not harm insulation.

Areas of Use: Wet or damp ignitions, electrical systems, motors, controls, starters, relays, radios, electronic equipment, etc.

PENETRATE: SS & STKS are the ideal solution to hundreds of different maintenance and production problems involving rust and corrosion. They work quickly and effectively on even the most severe cases of rusted equipment, parts and components. SS & STKS disperse quickly into rusted, corroded areas to loosen scale and free up working mechanisms, tight fitting parts and frozen fastenings. SS & STKS's low surface tension speed penetration even into normally inaccessible areas. SS & STKS will not affect painted surfaces.

Areas of Use: Rusted lugs or bolts, sliding parts, sluggish mechanisms, hinges, tools, products in storage, gear trains, wheels, rotating apparatus, linkages, cams, levers, industrial equipment, etc.

LUBRICATE: SS & STKS are a light, but lasting lubricant. They offer quick, positive, long-lasting lubrication on wide varieties of applications in industry, the shop and garage, the farm and at home. SS & STKS are ideal for automobiles and equipment, flowing and lubricating deeply into hard-to-reach internal areas.

Areas of Use: Metal mechanisms, gears, locks, linkages, wheel bearings, metal-to-metal surfaces, cams, levers, engines, motors, slides, hinges, garden equipment, etc.

PROTECT: SS & STKS stop rust dead in its tracks. These products' unique formulation uses a combination of the best rust and oxidation preventatives available. SS & STKS seek out rust, stop the oxidation process and prevent further rust from forming.

In addition, SS & STKS remove corrosion and corrosion bridges from printed circuit boards after a light spray and "toothbrush" scrubbing. This prohibits corrosion from also returning in the future. After corrosion is removed and excess SS & STKS are wiped from the board, a microfilm layer will remain on the surface of the metals to virtually eliminate the long-term effects of electrolytic bridging.

ADDITIONAL FEATURES OF SPRAY-SHIELD & STRIKE-SHIELD

SS & STKS contain Steel Shield EPA "ABF Technology"TM, one of the leading anti-friction, metal-treating products. EPA is a blend of petroleum products containing no graphite, PTFE, silicones, moly or synthetics. The dielectric strength of SS & STKS is rated at 45 KV (45,000 volts).

SS & STKS are not an aerosol - they are packaged in convenient hand pump spray bottles and conforms to DOT and OSHA regulations. The adjustable nozzle allows you to provide an overall misting of lubrication or pinpoint just the areas you want with jet spray. You can also use SS & STKS with Air Pressurized Sprayer, which works as well as an aerosol, but utilizes compressed air.

Please see the attached page for a quick reference chart on the comparison of these products.

Feature or Benefit	SS & STKS	WD-40
Loosens rusted parts	Within minutes	Within hours
Penetrates deep and fast	Immediately	Slowly
Keeps parts from freezing up	Long term	Short term
Protects metal against corrosion	Long term	Short term
Leaves a barrier film	Long term	Short term
Displaces moisture	YES	YES
Dries electrical equipment	YES	YES
Non-conductive	YES (45,000V DIELECTRIC)	YES (UNKNOWN)
Stops squeaks	Long term	Short term
Gummy residue	NONE	NONE
Long-lasting lubrication	YES	NO
Anti-wear properties	YES	NO
Extreme-pressure properties	YES	NO

TABLE 1 - SPRAY-SHIELD & STRIKE-SHIELD COMPARED TO WD-40

- Strike Shield and Spray Shield win

NOTE: The following disclaimer appeared on the WD-40 web site at the time of this writing: "The uses of WD-40 described on this Web site are provided to WD-40 Company by end-users of the product, and do not constitute recommendations or suggestions for use of WD-40 by WD-40 Company. These uses, including the 'Use of the Day', have not been tested by WD-40 Company. Consumers should exercise common sense whenever using WD-40. Always follow the instructions and take heed of any warnings printed on the WD-40 packaging." WD-40 is a registered trademark of WD-40 Company, San Diego, California, U.S.A.

I 3B. STEEL SHIELD GREASE COMPATIBILITY

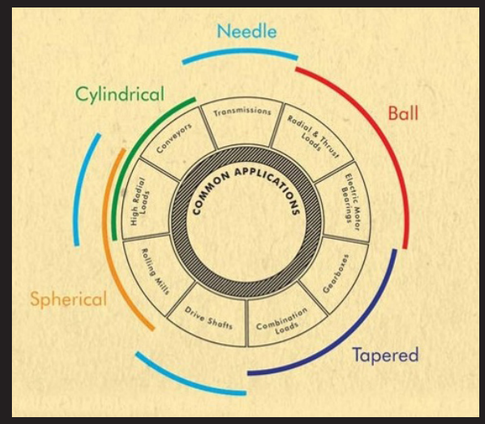
	Aluminum Complex	Barium Complex	Calcium Stearate	Calcium 12-Hydroxy	Calcium Complex	Calcium Sulfonate Complex	Clay (non-Soap)	Lithium Stearate	Lithium 12-Hydroxy	Lithium Complex	Polyurea (Conventional)	Polyurea (Shear Stable)
Aluminum Complex		I	I	C	I	B	I	I	I	C	I	C
Barlum Complex	I		I	C	I	C	I	I	I	I	I	B
Calcium Stearate	I	I		C	I	C	C	C	B	C	I	C
Calcium 12-Hydroxy	C	C	C		B	B	C	C	C	C	I	C
Calcium Complex	I	I	I	B		I	I	I	I	C	C	C
Caclium Sulfonate Complex	B	C	C	B	I		I	B	B	C	I	C
Clay (Non-Soap)	I	I	C	C	I	I		I	I	I	I	B
Lithium Stearate	I	I	C	C	I	B	I		C	C	I	C
Lithium 12-Hydroxy	I	I	B	C	I	B	I	C		C	I	C
Lithium Complex	C	I	C	C	C	C	I	C	C		I	C
Polyurea (Conventional)	I	I	I	I	C	I	I	I	I	I		C
Polyurea (Shear Stable)	C	B	C	C	C	C	B	C	C	C	C	

RELATIVE COMPATIBILITY RATING

- B = Borderline
- C = Compatible
- I = Incompatible
- Note: This chart is a general guide to compatibility. Specific properties of greases can dictate compatibility. Testing should be done to determine if greases are compatible.

I 3C. BEARING TYPES AND GREASES

COMMON APPLICATIONS OF DIFFERENT TYPES OF BEARINGS

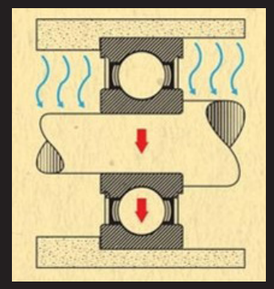


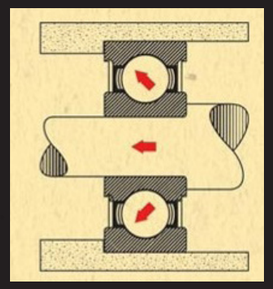
BEARING TYPE AFFECTS GREASE LIFE

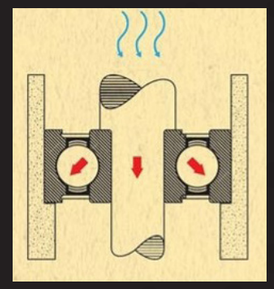
Bearing Type	Relative Type of Grease
Deep-groove, single-row ball bearing	1
Angular contact, single-row ball bearing	0.625
Self-aligning, single-row bearing	0.77 - 0.625
Trust ball bearing	0.2 - 0.17
Cylindrical, single-row roller bearing	0.625 - 0.43
Needle roller bearing	0.3
Tapered roller bearing	0.3
Spherical roller bearing	0.14 - 0.08

Larger bearings and high-speed bearings translate to short grease life. High DN grease is required.

BEARINGS UNDER DIFFERENT KINDS OF LOADS







Radial Load

- When the load is perpendicular to the shaft due to gravity

Axial or Thrust Load

- When the load is parallel to the shaft
- Left: Axial load in a horizontal pump
- Right: Axial load in a vertical pump or electrical motor due to gravity

I 3D. THE RIGHT GREASE SELECTION GUIDE

BASE OIL VISCOSITY

A common OEM grease specification might be to use an NLGI No. 2 lithium grease of good quality. Using this information alone, one could select the right consistency and thickener type. Other considerations include thickener concentration, consistency, dropping point and operating temperature range, worked stability, oxidation stability, wear resistance, etc.

A common mistake when selecting a grease is to confuse the grease consistency with the base oil viscosity. Because the majority of grease-lubricated applications are element bearings, one should consider viscosity selection for those applications. While most would not use an EP 220 gear oil for an oil-lubricated electric motor bearing, many people will use a grease containing that same oil for an identical grease-lubricated bearing. To determine minimum and optimum viscosity requirements for element bearings, one may use speed factors, commonly denoted as DN or NDm. Speed factors account for the surface speed of the bearing elements and are determined by the following formulas:

DN = (rpm) X (bearing bore)

NDm = rpm X ((bearing bore + outside diameter) / 2)

The NDm value uses pitch diameter rather than bore diameter because not all bearings of a given bore have the same element diameter, and thus have different surface speeds. Knowing the speed factor value and likely operating temperature, the minimum viscosity requirement can be read directly from charts like Figure 1. Figure 1 assumes the base oils' viscosity index. To be more precise, one would need to use a chart that identifies the viscosity at operating temperature, then determine the viscosity grade from a viscosity / temperature chart for a given lubricant.

ADDITIVES AND BASE OIL TYPES

Figure 2 shows some common additive requirements by application. Most greases are formulated using API Group I and II mineral oil base stocks, which are appropriate for most applications. However, there are applications that might benefit from the use of a synthetic base oil. Such applications include high or low operating temperatures, a wide ambient temperature range, or any application where extended re-lubrication intervals are desired.

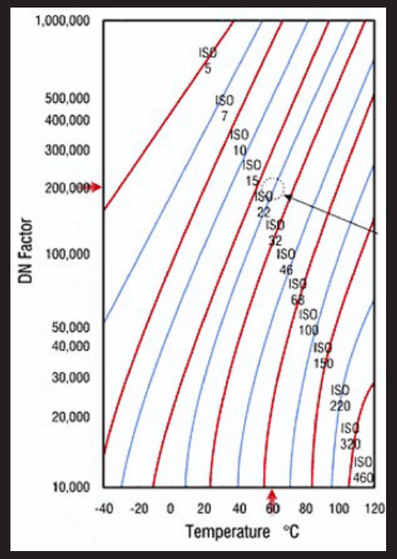


Figure 1
- The minimum viscosity requirement of oils

Additive	Journal Bearings	Ball Bearings	Thrust Bearings	Roller Bearings	Needle Bearings
Antioxidants	•	•	•	•	•
Antifoam Agents	•	•	•	•	•
Antiwear / EP		•	•	•	•
Rust Inhibitors	•	•	•	•	–
Extreme Pressure			–	–	
Demulsibility	•	•	•	•	–
VI Improvers	–	–	–	–	•
Corrosion Inhibitors	•	•	•	•	•

• Required;
– Depends on application

Figure 2
- Common additive requirements by applications

GREASE CONSISTENCY AND THICKENER TYPE

The NLGI has established a scale to indicate grease consistency which ranges from grades 000 (semifluid) to 6 (block grease). The most common NLGI grade is two and is recommended for most applications.

For bearings, speed factor and operating temperature can be used to determine the best consistency or NLGI grade for a given application. It may seem counterintuitive, but higher speed factors require higher consistency greases. Table 1 provides a general guide to selecting NLGI grade based on speed factor and operating temperature.

Numerous types of grease thickeners are currently in use, the most common types are simple lithium soaps, lithium complex and polyurea. Simple lithium soaps are often used in general-purpose greases and perform relatively well in most performance categories at moderate temperatures. Complex greases such as lithium complex provide improved performance particularly at higher operating temperatures. A common upper operating temperature limit for a simple lithium grease might be 250°F, while that for a lithium complex grease might be 350°F. Another thickener type that is becoming more popular is polyurea.

Like lithium complex, polyurea has good high-temperature performance as well as high oxidation stability and bleed resistance. Thickener type should be selected based on performance requirements as well as compatibility when considering changing product types.

Operating Temperature	DN (Speed Factor)	* NIGL No.
-30 to 100 °F	0 - 75,000	1
	75,000 - 150,000	2
	150,000 - 300,000	2
0 to 150 °F	0 - 75,000	2
	75,000 - 150,000	2
	150,000 - 300,000	3
100 to 275 °F	0 - 75,000	2
	75,000 - 150,000	2
	150,000 - 300,000	3

* Depends on other factors as well, including bearing type, thickener type, base oil viscosity and base oil type

PERFORMANCE PROPERTIES

If an application operates continuously at room temperature, properties like dropping and upper operating temperature limits are not as important. If an application operates under heavy loads at low speeds, load carrying tests such as four-ball EP or Timken OK load should be considered. It is also important to review these specifications on a periodic basis to guard against specification creep. While improving a lubrication program can be a tough job, lubricant specification is relatively easy. Armed with a little bit of knowledge and a few widely available tools, it is possible to rest easier knowing that the right grease is being used.

"With Steel Shield ABF Technology, the performance in stability, lubricity and interval of grease can be enhanced and improved to a much higher level."

NEVER USE GREASE OR OILS WITH SOLID ADDITIVES

"Solid additives such as Molybdenum will damage metal surface in the long term, never attempt to try those lubricants."

"Steel Shield lubricating oils and greases utilize unique ABF Technology which perform much better than any solid additives. Steel Shield is your wise choice."

Figure 3

- Upper: Steel Shield Grease - Lithi Shield does not contan any solid additive which have excellent performance in high loading operations without creating any undesire effects to metals
- Lower: Grease contains solid additive (Molybdenum). It will damage metal surface in the long term because it contans solid materials

14. STEEL SHIELD USA ORIGIN SYNTHETIC LUBRICANTS FOR AUTOMOTIVE

EURO SPORT

SST SAGATO GT

SUPER SYNTHETIC

XTR POWER

Not Just Oil...
IT'S TECHNOLOGY

EURO SPORT

Euro Sport is a fully synthetic lubricant line of the latest generation, specially formulated for the newest gasoline engines. Through Steel Shield ABF technology these oils provide superior performance in wear protection, better lubrication to help save fuel and reduce emissions of all types of pollutants. Euro Sport unique synthetic base stocks maintains ideal viscosity under a wide range of conditions; decrease volatility reducing emission from unburned oil in exhaust, evaporation and oil leaking into the combustion chamber; increase detergency, keeping engines free of sludge, varnish and other harmful substances. ABF Technology better protect the engine even under grueling driving conditions, ensuring long life for all moving parts and substantially reducing the need for engine servicing and overhauls.

SAE 0W30
SAE 5W40

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN THE USA

Advantages

- Unique ABF Technology treats the metal, not the oil
- Excellent dispersancy and detergency properties
- Againest oxidation, foaming, emulsfying, etc
- Excellent thermal and viscosity stabilities
- Effective control over high temperature deposits
- Protect engine against wear, corrosion
- Protect engine against extreme pressure
- Keep engine clean by actively removing debris without causing any damage to metals or composites
- Lower exhaust emission
- Prolong engine and lubricant life
- Excellent engine cold start protection
- Do not contain any solid additives

Applications

All types of latest gasoline engines

Standards

- API SN/CF
- ACEA A3/B4-10
- Meets requirements of VW 502.00/505.00, MB 229.5/229.3, BMW Longlife-01, Porsche A40 Maserati (5W40)

Properties	Standard	Unit	0W30	5W40
Viscosity @ 40 °C		mm²/s	73	93
Viscosity @ 100 °C		mm²/s	12	14.1
Viscosity at -30 °C		mPa.s	-	6300
Viscosity at -35 °C		mPa.s	6000	-
Viscosity Index			162	155
Pour Point		°C	-39	-39
Flash Point		°C	220	220
Mass Density @ 15°C		Kg / L	0.855	0.851

SST SAGATO GT

ZAGATO GT is designed for use in high-performance, high horsepower competition engines. Formulated with Steel Shield unique formula ABF Technology, Group II base oils, and shear stable viscosity modifiers, ZAGATO GT is made for Racing. It provides superior protection against wear and thermal breakdown under high loads and high operating temperatures experienced in racing engines.

SAE 15W40
SAE 20W50

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN THE USA

Advantages

- Unique ABF Technology treats the metal, not the oil
- Excellent dispersancy and detergency properties
- Againest oxidation, foaming, emulsfying, etc
- Excellent thermal and viscosity stabilities
- Effective control over high temperature deposits
- Protect engine against wear, corrosion
- Protect engine against extreme pressure
- Keep engine clean by actively removing debris without causing any damage to metals or composites
- Lower exhaust emission
- Prolong engine and lubricant life
- Excellent engine cold start protection
- Do not contain any solid additives

Applications

ZAGATO GT is sutiable for all types of racing engines. It is also recommended for supercharged, turbocharged and naturally aspirated competition engines utilizing racing gasoline, diesel fuel, methanol or nitromethane fuels. It also provides excellent protection in high-performance motorcycles and ATVs.

Standards

Properties	Standard	Unit	15W40	20W50
Viscosity @ 100°C		cSt	15.3	20.5
Viscosity @ 40°C		cSt	111	172
Viscosity Index (Min.)			148	135
Flash Point		°F/ °C	425 / 218	464 / 240
Pour Point		°F/ °C	0.78	0.63
Gravity		Degrees API	32	28.3
Phosphorus		ppm	1200	1200
Zinc		ppm	1300	1300

SUPER SYNTHETIC

Super Synthetic XL Motor Oils are specially formulated using synthetic base oils and high performance SST additive packages to provide superior performance benefits over conventional engine oils. These oils are formulated for excellent oxidation stability for long product life, superior low-temperature properties to insure protection during cold starts, lower volatility for reduced oil consumption, and excellent resistance to viscosity breakdown.

Super Synthetic XL Motor Oils meet the most demanding lubrication requirements of today's naturally aspirated, turbocharged and supercharged gasoline fueled and flex-fueled engines. These oils exceed the requirements of API SN, ILSAC GF-5 and are "Resource Conserving" for improved fuel economy.

SAE 5W30

Advantages

- Unique ABF Technology treats the metal, not the oil
- Excellent dispersancy and detergency properties
- Against oxidation, foaming, emulsfying, etc
- Excellent thermal and viscosity stabilities
- Effective control over high temperature deposits
- Protect engine against wear, corrosion
- Protect engine against extreme pressure
- Keep engine clean by actively removing debris without causing any damage to metals or composites
- Lower exhaust emission
- Prolong engine and lubricant life
- Excellent engine cold start protection
- Do not contain any solid additives

Applications

Super Synthetic XL Motor Oils are suitable for all types of naturally aspirated, turbocharged and supercharged gasoline fueled and flex-fueled engines.

Standards

- API SN
- ILSAC GF-5

Properties	Standard	Unit	5W30
Viscosity @ 40 °C		cSt	62
Viscosity @ 100 °C		cSt	11
Viscosity Index (Min.)			165
Pour Point		°C	-45
CCS		cP @ °C	5000 @-30°C
NOACK		wt%	11
HTHS @ 150 °C Viscosity		cP	3
Zinc		wt%	0.085
Phosphorus		wt%	0.077

ORIGINAL USA AUTOMOTIVE

XTR POWER

XTR Power is a premium, heavy-duty motor oil formulated with SST additive packages to safeguard all heavy duty engine applications including Gasoline, modern Exhaust Gas Recirculation and Diesel Particulate Filter equipped engines operating on Ultra-Low Sulfur Diesel fuel (15 ppm) and older on/off highway equipment running on Low Sulfur Diesel fuel (500 ppm).

XTR Power features long- lasting TBN protection and a unique soot dispersant chemistry to control wear and corrosion prevent piston deposits, control viscosity increase and maintain low temperature pumpability, excels in a wide range of heavy duty applications and operating environments found in the trucking, mining, construction and agricultural industries.

SAE 15W40

Advantages

- Unique ABF Technology treats the metal, not the oil
- Excellent dispersancy and detergency properties
- Against oxidation, foaming, emulsfying, etc
- Excellent thermal and viscosity stabilities
- Effective control over high temperature deposits
- Protect engine against wear, corrosion
- Protect engine against extreme pressure
- Keep engine clean by actively removing debris without causing any damage to metals or composites
- Lower exhaust emission
- Prolong engine and lubricant life
- Excellent engine cold start protection
- Do not contain any solid additives

Applications

All heavy duty engine applications

Standards

- API CJ-4, CI-4 Plus, CI-4, CH-4/SM
- ACEA E9-08, E7-08

Properties	Standard	Unit	15W40
Viscosity @ 40 °C	D-445	cSt	120
Viscosity @ 100 °C	D-445	cSt	15.7
Viscosity Index	D-2270		138
CCS Viscosity	D-5293	cP @ -20°C	6300
Pour Point	D-97	°C	-39
HTHS	D-4683	cP @ 150°C	4.2
Specific Gravity @ 15.6°C	D-4052		0.877
MRV	D-4684	cP @ -25°C	23,100
TBN	D-2896	mg KOH/g	10
NOACK	D-5800	Mass % loss	9.9

15. SINGAPORE AUTOMOTIVE LUBRICANTS WITH ABF TECHNOLOGY

ABF F1 M13

ABF M53 M13

ABF ECI M7 DIAMOND

ABF ECI M7 ENERGY

ABF ECI M7 PERFORMER

ABF ECI M7 RESOURCE

ABF ECI M7 SAFARI

ABF LITE E3 ALFA

ABF LITE E3 BETA

ABF LITE E3 CETA

ABF LITE E3 DOZA

ABF LITE E3 ECON

ABF LITE E3 FULA

ABF LITE E3 ISSA

ABF LITE E3 SPECIAL

ABF F1 M13

ABF F1 M13 is a high performance, full synthetic racing oil for use in Racing/ Modified high powered engines. Specially formulated extra high viscosity index base oils together with the unique Steel Shield ABF Technology provide an unsurpassed performance in extra protection to the engine under the most severe conditions. The synthetic base oil provides excellent film strength under high operating temperatures commonly found in racing conditions to effectively withstand oxidation of the oil. ABF-F1-M13 Racing Oil exceeds the toughest standards called for by Japanese, European and American Super-Car builders.

SAE 5W50
SAE 5W60

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Increased fuel economy
- A low coefficient of friction
- Significantly less bearing, ring, piston, cylinder and valve-train wear
- Increased engine durability
- Increased engine life
- Dramatically reduced down-times
- Reduced maintenance costs
- Increased output power

Applications

ABF F1 M13 is recommended for all high performance, high revving, turbo charged and supercharged multi-valve fuel injected engines found in racing engines, modern passenger cars and SUVs. It meets the requirement of Ford M2C913-A/B, LL-01, MB 229.3, VW 502.00/505.00, PSA B71 2294, Porsche A40.

Standards

- API SN/SM/SL/SJ/CF
- ACEA A3/B4-08

Properties	Standard	Unit	5W50	5W60
Viscosity @ 40 °C	ASTM D445	cSt	118	156
Viscosity @ 100 °C	ASTM D445	cSt	18	25
Viscosity Index	ASTM D2270		172	194
Pour Point	ASTM D97	°C	-30	-36
Flash Point COC	ASTM D92	°C	≥235	≥235
TBN	ASTM D2896	mgKOH/g	9.5	9.5
Sulphated Ash	ASTM D874	%wt	<1.0	<1.0
Mass Density @ 15°C		Kg / L	0.855	0.861

ABF M53 M13

ABF M53 M13 are premium fully synthetic engine oils enhanced with Steel Shield ABF Technology for ultimate performance that exceeds USA and European industry standards.

SAE 10W50
SAE 10W60

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Designed to provide protection under severe driving style or conditions
- Excellent wear protection and friction reduction across any operating conditions
- High detergency allows extended drain intervals and provides increased cleanliness
- High natural viscosity index (VI) provides thicker oil film in bearings and cams
- Improved fuel economy and ring seal for more power
- Increased output power
- Reduced downtime
- Stability and endurance under extreme conditions that can cause oils to break down
- Superior high temperature stability and oxidation resistance

Applications

ABF M53 M13 are recommended for all High Performance multi-valve and turbo types with or without catalytic converter gasoline engines, and all diesel engines turbo-charged or naturally aspirated.

Standards

- API SN/SM/SL/CF
- ACEA A3 B3/B4

Properties	Standard	Unit	10W50	10W60
Viscosity @ 40 °C	ASTM D445	cSt	160	170
Viscosity @ 100 °C	ASTM D445	cSt	17.8	22.8
Viscosity Index	ASTM D2270		163	187
Pour Point	ASTM D97	°C	-36	-36
Flash Point COC	ASTM D92	°C	≥230	≥230
TBN	ASTM D2896	mgKOH/g	9.5	9.5
Sulphated Ash	ASTM D874	%wt	<1.25	<1.25
Mass Density @ 15°C		Kg / L	0.856	0.861

ABF ECI M7 DIAMOND

ABF ECI M7 Diamond are high end fully synthetic engine oils formulated with synthetic base stocks and advanced additives. The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions such as sporty driving. M7 Diamond meet most stringent OEM requirements of MB p229.5, MB p229.3, BMW Longlife-04, Porsche A40, VW502 00/505 00, Renault 0700, 0710, Ford WSS-M2C913-C.

SAE 0W40
SAE 5W40

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Better mileage
- Excellent protection against corrosion, wear, keeps engine in good condition
- Increase output power
- Long oil drain interval
- Low volatility, lower oil consumption
- Reduce downtime dramatically
- Reduces deposit and maintains engine cleanliness
- Strong TBN retention, effectively neutralizes acid residue
- Superior oxidation control even under high temperature

Applications

ABF ECI M7 Diamond are recommended for use in all makes of high performance luxury cars especially for those low displacement naturally aspirated high revving gasoline engines such as Renault A40, BMW M5, etc.

Standards

- API SN/SM/CF
- ACEA A3/B3-08, A3/B4-10

Properties	Standard	Unit	0W40	5W40
Viscosity @ 40 °C	ASTM D445	cSt	75	85
Viscosity @ 100 °C	ASTM D445	cSt	13.5	14.2
Viscosity Index	ASTM D2270		180	172
Pour Point	ASTM D97	°C	-45	-38
Flash Point COC	ASTM D92	°C	228	222
TBN	ASTM D2896	mgKOH/g	10.1	10.1
Sulphated Ash	ASTM D874	%wt	1.08	1.08
Mass Density @ 15°C		Kg / L	0.897	0.897

ECI M7 ENERGY

ABF ECI M7 Energy are the new generation high performance diesel engine oils specially formulated to meet on-highway exhaust emission standards. With low SAPS technology, these oils provide excellent protection for emission control systems, reduce engine wear, and control piston deposits. When used in conjunction with ultra low sulphur (max. 15ppm), diesel fuel, the oil consumption will be significantly reduced.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 10W30
SAE 15W40

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Effective control of piston deposits, wear and corrosion
- Enhanced engine cleanliness and viscosity control
- Extended oil drain interval, Increase output power, Reduce downtime
- High thermal and high oxidation stability
- Protect the exhaust catalysts and particulate filters

Applications

ABF ECI M7 Energy are the most suitable diesel engine oils for use in 2007 models high performance diesel engines equipped with advanced diesel particulate filters and exhaust gas recirculation systems. It can also be used for all types of heavy duty diesel engines for both on- and off-highway fleets. They are also highly recommended for MB 228.31, MAN M 3275, VOLVO VDS-4, MACK EO-O PP07, Detroit Diesel 93K218, 93K215, Caterpillar ECF-1A, ECF-2 and ECF-3, RVI RDL-3, Cummins CES 20071 and CES 20081, etc.

Standards

- API CJ-4/CI-4, PLUS/CI-4, SM/SL/SJ
- ACEA E9-08/E7-08

Properties	Standard	Unit	10W30	15W40
Viscosity @ 40 °C	ASTM D445	cSt	70.8	116
Viscosity @ 100 °C	ASTM D445	cSt	11.5	14.8
Viscosity Index	ASTM D2270		143	136
Pour Point	ASTM D97	°C	-36	-25
Flash Point COC	ASTM D92	°C	212	218
TBN	ASTM D2896	mgKOH/g	10.1	10.1
Sulphated Ash	ASTM D874	%wt	<1.0	<1.0
Mass Density @ 15°C		kg/l	0.872	0.872

ABF ECI M7 PERFORMER

ABF-ECI M7 Performer is a series of long life motor oils formulated with synthetic base stocks and proprietary additives. Extensively compatible with various fuels and aftertreatment chemicals, the oils provide effective control of oxidation, nitration, exhaust particulates, piston wear and bearing corrosion in engines. These oils are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline, CNG or diesel equipped with or without exhaust particulate filters such as Mercedes Benz E200 CDI, E220 CDI, E280 CDI, and E420 CDI, Porsche, BMW, Renault, Volkswagen, Toyota, Hyundai, etc.

SAE 5W30
SAE 5W40

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Long service life and superior performance against oxidation and nitration
- Reduces deposit and maintains engine cleanliness
- Excellent protection against corrosion, wear, keep engine in good condition
- Fuel economy, energy saving
- Increase output power
- Reduce downtimes

Applications

ABF ECI M7 Performer are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline, CNG or diesel equipped with or without exhaust particulate filters such as Mercedes Benz E200 CDI, E220 CDI, E280 CDI, and E420 CDI, Porsche, BMW, Renault, Volkswagen, Toyota, Hyundai, etc. The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions. These oils exceed the latest OEM specification requirements of MB p229.51, MB p229.31, BMW Longlife-04, Porsche, VW502 00/505 00, Renault, GM dexos2, etc.

Standards

- API SN/SM/CF
- ACEA A3/B3-08, A3/B4-08, A5/B5-08, C3-08, C2-08

Properties	Standard	Unit	5W30	5W40
Viscosity @ 40 °C	ASTM D445	cSt	63	88
Viscosity @ 100 °C	ASTM D445	cSt	10.6	14.5
Viscosity Index	ASTM D2270		166	167
Pour Point	ASTM D97	°C	-38	-38
Flash Point COC	ASTM D92	°C	200	215

ECI M7 RESOURCE

ABF-ECI M7 Resource is fully synthetic utmost superior grade motor oils. With friction modifiers this oil provides better fuel economy and extra power output. The high viscosity index and low pour point properties provide excellent cold start-up wear protection and thermal stability. The oil exceeds the performance requirement of API SN-RC, SM, SL, SJ, ILSAC GF-5, GF-4, GF-3, etc.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 0W20, SAE 0W30, SAE 5W20
SAE 5W30, SAE 10W30

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Better protect vehicle emission system
- Excellent thermal and oxidation stability, extend oil drain interval
- Fuel economy, energy saving
- Increase output power
- Outstanding deposit control, improve engine cleanliness with ABF technology
- Reduce downtime
- Resource conserving ILSAC GF-5 with efficient cold engine start-up
- Superior wear and corrosion protection, prolong battery and engine components life

Applications

ABF-ECI M7 Resource is recommended for use in the latest models of passenger cars, racing cars, vans and light duty trucks with gasoline and gasoline turbo-charged engines where API SN, SM, SL, SJ etc. oils are required. Vehicle manufacturers recommendations on engine oil viscosity and performance level should be followed.

Standards

- API SN-RC, SM, SL, SJ
- ILSAC GF-5, GF-4, GF-3

Properties	Standard	Unit	0W20	0W30	5W20	5W30	10W30
Viscosity @ 40 °C	ASTM D445	cSt	45	56	48	61	64
Viscosity @ 100 °C	ASTM D445	cSt	8.6	10.3	8.8	10.5	10.5
Viscosity Index	ASTM D2270		173	175	158	162	152
Pour Point	ASTM D97	°C	-42	-42	-38	-36	-36
Flash Point COC	ASTM D92	°C	238	222	226	212	228
Resource Conserving			Yes	Yes	Yes	Yes	Yes

ABF ECI M7 SAFARI

ABF ECI M7 Safari is a semi-synthetic premium gasoline and light duty diesel engine oil recommended for use in high performance gasoline and direct injection diesel engines without DPF, such as Benz, Audi, VW, Seat, Fiat cars, and Renault, etc. where request VW501 01/505 00, MB229.1, etc oil.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 10W40

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE

MADE IN SINGAPORE

Advantages

- Superior detergency and dispersancy
- Enhanced oxidation stability
- Effective control of piston deposits, wear and corrosion
- Excellent low temperature pumpability
- Reduced oil consumption
- Increase output power
- Reduce downtime

Applications

High performance gasoline and direct injection diesel engines without DPF, such as Benz, Audi, VW, Seat, Fiat cars, and Renault, etc. where request VW501 01/505 00, MB229.1, etc oil.

Standards

- API SN/SM/CF
- ACEA A3/B3, A3/B4-10

Properties	Standard	Unit	10W40
Viscosity @ 40 °C	ASTM D445	cSt	95
Viscosity @ 100 °C	ASTM D445	cSt	14
Viscosity Index	ASTM D2270		152
Pour Point	ASTM D97	°C	-33
Flash Point COC	ASTM D92	°C	215
Sulfated Ash	ASTM D874	%wt	1.3
TBN	ASTM D2896	mgKOH/gm	10

LITE E3 ALFA

ABF Lite E3 Alfa are high end fully synthetic engine oils formulated with synthetic base stocks and advanced additives. The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions such as sporty driving. ABF Lite E3 Alfa meet most stringent OEM requirements of MB p229.5, MB p229.3, BMW Longlife-04, Porsche A40, VW502 00/505 00, Renault 0700, 0710, Ford WSS-M2C913-C.

SAE 0W40
SAE 5W40

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE

MADE IN SINGAPORE

Advantages

- Better mileage
- Excellent protection against corrosion, wear, keeps engine in good condition
- Increase output power
- Long oil drain interval
- Low volatility, lower oil consumption
- Reduce downtime dramatically
- Reduces deposit and maintains engine cleanliness
- Strong TBN retention, effectively neutralizes acid residue
- Superior oxidation control even under high temperature

Applications

ABF Lite E3 Alfa are recommended for use in all makes of high performance luxury cars especially for those low displacement naturally aspirated high revving gasoline engines such as Renault A40, BMW M5, etc.

Standards

- API SM/SL/SJ/CF
- ACEA A3/B3-08, A3/B4-10

Properties	Standard	Unit	0W40	5W40
Viscosity @ 40 °C	ASTM D445	cSt	75	85
Viscosity @ 100 °C	ASTM D445	cSt	13.5	14.2
Viscosity Index	ASTM D2270		180	172
Pour Point	ASTM D97	°C	-45	-38
Flash Point COC	ASTM D92	°C	228	222
TBN	ASTM D2896	mgKOH/g	10.1	10.1
Sulphated Ash	ASTM D874	%wt	1.08	1.08
Mass Density @ 15°C		Kg / L	0.897	0.897

LITE E3 BETA

ABF-Lite E3 Beta are fully synthetic passenger car motor oils. Formulated with advance additives the oils provide engine excellent wear and rust protection, outstanding sludge and deposit controlling and high temperature stability. These oils are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline or diesel which requires API SM, SL, SJ quality oils.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions. These oils exceed the latest OEM specification requirements of VW502 00/505 00, etc.

SAE 5W30
SAE 5W40

Advantages

- Excellent cold engine start-up protection
- Excellent oxidation stability
- Extend oil drain interval
- Improved deposit protection and maintains engine cleanliness
- Outstanding corrosion and wear protection, keep engine in good condition
- Fuel economy, energy saving
- Increase output power
- Reduce downtime

Applications

ABF Lite E3 Beta are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline, CNG or diesel equipped with or without exhaust particulate filters such as Mercedes Benz E200 CDI, E220 CDI, E280 CDI, and E420 CDI, Porsche, BMW, Renault, Volkswagen, Toyota, Hyundai, etc.

Standards

- API SM/SL/SJ/CF

Properties	Standard	Unit	5W30	5W40
Viscosity @ 40 °C	ASTM D445	cSt	69	85
Viscosity @ 100 °C	ASTM D445	cSt	11.2	14.8
Viscosity Index	ASTM D2270		145	165
Pour Point	ASTM D97	°C	-36	-36
Flash Point COC	ASTM D92	°C	222	220

LITE E3 CETA

ABF Lite E3 Ceta is a semi-synthetic premium gasoline and light duty diesel engine oil recommended for use in high performance gasoline and direct injection diesel engines without DPF, such as Benz, Audi, VW, Seat, Fiat cars, and Renault, etc. where request VW501 01/505 00, MB229.1, etc oil.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 10W40

Advantages

- Effective control of piston deposits, wear and corrosion
- Enhanced oxidation stability
- Excellent low temperature pumpability
- Increase output power
- Reduce downtime
- Reduced oil consumption
- Superior detergency and dispersancy

Applications

High performance gasoline and direct injection diesel engines without DPF, such as Benz, Audi, VW, Seat, Fiat cars, and Renault, etc. where request VW501 01/505 00, MB229.1, etc oil.

Standards

- API SM/SL/SJ/CF
- ACEA A3/B3, A3/B4-10

Properties	Standard	Unit	10W40
Viscosity @ 40 °C	ASTM D445	cSt	95
Viscosity @ 100 °C	ASTM D445	cSt	14
Viscosity Index	ASTM D2270		152
Pour Point	ASTM D97	°C	-33
Flash Point COC	ASTM D92	°C	215
Sulfated Ash	ASTM D874	%wt	1.3
TBN	ASTM D2896	mgKOH/gm	10

LITE E3 DOZA

ABF Lite E3 Doza are the new generation high performance diesel engine oils specially formulated to meet on-highway exhaust emission standards. With low SAPS technology, these oils provide excellent protection for emission control systems, reduce engine wear, and control piston deposits. When used in conjunction with ultra low sulphur (max. 15ppm), diesel fuel, the oil consumption will be significantly reduced.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 10W30
SAE 15W40

Advantages

- Effective control of piston deposits, wear and corrosion
- Enhanced engine cleanliness and viscosity control
- Extended oil drain interval, Increase output power, Reduce downtime
- High thermal and high oxidation stability
- Protect the exhaust catalysts and particulate filters

Applications

ABF Lite E3 Doza are the most suitable diesel engine oils for use in 2007 models high performance diesel engines equipped with advanced diesel particulate filters and exhaust gas recirculation systems. It can also be used for all types of heavy duty diesel engines for both on- and off-highway fleets.

These oils are also highly recommended for MB 228.31, MAN M 3275, VOLVO VDS-4, MACK EO-O PP07, Detroit Diesel 93K218, 93K215, Caterpillar ECF-1A, ECF-2 and ECF-3, RVI RDL-3, Cummins CES 20071 and CES 20081, etc.

Standards

- API CJ-4/CI-4, PLUS/CI-4, SM/SL/SJ
- ACEA E9-08/E7-08

Properties	Standard	Unit	10W30	15W40
Viscosity @ 40 °C	ASTM D445	cSt	70.8	116
Viscosity @ 100 °C	ASTM D445	cSt	11.5	14.8
Viscosity Index	ASTM D2270		143	136
Pour Point	ASTM D97	°C	-36	-25
Flash Point COC	ASTM D92	°C	212	218
TBN	ASTM D2896	mgKOH/g	10.1	10.1
Sulphated Ash	ASTM D874	%wt	<1.0	<1.0
Mass Density @ 15°C		kg/l	0.872	0.872

SINGAPORE AUTOMOTIVE

LITE E3 ECON

ABF-Lite E3 Econ is a fully synthetic utmost superior grade motor oils. With friction modifiers this oil provides better fuel economy and extra power output. The high viscosity index and low pour point properties provide excellent cold start-up wear protection and thermal stability. The oil exceeds the performance requirement of API SN-RC, SM, SL, SJ, ILSAC GF-5, GF-4, GF-3, etc.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 0W20, SAE 0W30, SAE 5W30

Advantages

- Better protect vehicle emission system
- Excellent thermal and oxidation stability, extend oil drain interval
- Fuel economy, energy saving
- Increase output power
- Outstanding deposit control, improve engine cleanliness with ABF technology
- Reduce downtime
- Resource conserving ILSAC GF-5 with efficient cold engine start-up
- Superior wear and corrosion protection, prolong battery and engine components life

Applications

ABF-Lite E3 Econ is recommended for use in the latest models of passenger cars, racing cars, vans and light duty trucks with gasoline and gasoline turbo-charged engines where API SN, SM, SL, SJ etc. oils are required. Vehicle manufacturers recommendations on engine oil viscosity and performance level should be followed.

Standards

- API SN-RC, SM, SL, SJ
- ILSAC GF-5, GF-4, GF-3

Properties	Standard	Unit	0W20	0W30	5W30
Viscosity @ 40 °C	ASTM D445	cSt	45	56	61
Viscosity @ 100 °C	ASTM D445	cSt	8.6	10.3	10.5
Viscosity Index	ASTM D2270		173	175	162
Pour Point	ASTM D97	°C	-42	-42	-36
Flash Point COC	ASTM D92	°C	238	222	212
Resource Conserving			Yes	Yes	Yes

LITE E3 FULA

ABF Lite E3 Fula is premium severe duty engine oil applicable for on and off highway heavy duty diesel engines with emission treat device, such as EGR etc. The oil offers more viscosity control, greater soot loading capability, and better shear stability. The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions.

SAE 20W50

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE

MADE IN SINGAPORE

Advantages

- Effective control over high temperature piston deposits
- Excellent dispersancy and detergency properties
- Increase output power
- Keep engine clean
- Lower exhaust emission
- Outstanding oxidation stability
- Prolong engine life
- Protect engine against wear, corrosion
- Reduce downtime

Applications

ABF-Lite E3 Fula is suitable for all makes of high speed four stroke turbocharged and supercharged diesel engines used on heavy duty both on-highway and off-highway applications and meets specifications of Mack EO-N Premium Plus' 03, Caterpillar ECF-2, Caterpillar SCF-la, Volvo VDS-3, Cummins CES 20076/78, MB 228.3, MAN 3275, JASO DH-1, MTU Type 2.

Standards

- API CH-4/CG-4
- ACEA E7-04

Properties	Standard	Unit	20W50
Viscosity @ 40 °C	ASTM D445	cSt	162
Viscosity @ 100 °C	ASTM D445	cSt	18
Viscosity Index	ASTM D2270		126
Pour Point	ASTM D97	°C	-25
Flash Point COC	ASTM D92	°C	≥210
TBN	ASTM D2896	mgKOH/g	10.5
Sulphated Ash	ASTM D874	%wt	<1.2
Mass Density @ 15°C		Kg / L	0.891
Evaporation Rate			<0.01

LITE E3 ISSA

ABF-Lite E3 Issa is Hi-Performance premium gasoline engine oil for all makes of passenger cars and light vehicles powered by gasoline engines. The oil offers more viscosity control, excellent anti-oxidation, anti-wear and anti-corrosion properties. ABF-Lite E3 Issa meets or exceeds the performance requirements of API SM, SL, SJ, CF, ILSAC GF-4, etc.

The unique Steel Shield ABF Technology provides outstanding performance and extra protection even in the most extreme conditions.

SAE 10W30

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE

MADE IN SINGAPORE

Advantages

- Effective control over high temperature piston deposits
- Excellent dispersancy and detergency
- Increase output power
- Keep engine clean
- Prolong engine life
- Protect engine against wear, corrosion
- Reduce downtime
- Superior oxidation and thermal stability

Applications

ABF-Lite E3 Issa is suitable for all makes of gasoline engines.

Standards

- API CH-4/CG-4
- ACEA E7-04

Properties	Standard	Unit	10W30
Viscosity @ 40 °C	ASTM D445	cSt	69
Viscosity @ 100 °C	ASTM D445	cSt	10.8
Viscosity Index	ASTM D2270		145
Pour Point	ASTM D97	°C	-36
Flash Point COC	ASTM D92	°C	215
Mass Density @ 15°C		Kg / L	0.891
Evaporation Rate			<0.01

LITE E3 SPECIAL

ABF LITE E3 Special are a series of long life motor oils formulated with synthetic base stocks and proprietary additives. Extensively compatible with various fuels and after-treatment chemicals, the oils provide effective control of oxidation, nitration, exhaust particulates, piston wear and bearing corrosion in engines.

The unique Steel Shield ABF Technology of the oils provides outstanding performance and protection even in the most extreme conditions. These oils exceed the latest OEM specification requirements of MB p229.51, MB p229.31, BMW Longlife-04, Porsche, VW502 00/505 00, Renault, GM dexos2 etc.

SAE 5W30
SAE 5W40

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE

MADE IN SINGAPORE

Advantages

- Excellent protection against corrosion, wear, keep engine in good condition
- Fuel economy, energy saving
- Increase output power
- Long service life and superior performance against oxidation and nitration
- Reduce downtime
- Reduces deposit and maintains engine cleanliness

Applications

ABF LITE E3 Special are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline, CNG or diesel equipped with or without exhaust particulate filters such as Mercedes Benz E200 CDI, E220 CDI, E280 CDI, and E420 CDI, Porsche, BMW, Renault, Volkswagen, Toyota, Hyundai, etc.

Standards

- API SN/SM/CF
- ACEA A3/B3-08, A3/B4-08, A5/B5-08, C3-08, C2-08

Properties	Standard	Unit	5W30	5W40
Viscosity @ 40 °C	ASTM D445	cSt	63	88
Viscosity @ 100 °C	ASTM D445	cSt	10.6	14.5
Viscosity Index	ASTM D2270		166	167
Pour Point	ASTM D97	°C	-38	-38
Flash Point COC	ASTM D92	°C	200	215

SINGAPORE AUTOMOTIVE

16. SINGAPORE ECONOMIC AUTOMOTIVE LUBRICANTS

SST BASIC

SST BASIC
SAE 0W40, SAE 10W40

SST Basic 0W40 and 10W40 are super premium quality synthetic oils developed to provide the highest standard of lubricant reliability and protection for all types of automobile engines. They are the ideal choices for anyone seeking the ultimate quality and dependable protection in a lubricant.

SAE 0W40
SAE 10W40

Advantages
- Excellent thermal and oxidation stability to reduce engine deposits and sludge build up
- Enhanced frictional properties to help save fuel
- Excellent low temperature capabilities for reliable cold weather starting allowing fast engine and electrical system protection
- High temperature fortified formulation provides reserve protection for the toughest driving conditions

Applications
SST Basic 0W40 and 10W40 are specially recommended for use in all types of vehicles, especially modern gasoline engines fitted with advanced computer controlled multi-valve fuel injection engines, turbochargers and other performance enhancement equipment. It is an excellent choice for all automobiles, light truck and vans.

Standards
- API SM/SL/SJ/CF

Properties	Standard	Unit	0W40	10W40
Viscosity @ 40 °C	ASTM D445	cSt	75	98
Viscosity @ 100 °C	ASTM D445	cSt	12.5	14.5
Viscosity Index	ASTM D2270		149	157
Pour Point	ASTM D97	°C	-35	-33
Flash Point COC	ASTM D92	°C	230	218
Mass Density @ 15°C		Kg / L	0.85	0.872

SINGAPORE AUTOMOTIVE

SST BASIC
SAE 5W30, SAE 5W40

SST Basic 5W30 and 5W40 are fully synthetic passenger car motor oils. Formulated with advance additives the oils provide engine excellent wear and rust protection, outstanding sludge and deposit controlling and high temperature stability.

These oils provides outstanding performance and protection in most extreme conditions. These oils exceed the latest OEM specification requirements of VW502 00/505 00, etc.

SAE 5W30
SAE 5W40

Advantages
- Excellent cold engine start-up protection
- Excellent oxidation stability
- Extend oil drain interval
- Improved deposit protection and maintains engine cleanliness
- Outstanding corrosion and wear protection, keep engine in good condition
- Fuel economy, energy saving

Applications
SST Basic 5W30 and 5W40 are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline or diesel which requires API SM, SL, SJ quality oils.

Standards
- API SM/SL/SJ/CF

Properties	Standard	Unit	0W20	0W30	5W30
Viscosity @ 40 °C	ASTM D445	cSt	69	85	61
Viscosity @ 100 °C	ASTM D445	cSt	11.2	14.8	10.5
Viscosity Index	ASTM D2270		145	165	162
Pour Point	ASTM D97	°C	-36	-36	-36
Flash Point COC	ASTM D92	°C	222	220	212

SST BASIC SPECIAL

SAE 5W30 SPECIAL, SAE 5W40 SPECIAL

SST-Basic Special are a series of long life motor oils formulated with synthetic base stocks and proprietary additives. Extensively compatible with various fuels and after-treatment chemicals, the oils provide effective control of oxidation, nitration, exhaust particulates, piston wear and bearing corrosion in engines.

These oils exceed the latest OEM specification requirements of MB p229.51, MB p229.31, BMW Longlife-04, Porsche, VW502 00/505 00, Renault, GM dexos2 etc.

SAE 5W30
SAE 5W40

Advantages

- Excellent protection against corrosion, wear, keep engine in good condition
- Fuel economy, energy saving
- Long service life
- Reduces deposit and maintains engine cleanliness
- Superior performance against oxidation and nitration

Standards

- API SN/SM/CF
- ACEA A3/B3-08, A3/B4-08, A5/B5-08, C3-08, C2-08

Applications

SST-Basic Special are recommended for use in all makes of latest models of passenger cars, racing car, van and truck burning gasoline, CNG or diesel equipped with or without exhaust particulate filters such as Mercedes Benz E200 CDI, E220 CDI, E280 CDI, and E420 CDI, Porsche, BMW, Renault, Volkswagen, Toyota, Hyundai, etc.

Properties	Standard	Unit	5W30	5W40
Viscosity @ 40 °C	ASTM D445	cSt	63	88
Viscosity @ 100 °C	ASTM D445	cSt	10.6	14.5
Viscosity Index	ASTM D2270		166	167
Pour Point	ASTM D97	°C	-38	-38
Flash Point COC	ASTM D92	°C	200	215

SINGAPORE AUTOMOTIVE

SST BASIC

SAE 15W40

SST Basic 15W40 is a super premium quality oil developed to provide the highest standard of lubricant reliability and protection for all types of automobile diesel engines fitted with advanced computer controlled multi-valve fuel injection engines, turbochargers and other performance enhancement equipment.

SAE 15W40

Advantages

- Built for new diesel engines with exhaust emission control systems
- Built for older on highway diesel engines requiring improved protection
- Built for fleets desiring one premium oil for simplified logistics, regardless of fuel sulfur levels
- Ideal for mixed fleets including gasoline applications
- Wear protection and reduced filter restriction at high soot levels
- High temperature deposit control, including single and two-piece pistons, and ring/liner wear protection
- High TBN level for long life performance
- Extend life of New and Older engines
- Low sulfur and ultra low sulfur fuel compatible

Applications

All types of automobile diesel engines fitted with advanced computer controlled multi-valve fuel injection engines, turbochargers and other performance enhancement equipment.

Standards

- API CJ-4, CI-4, CH-4, CG-4, CF-4/SM, SL, SJ
- Mack EO N Premium plus 03, EO N Premium Plus, EO-M Plus, EO-M
- Caterpillar ECF-3, ECF-2, ECF-1a, Cummins CES 20077, 20076
- ACEA E-7-04, E5, E3, MB p228.31, Volvo VDS-3, JASO DH-2, MAN 3275

Properties	Standard	Unit	15W40
iscosity @ 40 °C	ASTM D445	cSt	112
Viscosity @ 100 °C	ASTM D445	cSt	15
Viscosity Index	ASTM D2270		135
Pour Point	ASTM D97	°C	-32
Flash Point COC	ASTM D92	°C	235
Mass Density @ 15°C		Kg / L	0.872
TBN			11

SST BASIC SPECIAL

SAE 20W50

SST Basic 20W50 is premium severe duty engine oil applicable for on and off highway heavy duty diesel engines with emission treat device, such as EGR etc. The oil offers more viscosity control, greater soot loading capability, and better shear stability. It meets specifications of Mack EO-N Premium Plus' 03, Caterpillar ECF-2, Caterpillar SCF-Ia, Volvo VDS-3, Cummins CES 20076/78, MB 228.3, MAN 3275, JASO DH-1, MTU Type 2.

SAE 20W50

MADE IN SINGAPORE

Advantages

- Excellent dispersancy and detergency properties
- Outstanding oxidation stability
- Effective control over high temperature piston deposits
- Protect engine against wear, corrosion
- Keep engine clean
- Lower exhaust emission
- Prolong engine life

Applications

SST Basic 20W50 is suitable for all makes of high speed four stroke turbocharged and supercharged diesel engines used on heavy duty both on-highway and off-highway applications.

Standards

- API CH-4/CG-4 ACEA E7-04

Properties	Standard	Unit	20W50
Viscosity @ 40 °C	ASTM D445	cSt	162
Viscosity @ 100 °C	ASTM D445	cSt	18
Viscosity Index	ASTM D2270		126
Pour Point	ASTM D97	°C	-25
Flash Point COC	ASTM D92	°C	≥210
TBN	ASTM D2896	mgKOH/g	10.5
Sulphated Ash	ASTM D874	%wt	<1.2
Mass Density @ 15°C		kg/l	0.891
Evaporation Rate			<0.01

SINGAPORE AUTOMOTIVE

17. STEEL SHIELD USA ORIGIN SYNTHETIC LUBRICANTS FOR 4-STROKE MOTORCYCLE

STEEL SHIELD HI-PO RACING 4T

HI-PO RACING 4T

(Formerly 4-Cycle Ultimate Razer Quad-Motion)

Products that derive from our experience in motorcycle racing and close collaboration with the champions of the sector. A top synthetic lubricant combining the unique Steel Shield ABF technology specially formulated for race that guarantees maximum engine protection, also in severe riding conditions. It's characteristics of resistance to extreme conditions and optimal viscosity are also felt after prolonged use. In deed, the high level of viscosity encourages exceptional resistance to the shear stress to which the product is subjected, low volatility and a high level of thermos-oxidation stability.

SAE 20W50

Advantages

- Enhanced friction durability, optimizes clutch performance
- Excellent oxidation, thermal stability
- Extend oil drain interval
- Minimize maintenance costs
- Outstanding wear and corrosion protection
- Prolong engine life
- Superior engine cleanliness

ABF Technology ensures smooth cold start with maximum protection even when the engine has been standing for some time and high load conditions. The special formulation ensures high performance in terms of detergent/dispersant, antirust, antifoam, antioxidation and antiwear properties.

Properties	Standard	Unit	20W50
Viscosity @ 40 °C		mm^2/s	160
Viscosity @ 100 °C		mm^2/s	20.4
Viscosity at -15 °C		mPa.s	9000
Viscosity Index			149
Pour Point		°C	-39
Flash Point		°C	230
Mass Density @ 15°C		Kg / L	0.897

Applications

All types of gasoline 4T motorcycle engines

Standards

- API SG
- JASO MA, MA2

ORIGINAL USA MOTORCYCLE

18. SINGAPORE 4-STROKE MOTORCYCLE LUBRICANTS WITH ABF TECHNOLOGY

ABF ECI M7 4T FLASH

ABF ECI M7 4T GORDON

ABF LITE E3 4T GAMA

ABF LITE E3 4T HETA

Not Just Oil... IT'S TECHNOLOGY

ABF ECI M7 4T FLASH

ABF ECI M7 4T Flash is a premium quality fully synthetic lubricant especially developed for use in high powered 4-stroke motorcycles. It is formulated from premium quality base stocks and enhanced with Steel Shield ABF Technology to exceed the most demanding lubrication requirements of modern 4-stroke motorcycles. The oils provide excellent protection towards engine, gearbox and wet clutches used in 4-stroke motorcycles and ensures the highest possible reliability even under the most severe operating conditions.

SAE 5W40
SAE 5W50

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Controlled frictional properties eliminate clutch slippage improving driveability
- Ensures complete wear protection at start up under low ambient temperatures
- Exceptional anti-wear properties protect vital engine and gear components
- Highly recommended for a wide range of high powered 4-stroke motorcycles
- Increased output power
- Reduced downtime and maintenance cost
- Superior thermo-oxidative stability, minimizing deposits and sludge formation

Applications

All types of gasoline 4T motorcycle engines

Standards

- API SL
- JASO MA/MA2

Properties	Standard	Unit	5W40	5W50
Viscosity @ 40 °C	ASTM D445	cSt	90	127
Viscosity @ 100 °C	ASTM D445	cSt	14.2	19.3
Viscosity Index	ASTM D2270		160	173
Pour Point	ASTM D97	°C	-39	-45
Flash Point COC	ASTM D92	°C	≥200	≥222
Mass Density @ 15°C		Kg / L	0.85	0.855

ABF ECI M7 4T GORDON

ABF-ECI M7 4T Gordon is a premium quality synthetic based lubricant developed for use in all types of 4-stroke motorcycles. It is formulated from premium quality base stocks and enhanced with Steel Shield ABF Technology to exceed the most demanding lubrication requirements of modern 4-stroke motorcycles. The oils provide excellent protection towards engine, gearbox and wet clutches used in 4-stroke motorcycles and ensures the highest possible reliability even under the most harsh driving environment.

SAE 0W20

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Controlled frictional properties eliminate clutch slippage improving drivability.
- Ensures complete wear protection at start up at low amperage draw on your battery.
- Excellent resistance of the oil film at high temperatures.
- Exceptional anti-wear properties protect vital engine and gear components .
- Highly recommended for a wide range of 4-stroke motorcycles.
- Increased output power.
- Reduced downtime and maintenance cost.
- Superior thermo-oxidative stability, minimizing deposits and sludge formation.

Applications

All types of gasoline 4T motorcycle engines

Standards

- API SM
- JASO MA/MA2

Properties	Standard	Unit	0W20
Viscosity Grade		Kg / m^3	870
Viscosity @ 40 °C	ASTM D445	cSt	120
Viscosity @ 100 °C	ASTM D445	cSt	18
Viscosity Index	ASTM D2270		165
Pour Point	ASTM D97	°C	-48
Flash Point COC	ASTM D92	°C	≥237
Mass Density @ 15°C		Kg / L	0.855

ABF LITE E3 4T GAMA

ABF Lite E3 4T Gama is a premium quality fully synthetic lubricant especially developed for use in high powered 4-stroke motorcycles. It is formulated from premium quality base stocks and enhanced with Steel Shield ABF Technology to exceed the most demanding lubrication requirements of modern 4-stroke motorcycles. The oils provide excellent protection towards engine, gearbox and wet clutches used in 4-stroke motorcycles and ensures the highest possible reliability even under the most severe operating conditions.

SAE 5W40
SAE 5W50

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Controlled frictional properties eliminate clutch slippage improving driveability
- Ensures complete wear protection at start up under low ambient temperatures
- Exceptional anti-wear properties protect vital engine and gear components
- Highly recommended for a wide range of high powered 4-stroke motorcycles
- Increased output power
- Reduced downtime and maintenance cost
- Superior thermo-oxidative stability, minimizing deposits and sludge formation

Applications

All types of gasoline 4T motorcycle engines

Standards

- API SL
- JASO MA/MA2

Properties	Standard	Unit	5W40	5W50
Viscosity @ 40 °C	ASTM D445	cSt	90	127
Viscosity @ 100 °C	ASTM D445	cSt	14.2	19.3
Viscosity Index	ASTM D2270		160	173
Pour Point	ASTM D97	°C	-39	-45
Flash Point COC	ASTM D92	°C	≥200	≥222
Mass Density @ 15°C		Kg / L	0.85	0.855

ABF LITE E3 4T HETA

ABF Lite E3 4T Heta are premium four stroke motorcycle gasoline engine oils. Formulated with the unique ABF Technology the oils possess high friction durability, superior shear stability for gearboxes protection. They meet performance requirements of all types of 4T motorcycle gasoline engines made by Japanese OEM such as Honda, Yamaha, Suzuki, etc.

SAE 10W40
SAE 15W40

Not Just Oil... IT'S TECHNOLOGY
HIGH PERFORMANCE IONIC CHARGE
MADE IN SINGAPORE

Advantages

- Enhanced friction durability, optimizes clutch performance
- Excellent oxidation, thermal stability
- Extend oil drain interval
- Increased output power
- Outstanding wear and corrosion protection
- Prolong engine life
- Reduced downtime and maintenance costs
- Superior engine cleanliness

Applications

All types of gasoline 4T motorcycle engines

Standards

- API SM/SL/SJ/SG
- JASO T903:2006, MA-2

Properties	Standard	Unit	10W40	15W40
Viscosity @ 40 °C	ASTM D445	cSt	112	89
Viscosity @ 100 °C	ASTM D445	cSt	15.8	15.7
Viscosity Index	ASTM D2270		150	138
Pour Point	ASTM D97	°C	-30	-25
Flash Point COC	ASTM D92	°C	≥217	≥219
Sulfated Ash	JIS K2272	%	0.81	0.81
Mass Density @ 15°C		Kg / L	0.865	0.865

19. SINGAPORE 4-STROKE MOTORCYCLE LUBRICANTS – MASS MARKET

SST BASIC 4T

SST BASIC 4T

SAE 5W40, SAE 5W50

SST Basic 4T 5W40 and 5W50 are premium quality fully synthetic lubricants especially developed for use in high powered 4-stroke motorcycles. They are formulated from premium quality base stocks to exceed the most demanding lubrication requirements of modern 4-stroke motorcycles. These oils provide excellent protection towards engine, gearbox and wet clutches used in 4-stroke motorcycles and ensures the highest possible reliability even under the most severe operating conditions.

SAE 5W40
SAE 5W50

MADE IN SINGAPORE

Advantages

- Controlled frictional properties eliminate clutch slippage improving driveability
- Ensures complete wear protection at start up under low ambient temperatures
- Exceptional anti-wear properties protect vital engine and gear components
- Highly recommended for a wide range of high powered 4-stroke motorcycles
- Minimize maintenance cost
- Superior thermo-oxidative stability, minimizing deposits and sludge formation

Applications

All types of gasoline 4T motorcycle engines

Standards

- API SJ/SL
- JASO MA/MA2

Properties	Standard	Unit	5W40	5W50
Viscosity @ 40 °C	ASTM D445	cSt	90	127
Viscosity @ 100 °C	ASTM D445	cSt	14.2	19.3
Viscosity Index	ASTM D2270		160	173
Pour Point	ASTM D97	°C	-39	-45
Flash Point COC	ASTM D92	°C	≥200	≥222
Mass Density @ 15°C		Kg / L	0.85	0.855

SINGAPORE MOTORCYCLE

SST BASIC 4T

SAE 10W40, SAE 15W40

SST Basic 4T 10W40 and 15W40 are premium four stroke motorcycle gasoline engine oils. The oils possess high friction durability, superior shear stability for gearboxes protection. They meet performance requirements of all types of 4T motorcycle gasoline engines made by Japanese OEM such as Honda, Yamaha, Suzuki, etc.

SAE 10W40
SAE 15W40

MADE IN SINGAPORE

Advantages

- Enhanced friction durability, optimizes clutch performance
- Excellent oxidation, thermal stability
- Extend oil drain interval
- Minimize maintenance costs
- Prolong engine life
- Superior engine cleanliness

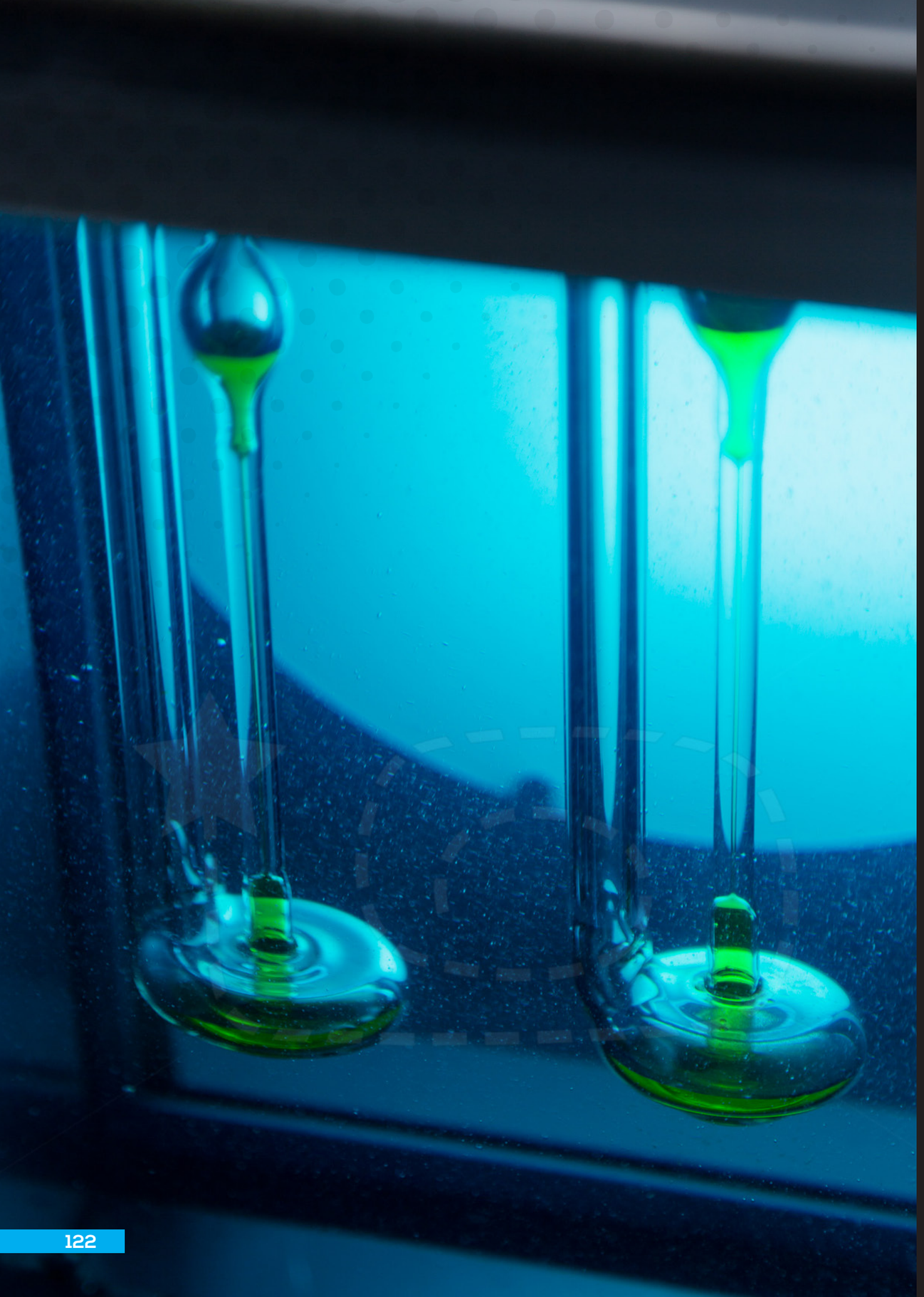
Applications

All types of gasoline 4T motorcycle engines

Standards

- API SM/SL/SJ/SG
- JASO T903:2006, MA-2

Properties	Standard	Unit	10W40	15W40
Viscosity @ 40 °C	ASTM D445	cSt	112	89
Viscosity @ 100 °C	ASTM D445	cSt	15.8	15.7
Viscosity Index	ASTM D2270		150	138
Pour Point	ASTM D97	°C	-30	-25
Flash Point COC	ASTM D92	°C	≥217	≥219
Sulfated Ash	JIS K2272	%	0.81	0.81
Mass Density @ 15°C		Kg / L	0.865	0.865

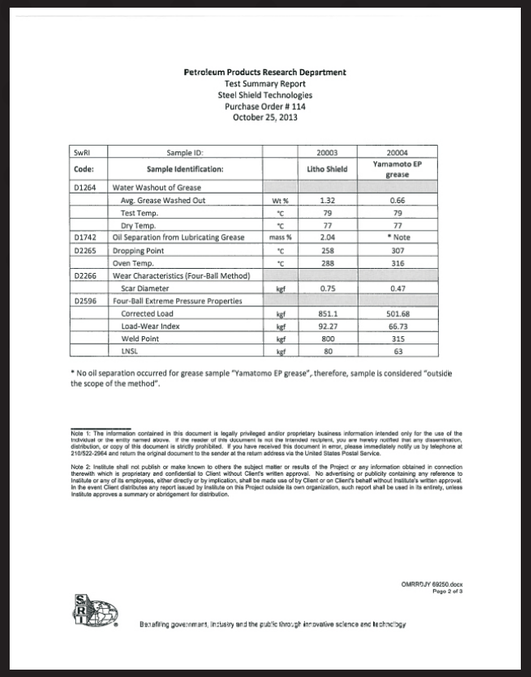


20. SOUTHWEST RESEARCH INSTITUTE TEST REPORTS

“Steel Shield lubricants with ABF Technology is proven to be superior to any other top-class lubricants in the world.”

20A. STEEL SHIELD VS. YAMAMOTO AND ATLAS

STEEL SHIELD LARGELY OUTPERFORMS REPUTED GREASES MADE BY YAMAMOTO AND ATLAS



Petroleum Products Research Department
Test Summary Report
Steel Shield Technologies
Purchase Order # 114
October 25, 2013

SwRI Code:	Sample Identification:		20003 Litho Shield	20004 Yamamoto EP grease
D1264	Water Washout of Grease			
	Avg. Grease Washed Out	Wt %	1.32	0.66
	Test Temp.	°C	79	79
	Dry Temp.	°C	77	77
D1742	Oil Separation from Lubricating Grease	mass %	2.04	* Note
D2265	Dropping Point	°C	258	307
	Oven Temp.	°C	288	316
D2266	Wear Characteristics (Four-Ball Method)			
	Scar Diameter	kgf	0.75	0.47
D2596	Four-Ball Extreme Pressure Properties			
	Corrected Load	kgf	851.1	501.68
	Load-Wear Index	kgf	92.27	66.73
	Weld Point	kgf	800	315
	LNSL	kgf	80	63

* No oil separation occurred for grease sample "Yamatomo EP grease", therefore, sample is considered "outsicle the scope of the method".

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Page 2 of 3

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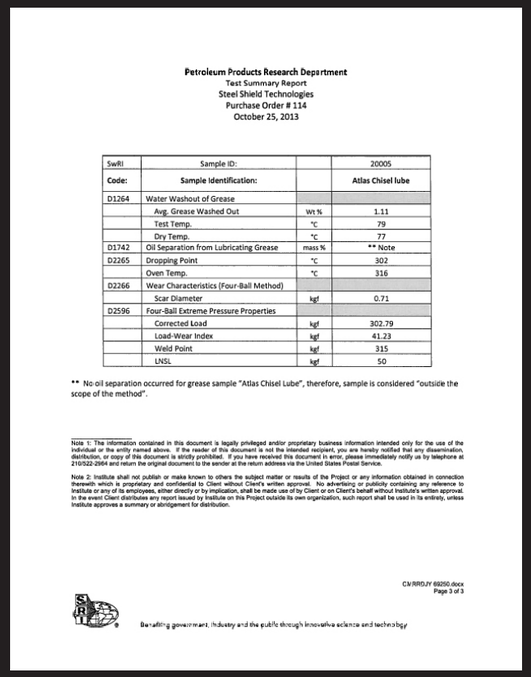

Petroleum Products Research Department
Test Summary Report
Steel Shield Technologies
Purchase Order # 114
October 25, 2013

SwRI Code:	Sample Identification:		20005 Atlas Chisel lube
D1264	Water Washout of Grease		
	Avg. Grease Washed Out	Wt %	1.11
	Test Temp.	°C	79
	Dry Temp.	°C	77
D1742	Oil Separation from Lubricating Grease	mass %	** Note
D2265	Dropping Point	°C	302
	Oven Temp.	°C	316
D2266	Wear Characteristics (Four-Ball Method)		
	Scar Diameter	kgf	0.71
D2596	Four-Ball Extreme Pressure Properties		
	Corrected Load	kgf	302.79
	Load-Wear Index	kgf	41.23
	Weld Point	kgf	315
	LNSL	kgf	50

** No oil separation occurred for grease sample "Atlas Chisel Lube", therefore, sample is considered "outsicle the scope of the method".

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Page 3 of 3

Benefiting government, industry and the public through innovative science and technology

Test Items	Four-Ball Extreme Pressure Properties	Steel Shield Lithi Shield	Yamamoto EP Grease	Atlas Chisel Lube
Loading Ability	Corrected Load	851.1	501.68	302.79
Anti-Wear Ability	Load Wear Index	92.27	66.73	41.23
High Temperature Loading	Weld Point	800	315	315
High Pressure Loading	LNSL	80	63	50

Figure 1
- Grease test report summary
- Steel Shield Lithi Shield is superior to Yamamoto EP Grease and Atlas Chisel Lube in Loading ability, Anti-Wear Ability, High Temperature Loading and High Pressure Loading.

Figure 2
- Steel Shield (right) and Atlas (left)

20B. STEEL SHIELD VS. SHELL AND MOBIL ONE

STEEL SHIELD OUTPERFORMS SHELL AND MOBIL ONE LUBRICANTS

The test reports from the Southwest Research Institute have clearly stated that Steel Shield Technologies products are the winners.

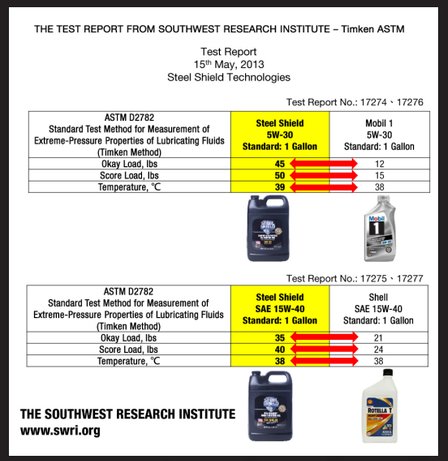
Timken Test is designed to test the performance of lubricants with viscosities lower than 5000 cSt@40°C. Temperature reflects the coefficients of friction of lubricants. By testing the maximum loading of lubricants within a specific temperature range (38 ~ 39°C), the degree of Load-Wear Index can be obtained. The results are compared as follows:

Steel Shield Super-XL 5W30 and Mobil 5W30 have scored 45 and 12 pound respectively in the Okay Load, and scored 50 and 15 pound respectively in the Score Load. Therefore, Steel Shield is superior to Mobil by 350% in loading and anti-wear abilities.

Steel Shield XHD-7 15W40 and Shell R-3T 15W40 scored 35 and 21 pound respectively in the OK Load, and scored 40 and 24 pound respectively in the Score Load. Therefore, Steel Shield is superior to Shell by 170% in loading and anti-wear abilities. These results proved that Steel Shield products have excellent performance in heavy loading conditions and have outstanding anti-wear abilities. Steel Shield can greatly improve the efficiencies of mechanical systems.

The 4-Ball Test tests high viscosities lubricants, and anti-wear additives. The 4-Ball Tests have proved that the anti-wear and high loading performance of Steel Shield products without high viscosities can be as excellent as greases. The most important indexes of 4-Balls Test are LWI and Weld Point which the majority of people believe indexes with larger numbers are better. But traditional lubricant formulas achieve anti-wear abilities by high viscosity. The higher the viscosity, the lower the efficiency. The Corrected Loads of Steel Shield Super-XL 5W30 and XHD-7 15W40 are 228Kgf and 139Kgf respectively. They are much higher than Mobil One (53Kgf) and Shell (55Kgf). The LWI are 47Kgf verse 42Kgf, and 40Kgf verse 42Kgf which appear similar. However, the Weld Point of Steel Shield are 315Kg and 250Kg which are higher than 200Kg (Mobil One and Shell). This tells us the truth.

Steel Shield Technologies have demonstrated its ultimate performance.



THE TEST REPORT FROM SOUTHWEST RESEARCH INSTITUTE – Timken ASTM

Test Report
15th May, 2013
Steel Shield Technologies

Test Report No.: 17274、17276

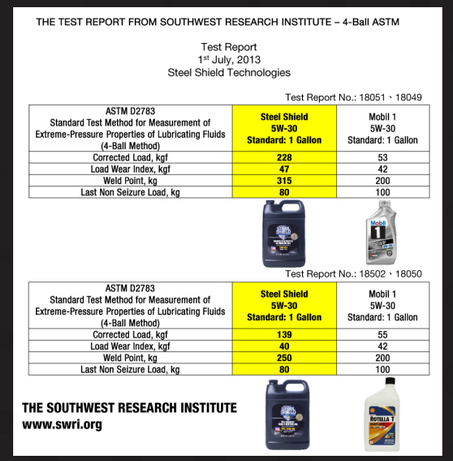
ASTM D2782 Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)	Steel Shield 5W-30 Standard: 1 Gallon	Mobil 1 5W-30 Standard: 1 Gallon
Okay Load, lbs	45	12
Score Load, lbs	50	15
Temperature, °C	39	38

Test Report No.: 17275、17277

ASTM D2782 Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)	Steel Shield SAE 15W-40 Standard: 1 Gallon	Shell SAE 15W-40 Standard: 1 Gallon
Okay Load, lbs	35	21
Score Load, lbs	40	24
Temperature, °C	38	38

THE SOUTHWEST RESEARCH INSTITUTE
www.swri.org

Figure 1
- Steel Shield largerly outperformed Mobil and Shell in Timken Okay Load by 350% and 170% respectively



THE TEST REPORT FROM SOUTHWEST RESEARCH INSTITUTE – 4-Ball ASTM

Test Report
1st July, 2013
Steel Shield Technologies

Test Report No.: 18051、18049

ASTM D2783 Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)	Steel Shield 5W-30 Standard: 1 Gallon	Mobil 1 5W-30 Standard: 1 Gallon
Corrected Load, kgf	228	53
Load Wear Index, kgf	47	42
Weld Point, kg	315	200
Last Non Seizure Load, kg	80	100

Test Report No.: 18502、18050

ASTM D2783 Standard Test Method for Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)	Steel Shield 5W-30 Standard: 1 Gallon	Mobil 1 5W-30 Standard: 1 Gallon
Corrected Load, kgf	139	55
Load Wear Index, kgf	40	42
Weld Point, kg	250	200
Last Non Seizure Load, kg	80	100

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Figure 2
- Steel Shield also outperformed Mobil and Shell 4-Balls Tests

20C. GAS ENGINE OILS AND COMPRESSOR OILS TESTS

STEEL SHIELD REVEALED POWERFUL PERFORMANCE IN TESTS

Products of the same class

SwRI Lab No.	24564	23728	23252	23727	25250	25251
ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)	SST Gas Engine Oil SAE 40 Ashless Without EPA	Steel Shield Gas Engine Oil GECAT SAE40 Low Ash With EPA	Steel Shield EPA	Steel Shield Compressor Oil ISO #100 / 150	Mobil Pegasus 805SAE 40 Gas Engine Oil	Mobil Pegasus 801SAE 40 Gas Engine Oil
Volume (Gallon)	1	1	1	1	1	1
OK Load (lbs)	40	40	75	55	9	9
Score Load (lbs)	45	45	80	60	12	12
Temperature (°C)	38	38	38	38	38	38

FIGURE 1 - STEEL SHIELD WINS IN Timken TEST (ASTM D2782)

- The SwRI Timken Test report clearly testified Steel Shield products are FAR Superior than Mobil products of the same classes
- Steel Shield outperforms Mobil in OK LOAD parameter by 444 % and in SCORE LOAD by 375 %

Products of the same class

SwRI Lab No.	24564	23728	23252	23727	25250	25251
ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)	SST Gas Engine Oil SAE 40 Ashless Without EPA	Steel Shield Gas Engine Oil GECAT SAE40 Low Ash With EPA	Steel Shield EPA	Steel Shield Compressor Oil ISO #100 / 150	Mobil Pegasus 805SAE 40 Gas Engine Oil	Mobil Pegasus 801SAE 40 Gas Engine Oil
Volume (Gallon)	1	1	1	1	1	1
Corrected Load (kgf)	70	109	NA	1	136	74
Load Wear Index (kgf)	35	46	NA	48	34	35
Weld Point (kg)	200	250	>800	250	200	200
Last Non Seizure Load (kg)	80	100	80	100	63	80

FIGURE 2 - STEEL SHIELD WINS IN 4-BALLS TEST (ASTM D2783)

- The SwRI 4-Balls Test testified Steel Shield products are superior than Mobil products of the same classes
- Steel Shield outperforms Mobil in the Weld Point (oil strength in resistant to EP) parameter by 129 % and in the Last Non Seizure Load (wear performance in respect to load) by 159 %.
- *** Remarks: 4-ball test is normally for heavy weight oil and grease.

FIGURE 3 - ORIGINAL TEST REPORTS FROM SWRI (RIGHT PAGE)

SOUTHWEST RESEARCH INSTITUTE®

6220 CULEBRA ROAD 78238-5166 • P.O. DRAWER 28510 78228-0510 • SAN ANTONIO, TEXAS, USA • (210) 684-5111 • WWW.SWRI.ORG

November 20th, 2014

George Fennell
Steel Shield Technologies
3351 Industrial Blvd
Bethel Park, PA 15102-2543
Phone: 1-800-390-1535
Email:

Re: Fuel Analysis Results
SwRI WO# 71111
PO# 120

Dear Mr. Fennell:

Analyses have been completed on your samples in accordance with the tests requested. Twelve samples were received in good condition between July 21st, 2014 and October 7th 2014 in good condition. Eleven samples were received in one gallon plastic containers and one sample was received in a one quart plastic bottle. Sample Identification and testing requesting is shown in the table on the following page. Testing took place between October 13th and November 11th 2014. Test results and sample identifications are shown in the table attached.

Analyses were performed according to the listed ASTM test procedures with no modifications or deviations. Precision should be consistent with those stated in the ASTM test procedures. Sample aliquots were taken in accordance with the various ASTM test procedures. The analyses above pertain only to the sample received by Southwest Research Institute and represent only that sampling lot. This report shall not be reproduced except in full without the express written permission of Southwest Research Institute.

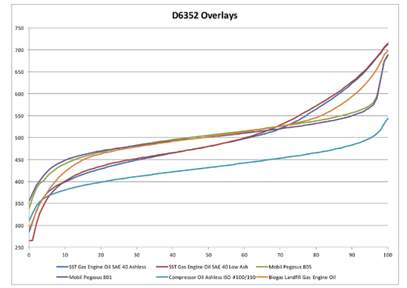
If there are any questions concerning these analyses, or if you need any additional testing on the samples, please contact me at (210) 522-2071. We appreciate the opportunity to be of service to your firm.

Sincerely,

Robert R. Legg
Fuels Laboratory Manager
Fuels & Lubricants Research Department
Office of Automotive Engineering

Benefiting government, industry and the public through innovative science and technology

Test Summary Report
November 20th, 2014
Steel Shield Technologies



In comparing the curves and D6352 chromatography, it is observed that samples SST Gas Engine oil SAE 40 Ashless and SST Gas Engine Oil SAE 40 Low Ash ar very similar with the exception that the Low Ash oil appears to have an added component that is somewhat lighter than the rest of the oil. The bulk of this oil is lighter than the others; however it does have a larger proportion of heavier compounds. In general it has broader array of hydrocarbons than the other oils. The Mobil Pegasus 801 and Mobil Pegasus 805 are essentially the same oil with the same boiling distribution. They both are a narrower cut reducing the amount of lighter and heavier hydrocarbon species. The Biogas Landfill Gas Engine Oil has a distribution in between the SST Gas Engine Oils and the Mobil Pegasus Oils. The Ashless Compressor oil is a significantly lighter oil than the rest of the samples.

Test Summary Report
November 20th, 2014
Steel Shield Technologies

SwRI Lab# 24564

SST Gas Engine Oil
SAE 40 Ashless
1 Gallon Plastic Jug

ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)

Okay Load, lbs	40
Score Load, lbs	45
Temperature, °C	38

ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)

Corrected Load, kgf	70
Load Wear Index, kgf	35
Weld Point, kg	200
Last Non Seizure Load, kg	80

ASTM D6352 Boiling Range Distribution of Petroleum Distillates from 174 to 700 °C by GC

IBP	285.3	20%	428.8	40%	464.8	60%	497.5	80%	564.9
1%	306.2	21%	431.1	41%	466.4	61%	499.2	81%	570.0
2%	333.2	22%	433.3	42%	467.9	62%	501.1	82%	575.1
3%	351.6	23%	435.4	43%	469.4	63%	503.0	83%	580.6
4%	364.1	24%	437.2	44%	470.9	64%	505.0	84%	586.2
5%	373.5	25%	439.2	45%	472.4	65%	507.1	85%	591.8
6%	380.5	26%	441.2	46%	474.0	66%	509.3	86%	597.5
7%	386.7	27%	443.1	47%	475.6	67%	511.8	87%	603.5
8%	391.9	28%	444.9	48%	477.1	68%	514.5	88%	609.8
9%	396.0	29%	446.7	49%	478.6	69%	517.3	89%	616.3
10%	399.1	30%	448.6	50%	480.2	70%	520.4	90%	623.3
11%	403.0	31%	450.5	51%	481.8	71%	523.7	91%	630.3
12%	406.6	32%	452.1	52%	483.4	72%	527.3	92%	637.6
13%	410.2	33%	453.7	53%	485.1	73%	531.2	93%	645.6
14%	413.5	34%	455.2	54%	486.8	74%	535.3	94%	653.8
15%	416.5	35%	456.9	55%	488.5	75%	539.6	95%	662.7
16%	419.1	36%	458.5	56%	490.2	76%	544.2	96%	672.9
17%	421.8	37%	460.1	57%	492.0	77%	549.2	97%	682.4
18%	424.3	38%	461.7	58%	493.8	78%	554.5	98%	692.4
19%	426.5	39%	463.2	59%	495.7	79%	559.7	99%	704.3
								FBP	713.1

Test Summary Report
November 20th, 2014
Steel Shield Technologies

SwRI Lab# 23728

Biogas Landfill Gas Engine Oil
SAE 40 (Gecat SAE 40 Low Ash)
1 Gallon Plastic Jug

ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)

Okay Load, lbs	40
Score Load, lbs	45
Temperature, °C	38

ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)

Corrected Load, kgf	109
Load Wear Index, kgf	46
Weld Point, kg	250
Last Non Seizure Load, kg	100

ASTM D6352 Boiling Range Distribution of Petroleum Distillates from 174 to 700 °C by GC

IBP	291.8	20%	462.9	40%	491.3	60%	512.8	80%	545.5
1%	308.9	21%	465.1	41%	492.4	61%	514.0	81%	548.7
2%	331.8	22%	467.0	42%	493.5	62%	515.2	82%	552.3
3%	349.1	23%	468.8	43%	494.7	63%	516.5	83%	556.3
4%	362.7	24%	470.4	44%	495.8	64%	517.8	84%	560.5
5%	374.7	25%	472.0	45%	496.9	65%	519.1	85%	565.1
6%	385.9	26%	473.6	46%	497.9	66%	520.4	86%	569.9
7%	396.5	27%	475.1	47%	498.9	67%	521.8	87%	575.0
8%	406.2	28%	476.5	48%	499.9	68%	523.1	88%	580.8
9%	415.0	29%	477.8	49%	500.9	69%	524.5	89%	586.8
10%	422.4	30%	479.1	50%	502.0	70%	526.0	90%	593.2
11%	429.0	31%	480.4	51%	503.0	71%	527.5	91%	599.9
12%	434.9	32%	481.6	52%	504.0	72%	529.0	92%	607.5
13%	440.2	33%	482.9	53%	505.1	73%	530.7	93%	615.4
14%	444.7	34%	484.2	54%	506.1	74%	532.4	94%	624.3
15%	449.2	35%	485.4	55%	507.2	75%	534.2	95%	633.7
16%	452.5	36%	486.6	56%	508.2	76%	536.1	96%	644.5
17%	455.4	37%	487.8	57%	509.3	77%	538.1	97%	656.4
18%	458.3	38%	489.0	58%	510.5	78%	540.4	98%	671.9
19%	460.7	39%	490.1	59%	511.7	79%	542.8	99%	688.2
								FBP	697.9

20D. DYNO TEST REPORT

STEEL SHIELD REVEALED POWERFUL PERFORMANCE IN TESTS

The following is a Dyno test report of a Ford Focus 2.0L car using a professional horse power tester. The result reveals that without any mechanical or electrical modifications, the horse power increased from 114.9 to the maximum of 130 with the presence of Steel Shield product - an increase of 13% in horse power.

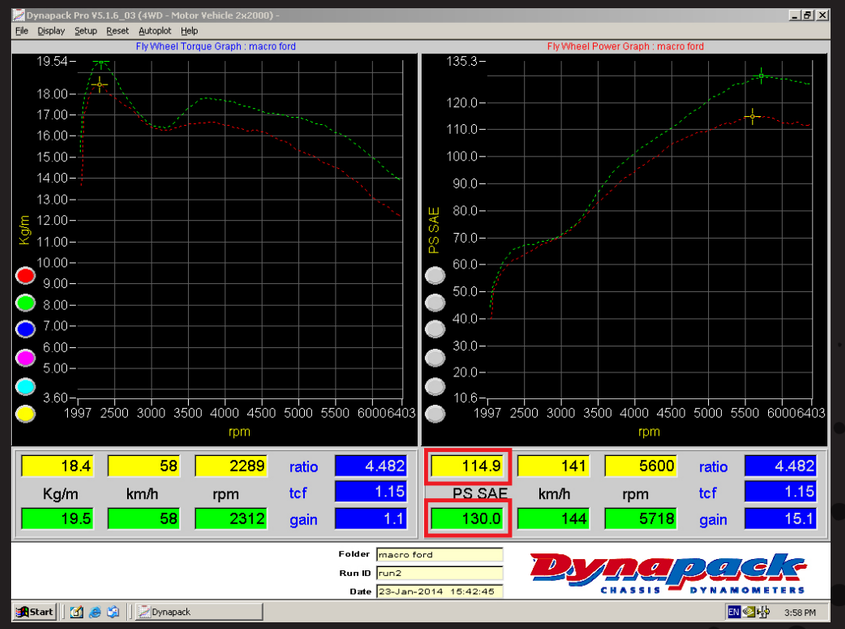


FIGURE 1 (TOP)
- The interface of the performance test

FIGURE 2 (BOTTOM LEFT)
- The Dyno machine

FIGURE 3 (BOTTOM RIGHT)
- The test vehicle

Test Summary Report
November 20th, 2014
Steel Shield Technologies

SwRI Lab# 25252

SST-EPA

1 Gallon Plastic Jug

ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)

Okay Load, lbs	75
Score Load, lbs	80
Temperature, °C	38

ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)

Corrected Load, kgf	
Load Wear Index, kgf	
Weld Point, kg	>800
Last Non Seizure Load, kg	80

Test Summary Report
November 20th, 2014
Steel Shield Technologies

SwRI Lab# 23727

Compressor Oil Ashless
ISO #100/150
1 Gallon Plastic Jug

ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)

Okay Load, lbs	55
Score Load, lbs	60
Temperature, °C	38

ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)

Corrected Load, kgf	133
Load Wear Index, kgf	48
Weld Point, kg	250
Last Non Seizure Load, kg	100

ASTM D6352 Boiling Range Distribution of Petroleum Distillates from 174 to 700 °C by GC

IBP	310.0	20%	398.6	40%	421.7	60%	442.0	80%	465.5
1%	326.9	21%	400.0	41%	422.7	61%	443.1	81%	466.9
2%	344.5	22%	401.4	42%	423.6	62%	444.1	82%	468.4
3%	354.0	23%	402.7	43%	424.6	63%	445.3	83%	469.9
4%	360.6	24%	404.0	44%	425.6	64%	446.4	84%	471.5
5%	365.4	25%	405.2	45%	426.6	65%	447.5	85%	473.2
6%	369.2	26%	406.4	46%	427.6	66%	448.7	86%	474.9
7%	372.5	27%	407.7	47%	428.6	67%	449.8	87%	476.7
8%	375.5	28%	408.9	48%	429.6	68%	450.9	88%	478.7
9%	378.2	29%	410.1	49%	430.6	69%	452.0	89%	480.7
10%	380.6	30%	411.2	50%	431.6	70%	453.1	90%	483.0
11%	382.8	31%	412.4	51%	432.6	71%	454.2	91%	485.6
12%	384.9	32%	413.4	52%	433.6	72%	455.4	92%	488.3
13%	386.9	33%	414.5	53%	434.6	73%	456.6	93%	491.4
14%	388.9	34%	415.5	54%	435.7	74%	457.8	94%	494.9
15%	390.7	35%	416.6	55%	436.7	75%	459.0	95%	498.8
16%	392.4	36%	417.7	56%	437.7	76%	460.2	96%	503.3
17%	394.0	37%	418.7	57%	438.8	77%	461.5	97%	509.1
18%	395.6	38%	419.7	58%	439.9	78%	462.8	98%	517.6
19%	397.1	39%	420.7	59%	440.9	79%	464.1	99%	531.3
								FBP	544.3

Test Summary Report
November 20th, 2014
Steel Shield Technologies

SwRI Lab# 25250

Mobil Pegasus
805
1 Gallon Plastic Jug

ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)

Okay Load, lbs	9
Score Load, lbs	12
Temperature, °C	38

ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)

Corrected Load, kgf	136
Load Wear Index, kgf	34
Weld Point, kg	200
Last Non Seizure Load, kg	63

ASTM D6352 Boiling Range Distribution of Petroleum Distillates from 174 to 700 °C by GC

IBP	338.1	20%	467.0	40%	495.3	60%	515.0	80%	538.2
1%	363.1	21%	468.9	41%	496.4	61%	516.1	81%	539.6
2%	384.2	22%	470.6	42%	497.4	62%	517.1	82%	541.0
3%	396.2	23%	472.3	43%	498.3	63%	518.1	83%	542.6
4%	401.9	24%	474.0	44%	499.3	64%	519.2	84%	544.2
5%	410.8	25%	475.6	45%	500.3	65%	520.3	85%	545.9
6%	419.2	26%	477.1	46%	501.3	66%	521.4	86%	547.7
7%	426.0	27%	478.6	47%	502.2	67%	522.5	87%	549.7
8%	431.6	28%	480.0	48%	503.2	68%	523.6	88%	551.8
9%	436.1	29%	481.5	49%	504.1	69%	524.7	89%	554.1
10%	440.5	30%	482.9	50%	505.1	70%	525.8	90%	556.5
11%	444.1	31%	484.2	51%	506.0	71%	526.9	91%	558.9
12%	447.6	32%	485.6	52%	506.9	72%	528.1	92%	561.8
13%	450.8	33%	486.9	53%	507.9	73%	529.3	93%	565.0
14%	453.5	34%	488.2	54%	508.9	74%	530.5	94%	568.7
15%	456.1	35%	489.4	55%	509.9	75%	531.7	95%	573.2
16%	458.5	36%	490.6	56%	510.9	76%	533.0	96%	580.2
17%	460.8	37%	491.8	57%	511.9	77%	534.2	97%	594.4
18%	463.0	38%	493.0	58%	512.9	78%	535.5	98%	634.2
19%	465.1	39%	494.1	59%	514.0	79%	536.8	99%	674.3
								FBP	689.6

Test Summary Report
November 20th, 2014
Steel Shield Technologies

SwRI Lab# 25251

Mobil Pegasus
801
1 Gallon Plastic Jug

ASTM D2782 Measurement of Extreme-Pressure Properties of Lubricating Fluids (Timken Method)

Okay Load, lbs	9
Score Load, lbs	12
Temperature, °C	38

ASTM D2783 Measurement of Extreme-Pressure Properties of Lubricating Fluids (4-Ball Method)

Corrected Load, kgf	74
Load Wear Index, kgf	35
Weld Point, kg	200
Last Non Seizure Load, kg	80

ASTM D6352 Boiling Range Distribution of Petroleum Distillates from 174 to 700 °C by GC

IBP	355.5	20%	469.5	40%	492.3	60%	510.0	80%	532.2
1%	372.7	21%	470.9	41%	493.3	61%	511.0	81%	533.6
2%	391.1	22%	472.3	42%	494.3	62%	511.9	82%	535.1
3%	401.9	23%	473.7	43%	495.2	63%	512.9	83%	536.5
4%	413.3	24%	475.0	44%	496.2	64%	513.9	84%	538.1
5%	422.1	25%	476.2	45%	497.0	65%	514.9	85%	539.7
6%	429.3	26%	477.4	46%	497.8	66%	516.0	86%	541.4
7%	435.4	27%	478.5	47%	498.7	67%	517.0	87%	543.2
8%	440.6	28%	479.7	48%	499.5	68%	518.0	88%	545.2
9%	444.6	29%	480.8	49%	500.4	69%	519.1	89%	547.4
10%	448.3	30%	481.9	50%	501.2	70%	520.2	90%	549.9
11%	451.6	31%	483.1	51%	502.1	71%	521.3	91%	552.7
12%	454.2	32%	484.2	52%	503.0	72%	522.4	92%	555.8
13%	456.7	33%	485.2	53%	503.8	73%	523.5	93%	559.1
14%	459.0	34%	486.3	54%	504.7	74%	524.7	94%	563.1
15%	461.0	35%	487.3	55%	505.5	75%	525.9	95%	568.2
16%	462.9	36%	488.4	56%	506.4	76%	527.1	96%	575.2
17%	464.7	37%	489.4	57%	507.2	77%	528.3	97%	590.1
18%	466.5	38%	490.3	58%	508.1	78%	529.6	98%	633.5
19%	468.1	39%	491.3	59%	509.0	79%	530.9	99%	673.0
								FBP	687.9

21. INSURANCE CERTIFICATE & CONFIRMATION OF NO INSURANCE CLAIM

"The most powerful and reliable evidence showing that Steel Shield is the only lubricant you can trust."

21A. CERTIFICATE OF LIABILITY INSURANCE

OVER USD 2,000,000 INSURANCE

ACORD

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 5/14/2014

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IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Best Insurance Agency
340 S. Main St., P.O. Box 670
Butler PA 16003-0670

CONTACT NAME: Jamie McDonald
PHONE (A/C, No, Ext): (724) 283-5670 FAX (A/C, No): (724)283-1160
E-MAIL ADDRESS: jamie@bestinsurancebutler.com

INSURER(S) AFFORDING COVERAGE — NAIC #
INSURER A: Cincinnati Insurance Companies
INSURER B:
INSURER C:
INSURER D:
INSURER E:
INSURER F:

INSURED
Steel Shield Technologies Inc
3351 Industrial Blvd /
Bethel Park PA 15102

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INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE X OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: X POLICY PRO-JECT LOC			ENP04242014	4/24/2014	4/24/2015	EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 1,000,000 $ 100,000 $ 5,000 $ 1,000,000 $ 2,000,000 $ 2,000,000
	AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS HIRED AUTOS NON-OWNED AUTOS						COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ $ $ $
A	X UMBRELLA LIAB OCCUR EXCESS LIAB CLAIMS-MADE DED RETENTION $			ENP04242014	4/24/2014	4/24/2015	EACH OCCURRENCE AGGREGATE	$ 1,000,000 $
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N N/A If yes, describe under DESCRIPTION OF OPERATIONS below						WC STATU-TORY LIMITS / OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	$ $ $

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

CERTIFICATE HOLDER
Steel Shield Technologies Inc.
3351 Industrial Blvd.
Bethel Park, PA 15102

CANCELLATION
SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.
AUTHORIZED REPRESENTATIVE

ACORD 25 (2010/05)
INS025 (201005).01

FIGURE 1 - ORIGINAL CERTIFICATE OF LIABILITY INSURANCE

Best Insurance Agency
340 S. Main St., P.O. Box 670
Butler, PA 16003-0670
(724)283-5670 (724)283-1160Fax
Email: Ray@Bestinsurancebutler.com

September 18, 2013

Steel Shield Technologies (Asia Pacific) Limited
22nd Floor, W. Business Centre
4 Kam Hong Street
North Point, Hong Kong

To Whom It May Concern:

Please be advised that Steel Sheild Technologies Inc, manufacturer of specialty lubricants and greases, located in Bethel Park,Pennsylvania, USA, has had no claims, claim related incidents or notices of loss under any General Liability policy issued by our office. We have provided them with General Liability coverage continously since April 24, 2008

If you have any questions or need further information please feel free to contact me. I will be happy to be of further assistance.

Sincerely,

Raymond A. Rosenbauer
Vice President

FIGURE 2 - CONFIRMATION LETTER OF NO INSURANCE CLAIM

- Steel Shield had NEVER been claimed

22. MAJOR CORPORATE CLIENTS

“Your trust is our motivation.”

22A. THE MOST REPUTED CUSTOMERS

UNITED STATES DEPARTMENT OF DEFENSE

- The most advanced army in the world

SIEMENS

- The largest engineering company in Europe

UNION PACIFIC RAILROAD

- The largest railway company in the US
- New York Stock Exchange No.: UNP

DONG JIANG ENVIRONMENT

- A leading provider for wastes management and environmental services in the PRC
- Hong Kong Stock Exchange No.: 895

23. SUPER CAR OWNERS

“Once you use Steel Shield lubricants, you will be addicted to its ABF Technology.”

23A. HIGH CUSTOMERS LOYALTY

"Super performance cars using Steel Shield help reducing engine noise, more power at the wheels, swift response, extends battery life and cleaner engine. These car owners were surprised to see the cars behaved just like NEW ! Cruising on the highways they gained an average 12-15% less fuel."

MASERATI QUATTROPORTE

PORSCHE PANAMERA 4S

BENZ CLS

24. AUTHORITATIVE COMPLIMENTS LETTERS

“Formalized respectful compliments to STEEL SHIELD by the most renowned Corporations in the World. IN STEEL SHIELD, WE TRUST! ”

24A. COMPLIMENTS FROM THE US ARMED FORCES

WEAPON SHIELD WAS TRUELY A LIFE SAVER

Mark W. Pushnick
President & CEO
Steel Shield Technologies, Inc
3351 Industrial Blvd
Bethel Park, PA 15102-2543

07 May 2008

Mark,

I wanted to take time to express my sincere thanks to you and Steel Shield Technologies, Inc. for your support while I was deployed overseas in support of the Global War on Terrorism.

Your product, Weapon Shield, was truly a "life saver".

In my first combat tour to Afghanistan in late 2003, not knowing much about your product, I began to use it for my personal weapon and my crew-served vehicle weapon as a just another oil that I received in my care packages from home. I soon became educated on how this product was head and shoulders above the rest.

In the grueling conditions of southwestern Afghanistan, our weapons were subject to severe heat, dust, and even potential rust due to the humidity in the area. Compared to the other oils that we received, Weapon Shield was the only product that stood up to the battlefield environment and did not cause the bolt of the weapons to become "gummy" or "sticky". Weapon Shield actually acted as a "shield" and as a dust repellent.

When I found out that I was deploying back to Iraq in 2007, one of my first calls was to my father to get my hands on Weapon Shield. While conducting pre-deployment training at Fort Bragg, I introduced my soldiers to this product. When it comes to selling to a tough audience, young enlisted men are some of the toughest to buy into a new idea. Within days, all of the men were carrying this product and were even hoarding bottles within their packs.

When we got to Iraq, Weapon Shield bottles became a part of the combat packing list as assigned by my Detachment Sergeant. Weapon Shield was now the Standing Operating Procedure, a small bottle on each man and tube of grease in each truck.

Weapons Shield brought us through over 25 fire fights with great success when other soldier's from different unit's weapons failed. On one occasion on patrol with another unit, their .50 cal machine gun jammed. One of my gunners tossed a bottle of Weapon Shield to them. They broke down their weapon, applied the shield and quickly got back into the firefight. In our mission after action review, my soldiers quickly commented on how their weapons would only be treated with this product.

The bottom line is this... In two combat tours to both Afghanistan and Iraq, weapons treated with Weapon Shield, NEVER jammed. That saved lives. As a unit commander, my most important job was to complete this mission while bringing all of my soldiers home. Weapon Shield was a great contributor to my unit accomplishing that mission. In combat, the only option is perfect. If you are not, you can die. Weapon Shield was PERFECT every time.
Victory!

Craig A. Hickerson
MAJOR, Infantry
USAR

FIGURE 1 (ABOVE) - US SOLIDERS HOLDING STEEL SHIELD BANNER

FIGURE 2 (RIGHT) - EMBLEM OF THE UNITED STATES DEPARTMENT OF THE ARMY

FIGURE 3 (LEFT) - LETTERS OF THANKS AND COMPLIMENTS FROM THE US ARMY

24B. COMPLIMENTS FROM THE SIEMENS

STEEL SHIELD PRODUCTS ARE GREAT CONTRIBUTORS TO SIEMEN'S SUCCESS

SIEMENS
VAI

December 10, 2008

Mark W. Pushnick
President & CEO
Steel Shield Technologies, Inc.
3351 Industrial Blvd.

Mark,

I would like to take this opportunity to thank you for introducing us to Steel Shield Technologies line of lubricants and Metal Treatment products. The performance of your products has been overwhelmingly superior to any other lubricants or metal treatments we have used in the past.

We are currently using the Lithi-Shield grease in our shop and it has proven to work very well in our high temperature applications. We have experienced absolutely no down time due to bearing failure on our high temp furnace since we began using the Lithi-Shield grease. In the past all bearings were replaced on a quarterly basis causing a significant amount of downtime and material cost. We also use the grease in our automated welding equipment and anywhere else frequent greasing is needed. It has out performed our previously used grease in every application and we use it as often as possible.

Because of the performance of the Lithi-Shield grease we started using Steel Shield EPA in all of our metalworking equipment. Since its introduction to our machines we have not experienced a significant breakdown of any kind and it has left them running smoother and quieter than ever. The Steel Shield Drill and Tap fluid is also used our shop and has significantly decreased our tooling costs and become a favorite of most of our machinists. The Spray Shield product is used by our maintenance department and it is proving to be superior to anything used here in the past. We are very happy with the cost and performance of Steel Shield Technologies products and I highly recommend them. I am continually looking for ways to reduce costs and downtime Steel Shield products have been a great contributor to our success.

Bob Cavill
Maintenance Department Supervisor
Siemens VAI Services, LLC
2901 Industrial Blvd.
Bethel Park, PA 15102
412-851-6700

FIGURE 1 - THE ORIGINAL LETTER OF COMPLIMENT FROM SIEMENS

24C. LETTERS FROM UNION PACIFIC RAILROAD

UNION PACIFIC RAILROAD USES STEEL SHIELD PRODUCT EXTENSIVELY. STEEL SHIELD HAS BEEN PROVED TO BE FUNCTIONAL AND COST-EFFECTIVE, AND ARE HIGHLY RECOMMENDED

May 5, 2008

Mark W. Pushnick
Steel Shield Technologies, Inc.
3351 Industrial Blvd.
Bethel Park, PA 15102-2543

Dear Mr. Pushnick,

I would like to take a moment to endorse your products. I have been involved with your Advanced Boundary Film Technology for quite a few years on various Regions of the Union Pacific Railroad with different instructions per each Region. On the regions that have used your products continuously, they have seen great results with the products experiencing increased longevity of the equipment and reduced down time.

The last year and half I have been without the use of your products and have experienced increased failures in all areas of our equipment maintenance program (Engines, Transmissions, Hydraulic Systems, Gearboxes and Rear-ends).

I recently got the commitment of the Service Unit Director of Track (Kevin Hicks) to put out instructions for the next twelve months, the only grease that is to be used on the equipment is the LITHI-SHIELD Grease. I will be doing my part, which is supplying the Rail Equipment Shield (Metal Treatment) for the rest of the applications as needed. I have great expectations of getting back the results that I experienced in the past over the next twelve months. Hopefully this will be the last pilot program needed to prove the ROI that these products provide with increased longevity of the equipment and reduced down time.

Thanks,

Richard E. Best
Mgr Work Equipment
501-258-8009

UNION PACIFIC RAILROAD 1000 West Fourth Street, North Little Rock, AR 72114

FIGURE 1 - THE ORIGINAL LETTER FROM MR. RICHARD E. BEST, THE MANAGER OF THE WORK EQUIPMENT

Joe Hendricks
6455 East Commerce
Kansas City, MO 64120
MMEO Central Region

10/01/2003

Marla Carrow
6455 East Commerce
Kansas City, MO 64120

RE: MT-10

Marla:

I want to update you on our progress with the MT-10 product. Sense my last report I have applied MT10 to all of my service units. We use the product in our engines, transmissions, gearboxes and hydraulic tanks thus protesting the entire systems. The product performed as expected. Our failures with these components have decreased even more. Now we are able to work on equipment from the preventative maintenance side instead of a breakdown mode.

We have had cases that I can attribute directly to MT10 and were able to save the company thousands of dollars on the spot. This product proves itself worthy over and over and should be used by all departments to get the maximum savings for the Union Pacific.

Sincerely

Joe Hendricks
Manager M/W Equipment Operations CR
816-245-2733

Joe F. Hendricks
Mgr. M/W Equipment Operations
Central Region
UNION PACIFIC RAILROAD
6455 E. Commerce Ave., Kansas City, MO 64120
ph. (816) 245-2733 c. (816) 804-6880
pgr. ~~6-0890-1650-7001-pin-880986~~
jfhendri@up.com

FIGURE 2 - THE ORIGINAL LETTER FROM MR. JOE HENDRICKS, THE MANAGER M/W EQUIPMENT OPERATIONS CR

24D. LETTERS FROM THE PA PORT AUTHORITY

SAVED AROUND USD 45 IN MAINTENANCE COST FOR EVERY USD ONE DOLLAR INVESTMENT IN STEEL SHIELD PRODUCTS. ALSO, THE VEHICLES MALFUNCTIONS DROP TO AROUND 10%

FIGURE 1 (TOP RIGHT) - THE ORIGINAL LETTER FROM MR. MARK P. FERRARI, C.P.M., A.P.P., MANAGER OF CONTRACT ADMINISTRATION OF BUS & RAIL

FIGURE 2 (BOTTOM LEFT) - THE GEARBOX SYSTEM OF LIGHT RAILS

FIGURE 3 (BOTTOM RIGHT) - THE LIGHT RAIL VEHICLES OF PORT AUTHORITY

PORT AUTHORITY

August 14, 2002

Mark Pushnick
President
Mark Pushnick Enterprises
3351 Industrial Blvd.
Bethel Park, PA 15102-2543

Re: Return on Investment of MT-10 Metal Treatment

Dear Mr. Pushnick:

As you are probably aware, Port Authority of Allegheny County's experiences with MT-10, has been very good. We have been using this product in the gearboxes of our light rail vehicles for approximately 8 of the last 9 years now. One year we discontinued the use of MT-10 and experienced a sharp decline in gearbox reliability and since have resumed the use of its application.

We regularly have oil analysis performed, by an independent testing laboratory and the results of the analysis have indicated that the use of MT-10 has significantly lowered the wear metals that we previously experienced prior to its use. The MT-10 has appreciably extended the service life of our existing gearboxes.

Based on the costs we were incurring prior to the use of the MT-10 product verse the costs we are currently incurring, we have realized a Return On Investment (ROI) of approximately $45 saved for every $1 expensed or 45:1 ratio. The most significant factor was the increase in reliability as well as availability. The vehicles were able to perform when needed and the missed trips were lowered to approximately 10% of past history.

As you are also aware, we continue to use the Power Cut (PC-10) and Power Lift (PL-10) grease with similar experiences.

If you have any questions or I can be of any further assistance, feel free to contact me at (412) 566-5149.

Sincerely,

Mark P. Ferrari

Mark P. Ferrari, C.P.M., A.P.P.
Manager of Contract Administration
Bus & Rail

This testimonial is neither a solicited or paid testimonial of Muscle Products. This is a personalendorsement of Mr. Ferrari. Mr. Ferrari is not an official spokesperson for Port Authority of Allegheny County.

24E. LETTER FROM VOLVO CHINA

THE HORSEPOWER OF VOLVO VEHICLES INCREASED BY 8% TO 12% AFTER USING STEEL SHIELD PRODUCTS

中沃汽车有限公司

致：美国离子能源有限公司
香港荃湾德士古道 188-202 号
立泰工业中心二期 11 楼 K 室

感谢 贵司提供神盾润滑油予我司作汽车马力输出测试。于是次测试当中，我司将神盾润滑油使用于 4 辆沃尔沃 Volvo 汽车[型号：沃尔沃 S80]，并将 4 辆汽车分别放上汽车马力输出测试机(Dyno-Shaft On-Vehicle Dynamometer) 进行测试。测试结果显示，4 辆进行测试的沃尔沃 Volvo 汽车在使用神盾润滑油之后，所输出的马力比起未有使用之前增加了 8%－12%。我司非常乐意向客户推荐神盾润滑油。

顺祝

商祺

中沃汽车有限公司
2013 年 11 月 8 日

地址：杭州市滨江区江南大道 3688 号通策广场 2 幢 1613 室 电话:0571-86852031
Http://www.sinoworldcar.com

FIGURE 1 - THE ORIGINAL LETTER FROM VOLVO

Volvo Car Corporation

8th November, 2013

To: Steel Shield Technologies (Asia Pacific) Limited
Unit K, 11/F, Leader Industrial Centre, Phase 2,
188-202 Texaco Road, Tsuen Wan, H.K.

Dear Ms. Eva Lam,

We would like to express our gratitude to Steel Shield Technologies (Asia Pacific) Limited for providing Steel Shield lubricants for our vehicle horse power tests. In this test, our company applied Steel Shield lubricants to 4 Volvo cars (model: Volvo S80). We mounted the 4 cars on the horse power testing machines (Dyno-Shaft On-Vehicle Dynamometer) and conducted the tests individually.

The results indicate that, the 4 Volvo cars which had Steel Shield lubricants applied got horse power boosted by 8% - 12% compared with the same 4 cars without Steel Shield lubricants. Our company will be pleased to recommend Steel Shield to our customers.

Sincerely,
Volvo Car Corporation
R/M 1613, 2th Phase, Tongce Square,3688 Jiangnan Road,
Binjiang, Hangzhou, China
Tel.: 0571-86852031 www.sinoworldcars.com

FIGURE 2 - THE ENGLISH TRANSLATION FROM THE ORIGINAL LETTER OF VOLVO

FIGURE 3 - VOLVO V70

25. CUSTOMERS' TESTIMONIES & FEEDBACKS CASE STUDIES

"Voice of customers is important for the success of STEEL SHIELD."

25A. PERSONAL / PASSENGER VEHICLES

VOLVO 4S SHOP

Hangzhou Volvo 4S Shop (4S means Sale, Spareparts, Service (After Sale) and Survey (Customers' Feedback)) [Different 4S Franchise chains are gaining popularity all over China] used 4 Volvo cars to test the output power by using Steel Shield products. The results are: with the use of Steel Shield lubricant oil, the average output power increased by 8% ~ 12%, the fuel consumptions also reduced noticeably.

BENZ C63 AMG LUXURY CAR

A user added Steel Shield into the engine and gear box system of his C63 AMG luxury car. He then drove from Shenzhen to Humen through Shenzhen Bay. He felt very comfortable and the engine was very silent during that 70km travel. But when he arrived Humen Oil Station, the staff told him the lubricants had totally leaked out because he hadn't closed the lubricant tank knob properly. At that moment, he started to realize that Steel Shield had ionized the machines. Therefore, the engine could still run for a long distance smoothly with the presence of magnetic levitation. This evidence proved that Steel Shield can work without lubricating oil !

MAZDA 6 CAR OWNER

A MAZDA 6 car owner, whose hometown is in Hunan, has been operating lubricants trading business over 20 years. Every time he drove from Shenzhen to his hometown in Hunan, the fuel indicator would light up after he travelled two-third of entire distance, and he needed to go to the oil station to refuel. Later, he applied Steel Shield to the same MAZDA 6 and repeated the trip. He discovered that the fuel indicator didn't light up again even he arrived the oil station he visited previously. He continued to drive, and he refueled his car after he arrived Hunan. How amazing it was. He got the same result when he returned to Shenzhen from Hunan. It was impossible for him to believe the results if he hadn't experience the trials personally. He finally became one of the distributors of Steel Shield.

MITSUBISHI 2.5 - LITER V6 CAR

One of our company's founder, Mr. Wan, have a Mitsubishi 2.5-liter V6 car. He found that 1 liter of petrol could only drive 10.50 km. However, with Steel Shield added, 1 liter of petrol has been able to drive 13 km which saves about 23 % of fuel.

25B. COMMERCIAL VEHICLES

GUANGZHOU BAIYUN TAXI

Guangzhou Baiyun Taxi Group Co. Ltd. deployed 5 LPG taxis to test the performance of Steel Shield. After 1 month, the 5 taxi drivers were amazed by the average 5% (3~8%) LP gas saving.

DONGJIANG ENVIRONMENT – EURO 5 CARS

Dongjiang Environment is a public listed company in Hong Kong and Shenzhen. They have a fleet of over 50 heavy duty vehicles. After applying Steel Shield lubricants to a 24 tons and a 30 tons Euro 5 vehicles, they found that, an average fuel savings of 6% has been achieved.

TRUCK FLEET THAT RUNS BETWEEN AHENZHEN AND BEIJING

A truck fleet routinely travels between Shenzhen and Beijing. They saved about 7% diesel fuel on average after using Steel Shield lubricants on the engine, gear box and the rear axle.

"STEEL SHIELD ABF Technology is the only solution for all passenger / commercial vehicles. Steel Shield helps improve Engine performance with increased power at wheels and reduce maintenance cost dramatically."

26. STEEL SHIELD EVENTS

“Practical experience with STEEL SHIELD lubricants.”

26A. RACING EVENTS SPONSORED BY STEEL SHIELD

61ST MACAU GRAND PRIX 2014

ZHUHAI 3 HOURS MOTORCYCLE COMPETITION 2014

60TH MACAU GRAND PRIX 2013

USA RACING EVENTS

26B. STEEL SHIELD REMARKABLE EXHIBITIONS

HONG KONG MOTORCYCLE SHOW 2014

HONG KONG MOTORCYCLE SHOW 2013

GUANGZHOU LUBRICSHOW 2013

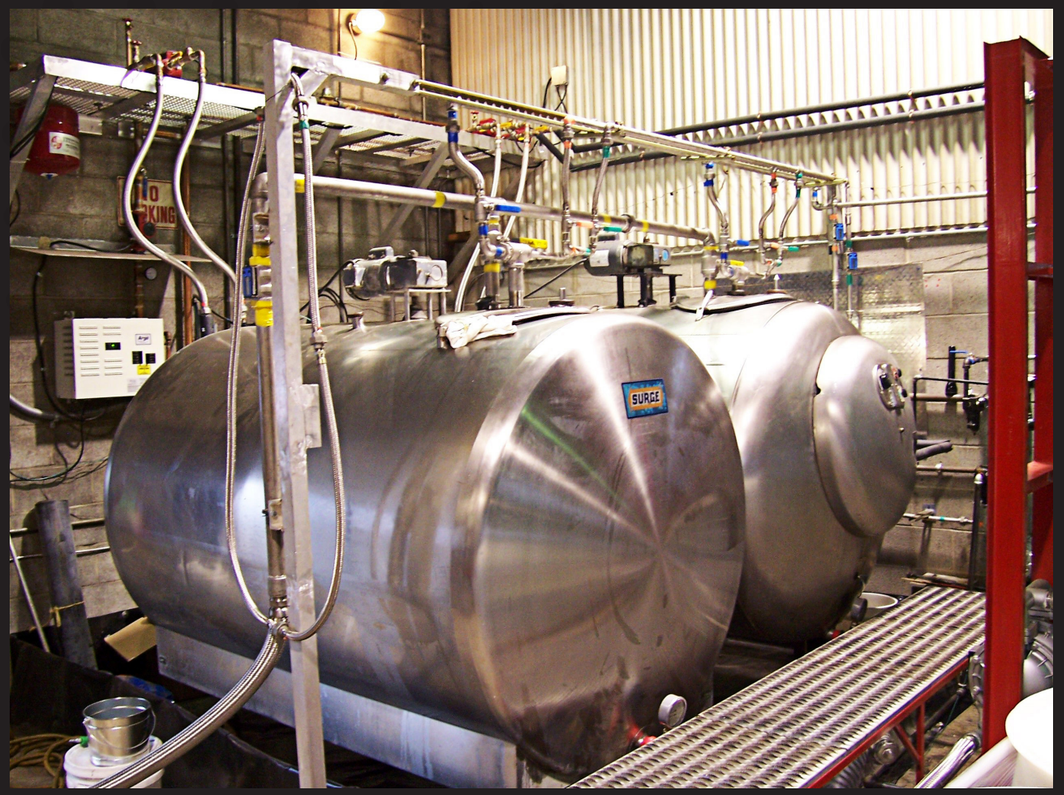
QINGDAO LUBRICANT SHOW 2013

27. STEEL SHIELD OFFICES & FACILITIES

“Consolidated manufacturing plant of ABF Technology and management offices enabled STEEL SHIELD to expand the service networks to differenct sectors all over the world.”

27A. STEEL SHIELD TECHNOLOGIES US HEADQUARTER

THE BASE OF ABF TECHNOLOGIES



27B. STEEL SHIELD TECHNOLOGIES H.K. OFFICE

HEADQUARTER OF ASIA PACIFIC NETWORK

28. STEEL SHIELD WEBSITE & VIDEOS

“Up-to-Date information and demonstrations are available through mouse clicks.”

STEEL SHIELD VIDEOS PAGE

www.steelshieldtech.com.hk/Media_steel_shield_videos.html

STEEL SHIELD VIDEOS DESCRIPTIONS

STEEL SHIELD TECHNOLOGY INTRODUCTION

- How ABF Technology works?
- What benefits can you gain from Steel Shield?

STEEL SHIELD TECHNOLOGY INTRODUCTION (CHINESE)

- How ABF Technology works?
- What benefits can you gain from Steel Shield?
- Chinese dialogue and subtitles

TIMKEN TEST DEMONSTRATION

- How Steel Shield lubricants defeat other preminum lubricants in the market?
- How ABF Technology dramatically reduce metal wear, maintenance costs and energy?

GUANGDONG SPORT TV INTERVIEW

- Steel Shield being recongized by the Chinese customers and market

STEEL SHIELD MOTORHEAD GARAGE COMMERCIAL

- The original US promotion show introducing Steel Shield products

STEEL SHIELD TECH FULL FEATURE ON MOTORHEAD GARAGE

- The original US video showing how Steel Shield lubricants with ABF Technology enhance engine performance

STEEL SHIELD TECHNOLOGIES

www.steelshieldtech.com.hk

www.facebook.com/steelshildtech

www.weibo.com/steelshield

809B, 8/F., Block B,
Goodview Industrial Building,
11 Kin Fat Street, Tuen Mun,
N.T., HK

Tel.: (852) 2545 8029
Fax.: (852) 2545 8030

email: steelshieldtech@yahoo.com

Not Just Oil... IT'S TECHNOLOGY

HIGH PERFORMANCE IONIC CHARGE