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NEW GASOLINE PASSENGER CAR ENGINE OIL PERFORMANCE CATEGORY

Abstract

Future engine designs will be more fuel efficient and environmentally friendly. These are being driven by government regulations and mandates as well as consumer demand. The International Lubricant Standardization and Approval Committee (ILSAC), which is comprised of the North America Engine Manufacturer's Association (EMA) as well as the Japanese Automobile Manufacturer's Association (JAMA), was formed to develop minimum performance standards for lubricants which enable vehicle and engine manufacturers to increase fuel economy, reduce emissions, and improve durability and reliability of their vehicles and engines.

The current performance category of ILSAC oil, GF-4, was introduced in July 2004. Work on the next generation oil, GF-5, began in 2005 and is scheduled to be completed in time for a commercial introduction of GF-5 oil during the 4th quarter of 2010 in time for 2011 model year vehicles. Relative to GF-4, there are three primary performance areas of GF-5 that have been identified for improvement: (1) Fuel economy and fuel economy durability, (2) Emissions system compatibility, and (3) Overall oil robustness. The desire for fuel economy improvements are being driven in part by U.S. government regulations requiring Corporate Average Fuel Economy (CAFÉ) to reach 35 miles per gallon by 2020. The current CAFÉ requirement is 27.5 miles per gallon. In addition to government mandates, record fuel prices have driven consumer demand and focus towards improved fuel economy. The ILSAC GF-5 category will include a new lab engine test which will assess the ability of engine oils with respect to fuel economy performance. In order to assure emissions compliance during the life of the vehicle, the Environmental Protection Agency (EPA) has established a 10 year/120,000 mile (194,000 km) useful life in which the vehicle must remain within certain emissions limits. In addition, the mandated use of On-Board Diagnostic (OBD) systems assure the vehicles do not exceed certain limits and continue to operate properly during their useful life. A certain amount of engine oil is burned in engines and ash forming compounds can lead to fouling of exhaust emissions systems. Therefore, besides protecting the engine from wear, compatibility of engine oil with exhaust emissions systems is an important performance parameter. The ILSAC GF-5 category will include a test and chemical limits that help assure improved emissions system compatibility.

Improvements in vehicle and engine design, as well as increased purchase costs, have resulted in customers extending trade-in cycles and, as a result, the average vehicle age has increased in many markets. Oil robustness plays a major role in extended engine life. The ILSAC GF-5 category will include engine tests and performance targets to assure proper engine oil robustness to allow extended engine durability. In this presentation, we will provide an overview of the drivers for the ILSAC GF-5 engine oil category and also discuss the performance tests and limits that are being established to assure the category meets the industry objectives.

1. Introduction

This paper primarily focuses on the development of the International Lubricant Standardization & Approval Committee (ILSAC) GF-5 passenger car engine oil category in North America and Japan. New ILSAC GF-5 is scheduled to be introduced during the 3rd quarter of 2010 and will supersede ILSAC GF-4 and previous categories. It will also be backward compatible and will provide improved performance relative to GF-4 in many respects. At the same time, when GF-5 is introduced, it is anticipated that API SN will also be introduced as a new performance category to supersede the current category, API SM.

In North America, the industry structure was established to develop new engine oil categories. The organization includes all of the key industry stakeholders in the development process and it results in a performance category that best meets everyone's needs. There are two primary groups that report into ILSAC/OIL: (1) the "Oil" side which is comprised of the oil blenders/marketers and the additive suppliers, and (2) the "Automobile" side which is comprised of the American and Japanese OEMs. The American Society of Testing and Materials (ASTM) are responsible for developing industry standard test procedures with known and accepted precision. These tests are used as the basis for evaluating candidate oils to demonstrate performance in certain key areas.

The Society of Automotive Engineers (SAE) defines the viscosity grades through their SAE J300 specification. All of the industry associations play an important role in the development and oversight of new and existing passenger car engine oil performance categories. The lack of any large scale field performance issues related to engine oil is a good testament to the effectiveness of the current system.

There are many steps in taking a new performance category from concept to commercialization. Like most developments, the first part of the project in which the need for a new category is identified and defined is very important. There is always going to be some degree of friction between those asking or demanding improvements and those who must develop the new engine oil components and formulations. In the end, the product introduced to the market must meet the needs of the existing car population as well as new technologies that are anticipated to be introduced during the life of the category. The entire process from developing the "Needs Statement" to a commercialization of finished engine oil usually takes about 3~5 years. Organizations play various roles in the process.

Ultimately, there needs to be an agreed upon voting structure to resolve conflict and differences to move forward with engine oil performance categories that meets everyone's needs. The voting is balanced so the "Oil" side and the "Auto" side each have 3 votes. Within ILSAC, API LC, and ACC PAPTG, there are different methods used to reach an industry position. Some organizations use consensus (e.g. ILSAC), some use simple majority (e.g. API LC), and others use a hybrid version of the previous two (e.g. ACC PAPTG).

2. Technical requirements on GF-5

New engine technologies are constantly being developed and introduced in order to meet increasing customer demands and government regulations. In many cases, improved engine oil performance is necessary to facilitate the implementation of new engine technologies. Predictions of new engine technology introductions during the life of the new category are taken into consideration in establishing some of the performance requirements for the new category. Of course, it is equally important for the oil to perform well in the existing gasoline vehicles that are on the road. In the U.S., it is about 200 million gasoline vehicles on the road and the annual sales are about 16 million vehicles. Therefore, the average turn over of the fleet is about 8% per year. The average vehicle age is now more than 9 years old so backward compatibility is important.

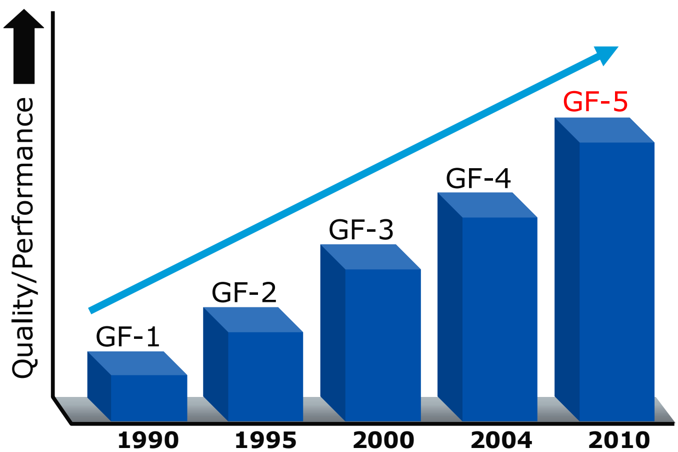


Figure 1: GF-x specification introduction

The ILSAC GF performance system was introduced in 1990 and new performance categories have been developed about every 5 years as shown in Figure 1. Each new category has resulted in performance improvements.

ILSAC GF-4 (GF-4) was developed with several targeted areas to improve performance relative to ILSAC GF-3 (GF-3). Following is the targeted items:

- Improved Oxidation Resistance (~100%)
- Improved High Temperature Deposit Control (~25%)
- Improved Fuel Efficiency and Retention
- Improved Low Temperature Wear Protection
- Improved Low Temperature Used Oil Pumpability
  - None previously
- Reduced Phosphorous Content
  - Reduced catalyst poisoning to improve emissions system durability

Use of engine oils meeting ILSAC GF-4 was recommended in the owner’s manuals of most model year 2005 passenger vehicles in North America and Japan. The category was actually introduced in July 2004.

In ILSAC GF-5 (GF-5), there are 3 primary areas of desired improvement for GF-5 relative to GF-4.

- Fuel Economy and Fuel Economy Retention
- Protection of Emissions Control Systems
- Overall Engine Oil Robustness

The spider diagram (Figure 2) shows the relative performance of GF-5 compared to GF-4 for various performance areas. The performance is shown on a qualitative basis. Further out on the diameter of the ring is higher performance. The primary performance areas where performance was upgraded over GF-4 are shown in red. The new performance areas were added to address the needs to new fuels and hardware technologies that are forecasted to grow or be introduced during the life of the category.

There are trade offs in formulating that must be considered when we are establishing performance requirements. Improved performance in one area may actually result in degradation in performance in another area. Traditional ash forming detergents and anti-wear components can lead to fouling of emissions system equipment. However, simply removing or eliminating them from oil formulations could possibly lead to engine durability issues in engines currently on the road that were designed to operate on them. A balance of engine durability versus emissions system compatibility needs to be struck. The science of formulating well balanced engine oil is based on being able to optimize the performance benefits while minimizing any of the trade-offs.

As an example of formulating optimization, Figure 3 shows the impact of detergent types on friction in a bench torque test. Friction performance is directly related to fuel economy. Therefore, this data shows that selection of detergent type can potentially have an impact on fuel economy. Of course, there are other considerations besides friction in selecting detergents, such as piston deposit performance.

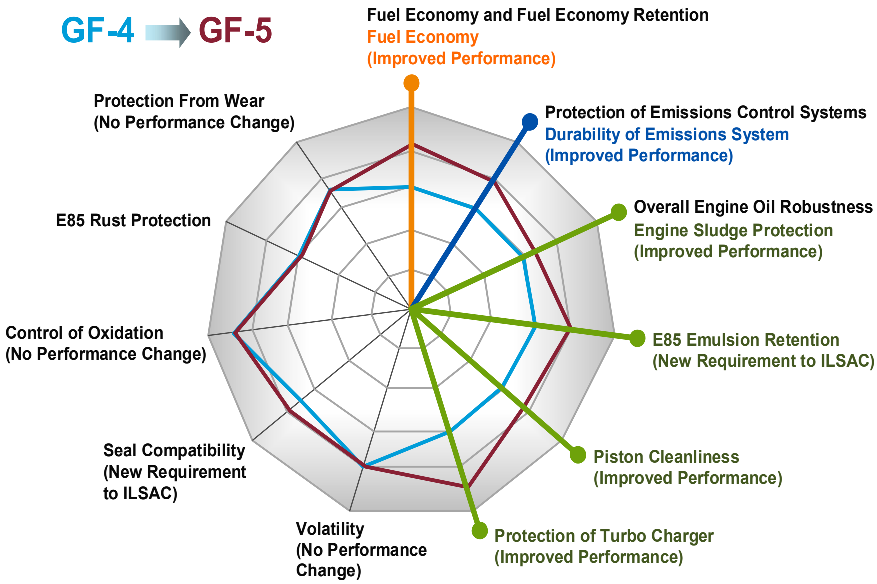


Figure 2: GF-5 compared to GF-4

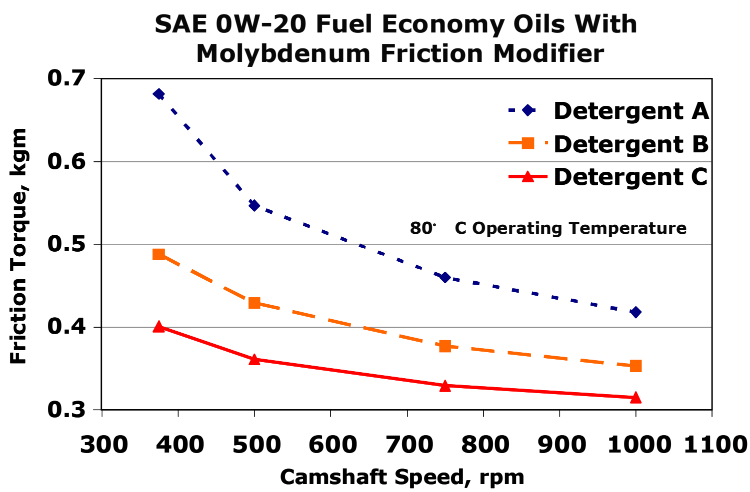


Figure 3: An example of formulating optimization

Fuel economy

Auto manufacturers are constantly developing new engine technologies to address the needs of the customer. Fuel economy is no exception. As shown in Fig. 4, there are numerous ways to affect positively the fuel efficiency of a passenger car engine.

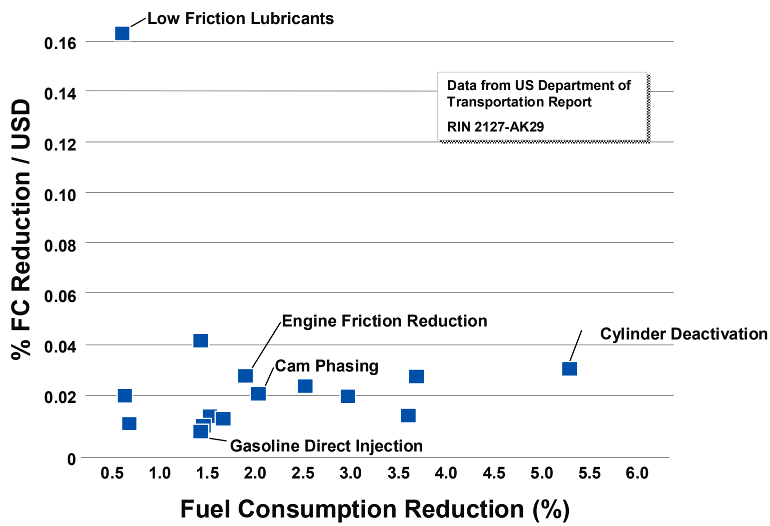


Figure 4: Fuel economy improvement

The Energy Independence and Security Act (EISC) of 2007 include a provision in which the Corporate Average Fuel Economy (CAFÉ) will be increase from the current 27 miles per gallon (MPG) to 35 MPG. This is forcing the engine builders to look at all avenues to improve fuel economy. Small incremental gains in fuel economy can be achieved through engine oil formulation and selection. The Sequence VI-D fuel economy test which will be included in ILSAC GF-5 has been designed to correlate with performance in the Federal Test Procedure (FTP) that is used to determine CAFÉ. The desire for improved fuel economy is a global phenomenon. As shown in Figure 5, the U.S. lags other countries in fuel economy performance. The U.S. mandates fuel economy requirements through the use of CAFÉ. Other countries encourage consumer demand for higher fuel economy through the use of high fuel taxation. For example, fuel prices in most parts of Europe are typically two to three times higher than those in the U.S. The difference is typically due to taxes.

Why is it essential in fuel economy? Of utmost importance during development of the Sequence VI-D (VI-D) was to maintain the link to real world driving conditions. For the test to be perceived as a legitimate test for assessing fuel economy performance, it must have this correlation. Additionally, correlation to the real world was done through the FTP drive cycle, which is used for CAFÉ standards. Without relation to this, buy-in form the OEMs would have been very difficult. Also, a realistic test will produce changes in additive formulations that yield real world gains. The FTP numbers are posted on the window when you buy a car, so by having it correlate to the FTP and it correlates to the actual number of the customer sees when buying the car.

How was it accomplished? The FTP drive cycle is well known. The VI-D statistical group originally developed 10 stages – which were later recorded to 6 – based on fully encompassing the FTP of conditions. The stages were analyzed with different oils (viscosity and FM) in a variety of ways. FM discrimination, viscosity discrimination, test precision, closeness to FTP conditions – all these were considered prior to dropping 4 stages. After the stages were selected, they were weighted in such a way to accomplish the goals set out by the consortium – correlation to FTP, FM and Viscosity discrimination, and improved test precision.

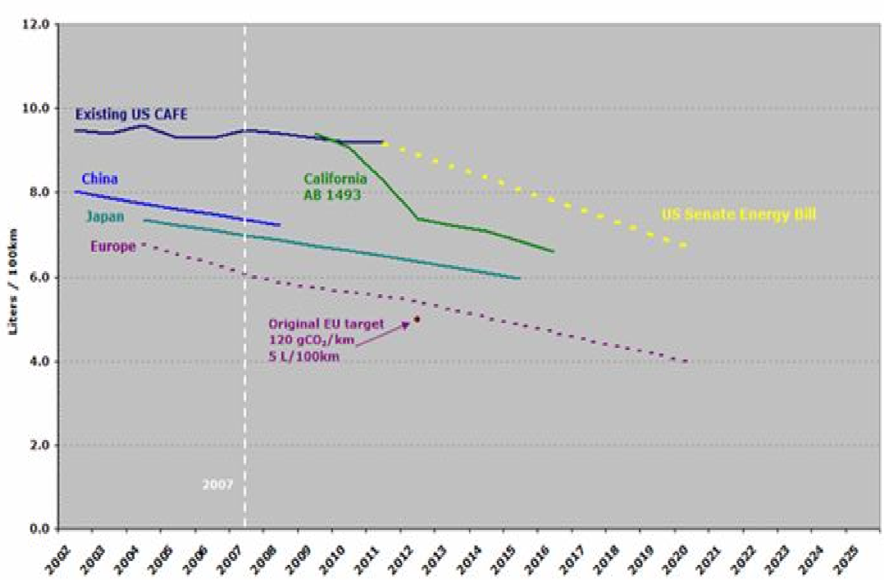


Figure 5: Nominal international fuel consumption and greenhouse gas standards or proposals

There are two primary effects of engine oils on fuel economy

- Reduced Pumping Loss (lower viscosity oils)
- Reduced Friction (friction modifiers)

Both areas are being investigated and pursued within GF-5 to assure optimized fuel economy performance. Despite the known fuel economy benefits of reducing oil viscosity grade, the market has been slow to move towards lower viscosity grades. Many people still believe that more viscous oils develop a thicker oil film which provides additional protection relative to less viscous oils with thinner oil films. As shown in Figure 6, SAE 10W-30 is still the most widely used viscosity grade in the U.S., even though the primary recommendation has been SAE 5W-30 for most vehicles for more than 10 years. The basic conclusion from this chart is that customers and installers don't always follow the OEM recommendations with respect to viscosity grade selection of their motor oil.

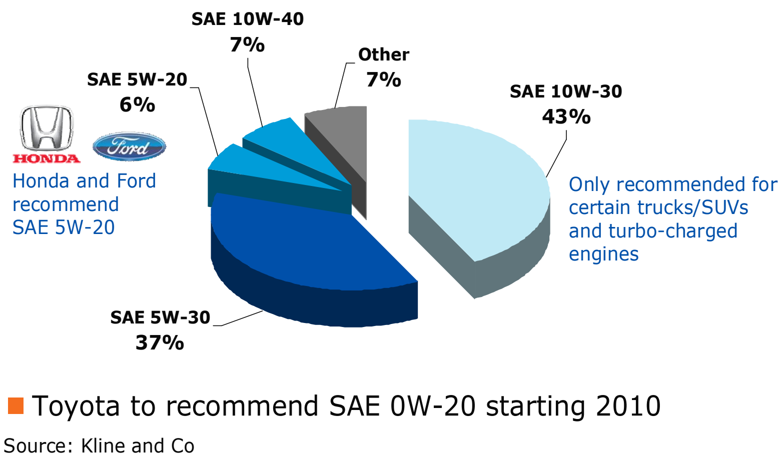


Figure 6: Viscosity grade repartition in the US market in 2008

The move towards lower viscosity oils like SAE 5W-30 and SAE 5W-20 is expected to accelerate in the future as shown in Figure 8. This chart was created before Toyota announced they plan on moving towards SAE 0W-20 as their primary viscosity recommendation starting in 2010. Honda are also using SAE 0W-20 as factory fill in some applications and there are some indications they may also move towards SAE 0W-20 as their primary recommendation. Turbocharger manufacturers require a minimum viscosity grade of xW-30. Most Direct Injection Spark Ignition (DISI) engines are equipped with a turbocharger.

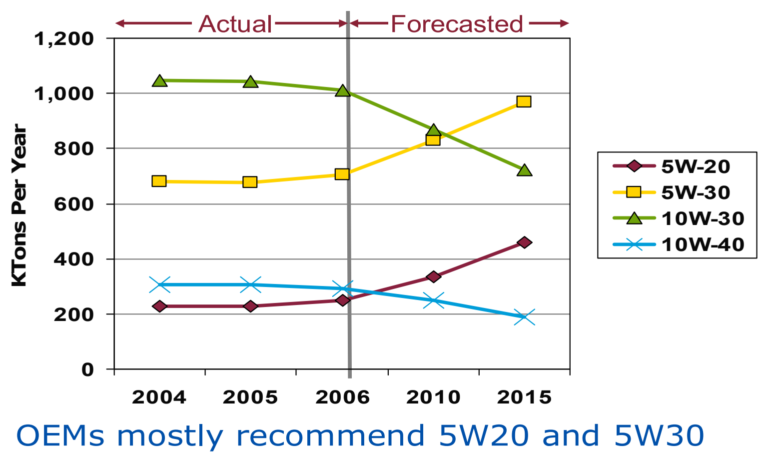


Figure 7: Viscosity grade outlook

Therefore, as DISI engines are introduced, the move towards xW-20 may be stalled unless turbocharger manufacturers can accept to operate reliably with lower viscosity grade oils.

In order to reduce wear rates, improve engine durability, reduce friction, and improve fuel economy, modern engine design practices have largely focused on reducing boundary lubrication. Instead, most areas of the engine operate under hydrodynamic lubrication conditions. There are certain regions of the engine that operate under mixed lubrication regimes such as the piston ring sliding along the cylinder wall. During ring reversal at top dead center, the hydrodynamic oil film can be lost and boundary lubrication can occur. In order to reduce friction, roller type followers have replaced slider followers in most modern engines. Historically, slider followers have operated in boundary type lubrication conditions. Moly type friction modifiers act upon the surface and are able to reduce friction in boundary conditions. However, they are not as effective in elasto-hydrodynamic lubrication conditions. Organic Friction Modifiers are much more effective in elasto-hydrodynamic lubrication conditions. In Figure 8's graph plot represents one FTP drive cycle, logged at 10 Hz. It is a visual representation of the data the consortium matched with the Sequence VI-D stages. The x-axis is engine speed, and the Y-axis is MAP – manifold actual pressure. If one thinks in terms of the fluid film that different engine speeds and MAP will create, it can be seen that for a given temperature high speed low pressure conditions will produce large films, separating surfaces and yielding hydrodynamic lubrication (lower right of graph). The converse is true, low speed, high pressure conditions – upper left of graph – will produce thin films, yielding more boundary lubrication. Now of course this does not show the change in temperature, which can influence film thickness but in this case the variation in temperature is small for a majority of the data.

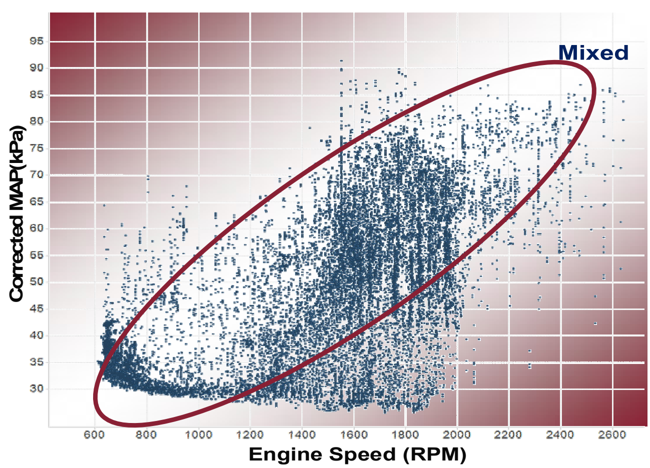


Figure 8: FTP drive cycle

What can be seen from the graph is that indeed most of the time the FTP cycle is not in 'extreme' conditions. That is, it is rarely full boundary or full hydrodynamic. Intuitively this should make sense – only a small time are high load/slow speed engine conditions experienced. The same is true for high speed low load, although the concession is made for high speed highway driving – and this is also seen in the figure – engine speed around 1800 rpm with low loads.

An important consideration with friction is lubrication condition. The mini traction machine provides a convenient means of measuring friction over a range of conditions. Figure 9 is data from three oils differing only in friction modifier. Friction is measured as a function of entrainment speed. At high speeds there is a thicker hydrodynamic oil film resulting in a hydrodynamic lubrication condition which depends primarily on viscosity. At low speeds the oil film breaks down and metal to metal surface contact dominates of the boundary condition. The transition between hydrodynamic and boundary is called the mixed condition and is usually defined as having a fluid film between 1 and 3 times the average surface roughness of the two surfaces. As shown in previous figure, the FTP drive cycle is primarily mixed regime. It is important to recognize that the response of a friction modifier is dependent on the lubrication condition. Molybdenum provides excellent boundary friction reduction, however, it is not necessarily the most effective in the mixed and hydrodynamic conditions. Organic friction modifiers can provide good performance in mixed lubrication. The effectiveness of organic friction modifiers is dependent on formulation interactions. Test methods used in Japan are different to simulate idle and city conditions, to reflect their conditions more. These tests might yield different additive response than VI-D.

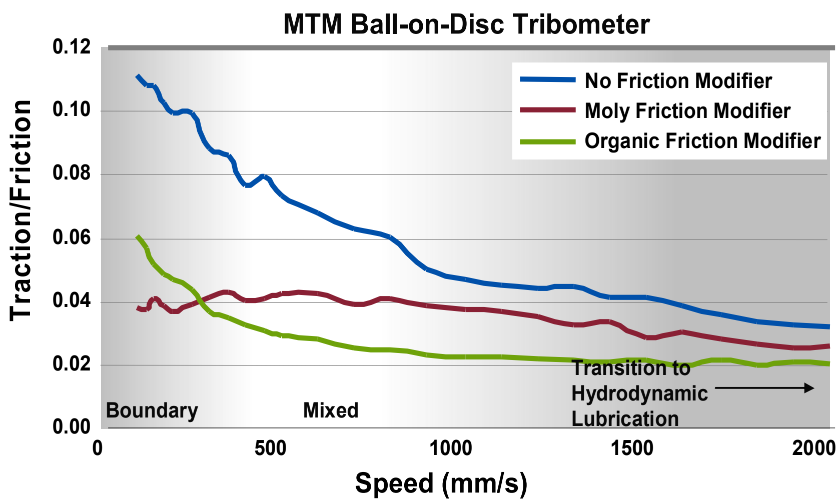


Figure 9: MTM Ball-on-disc Tribometer

Of course viscosity plays a large role in fuel economy. In Figure 10, Phase 2 Sequence VI-B data is shown. There is a clear correlation to viscosity. This is not a surprise, but with limitations on viscosity to meet grade requirements, we largely depend on very specific fresh oil viscosities. What can be seen here, and what I'd like to stress, are that the better correlation is to EOT viscosity. This makes the selection of polymer, and more importantly it's shear stability, more important when formulating a fuel efficient engine oil.

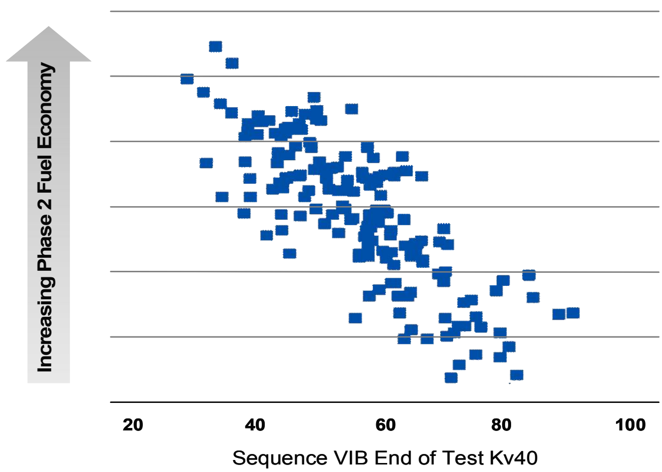


Figure 10: Sequence VIB EOT kV40

Multiple industry associations have been involved in the new FE test as follows: Passenger Car Engine Oil Classification Panel (PCEOCP – Part of ASTM), API Lubricants Committee, VI-D Consortium, ILSAC/Oil. In New FE test, the FTP is used to measure a vehicle's emissions and fuel economy under standardized test conditions. The FTP is also used as a basis for CAFÉ. OEMs are required to meet certain fleet CAFÉ limits or pay fines. General Motors agreed to the fuel economy test sponsor and the GM 3.6l V-6 has been selected for the development of the VI-D fuel economy evaluation. An important part of the VI-D development has been the correlation with the FTP test that is used for CAFÉ. Directional differences in the fuel economy performance of oils should be consistent between the FTP and the VI-D test. Fuel economy is very difficult to measure with precision. Initially, a 5 car test was developed as a basis for the fuel economy performance in 1982. The 5 car test had the advantage of including multiple engine types. However, differences in drivelines and operators resulted in poor test precision. In order to improve precision and eliminate some of the variables, all of the more recent standard fuel economy procedures have been based on lab engine tests.

The VI-D is no exception. The downside to a laboratory engine test procedure is the fact that only one engine type is used to assess fuel economy performance.

As long as the engine is representative of other modern engines, or at least other engines respond in a similar manner to oil formulations, it's not a problem. History of Industry Standard Tests to Measure Oil Impact on Fuel Economy is:

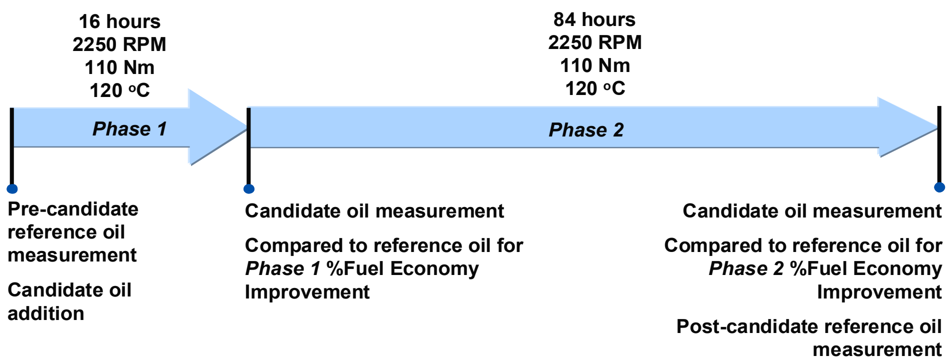
- 1982 – ASTM Five Car Test
- 1989 – Sequence VI Lab Engine Test
- 1994 – Sequence VIA Lab Engine Test
- 1998 – Sequence VIB Lab Engine Test
- 2008 – Sequence VID Lab Engine Test

What drives the need for a new fuel economy test? Why can't we just use the old one? One key factor is CAFÉ limits of regulation. The Energy Independence and Security Act (EISA) of 2007 includes a provision in which the CAFÉ will be increase from the current 27 miles per gallon (MPG) to 35 MPG. This is forcing the engine builders to look at all avenues to improve fuel economy. Small incremental gains in fuel economy can be achieved through engine oil formulation and selection. The VI-D fuel economy test which will be included in ILSAC GF-5 has been designed to correlate with performance in the FTP that is used to determine CAFÉ. Correlation to the real world – Obviously, any fuel economy engine test needs to reflect the performance of an oil in real world driving conditions. An important part of the VI-D development has been the correlation with the FTP test that is used for CAFÉ. The Federal Test Procedure is actually two separate fuel economy tests simulating city driving and highway driving: 1) The city driving program consists of starting with a cold engine and making 23 stops over a period of 31 minutes for an average speed of 20 mph (32 km/h) and with a top speed of 56 mph (90 km/h); 2) The highway program uses a warmed-up engine and makes no stops, averaging 48 mph (77 km/h) with a top speed of 60 mph (97 km/h) over a 10 mile (16 km) distance. The measurements are then adjusted downward by 10% (city) and 22% (highway) to more accurately reflect real-world results. Directional differences in the fuel economy performance of oils should be consistent between the FTP and the VI-D test. VI-B is old V8 engine – switched to V6 modern design. Customer Demand – With the reduction of CO_2, and the increase in gas prices over the last few years in North America the desire for improved fuel economy has moved to the forefront of customer desires. In fact, in a recent national survey 36 percent of respondents attributed the rise in JAMA market share to the superior fuel economy of their cars. Consumers' priorities are changing, and their automobile interests reflect this. Improved test precision – As with any move to a new test, there is a desire for improved test precision over the previous version. This test is no exception. One of the three stated goals of the VI-D consortium during development was improved test precision over the VI-B test. The engines which have been used for the FTP testing:

- GM (10 engines, 4 oils)
- Ford (3 engines, 5 oils)
- JAMA (1 engine, 3 oils)

And the field test (which was used the engines) was finished by end of 2006. Based on the test data, in the end, the GM 3.6L V-6 OHC was selected to move forward for development of the VI-D test procedure. In the VI-D test condition (see Table 1), highlight fact that both reference measurements (pre and post) are used for each phase (in case of carry over, etc). All lubrication regimes are represented in the each stage. Stages 4 and 6, with their higher temperatures and lower speed, are more likely to produce metal to metal contact due to thinner lubricant films – boundary lubrication. The conditions in stages 2 and 5 have the opposite effect – lower temperatures and higher speeds would yield thicker films and little surface contact. Stages 1 and 3 lie somewhere in the middle, in the transition from two surfaces completely separated by lubricant to a fully starved tribo-contact (no lubricant).

Table 1: VI-D test condition



Stage	1	2	3	4	5	6
Speed, RPM	2000	2000	1500	695	695	695
Torque , Nm	105	105	105	20	20	40
Oil Temp, °C	115	65	115	115	35	115

In order to reduce wear rates, improve engine durability, reduce friction, and improve fuel economy, modern engine design practices have largely focused on reducing boundary lubrication. Instead, most areas of the engine operate under mixed lubrication.

In order to reduce friction, roller type followers have replaced slider followers in most modern engines. Historically, slider followers have operated in boundary type lubrication conditions (Fig. 11). Friction modifiers acting only in boundary lubrication might not give the optimum results as boundary lubrication decreases in modern engines. This change affects not only fuel economy, but amount of anti wear inhibitor in formulation, and it would be better catalyst compatibility in engine.

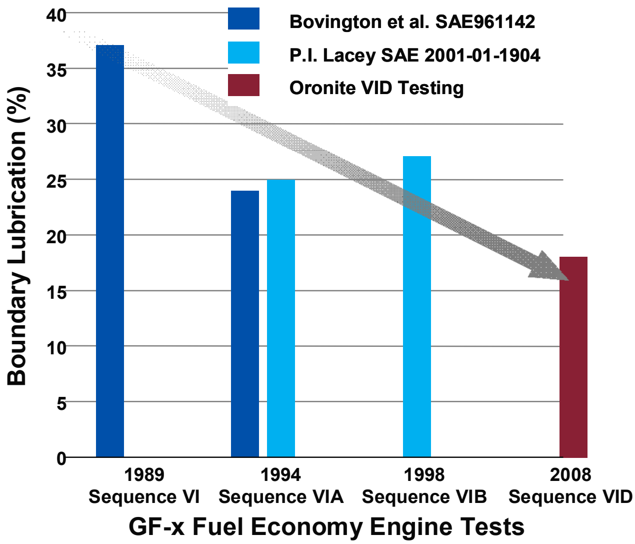


Figure 11: GF-x fuel economy engine tests

After treatment (emission) system compatibility

Phosphorous is known to affect and foul emission catalysts. Phosphorous levels in finished GF-4 oils have been limited to 0.08 wt% to limited catalyst fouling. In order to make GF-5 oils even more compatible with emissions systems, phosphorous volatility has been taken into consideration. Phosphorous levels in the fresh oil and used oil in the severe Sequence IIIG (IIIG) oxidation test are used to measure phosphorous retention in the used oil. Passenger car emissions systems in the U.S. must meet “in-use” emissions requirements for 10 years or 150,000 miles. In order to do so, the OEMs need to make the systems robust. In addition, they will pursue any opportunity they have to limit or reduce the use of compounds known to foul catalysts. New test is proposed by Emissions System Compatibility Improvement Team (ESCIT). They determined that the IIIG is the best choice for measuring the engine oil’s impact on the catalyst. Their recommendation uses the IIIG 100 hour used oil sample to measure the phosphorous impact on emissions system and calculate P retention in used oil.

$$PR = \frac{Ca_0}{Ca_{100}} \times \frac{P_{100}}{P_0} \times 100\%$$

E85 compatibility

Vehicles capable of running up to 85 volume-% ethanol (E85) are known as Flex Fuel Vehicles (FFV). Ethanol is hydroscopic and attracts water. It is important for the crankcase oil to be able to form an emulsion and control rust. If water separates from the oil in the oil pan, it can freeze and block oil from entering the oil screener.

Catastrophic engine failure can result from oil starvation. Largely driven by CAFÉ credits, certain OEMs are offering vehicles capable of running on ethanol blends up to E85. As noted, the number of vehicles capable of running on these blends is predicted to increase substantially in the next 5 to 10 years (see Figure 12). Currently, less than 1% of the service stations in the U.S. actually offer E85 as an option. Therefore, even though the number of vehicles capable of running on E85 is increasing substantially, there is still some question as to the number of vehicles which will actually be exposed or operate on E85. Nevertheless, in many situations, we must formulate for the most severe circumstances even if the engine doesn't operate under those conditions very often. The EISA of 2007 has a provision which requires the use of renewable fuels to increase from the current level of 7 billion gallons per year up to 36 billion gallons. A large percent of the mandated use of renewable fuels will be in the form of ethanol, either from corn or the next generation cellulosic ethanol. In either case, the availability and exposure to ethanol should increase in the next 10 years due to mandates included in EISA. Interestingly, EISA also includes a provision to phase out the E85 CAFÉ credit starting 2015. By 2020, there will be no CAFÉ credit for vehicles capable of running on E85.

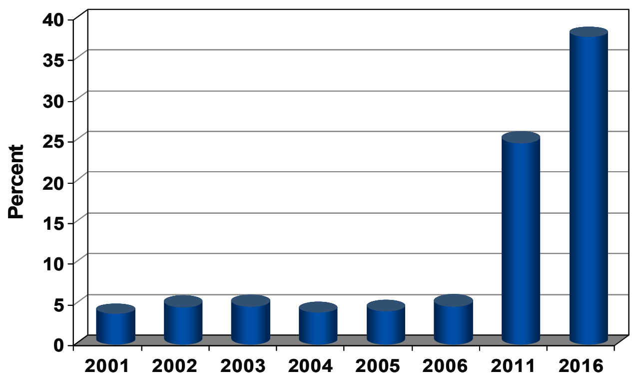


Figure 12: U.S. vehicle population capable of using E85

Deposit control requirements on advanced engine

Many OEMs are moving to smaller engine displacements to improve fuel economy. In these cases, they often use turbo-chargers to provide power on demand. From an engine oil standpoint, turbochargers are often more severe with respect to oil oxidation. Oil is used to lubricate and cool critical turbo bearings. During engine operation, the engine oil flows through the bearings and cools and lubricates the bearings. At engine shutdown, the oil no longer flows through the bearings and is exposed to high heat. The oil formulation can form deposits if not formulated in the proper manner to withstand the heat in the turbo bearing region. Most of the direct injection spark ignition (DISI) engines that are being introduced couple a turbocharger with the DISI. Therefore, as DISI engine use grows, the use of turbochargers will also grow (see figure 13).

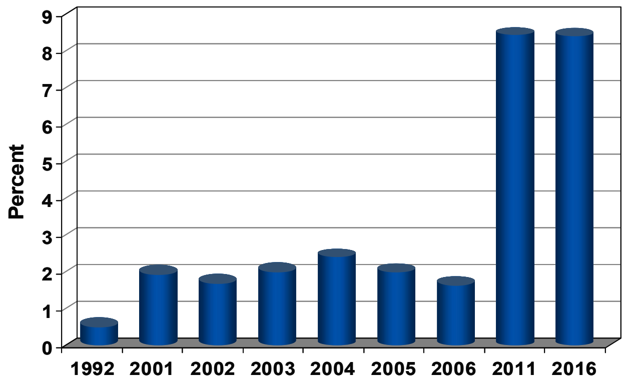


Figure 13: Turbocharged cars sold in U.S.

3. Time line on GF-5

ILSAC GF-5 is on track to see first licensing on Oct 1st, 2010 as shown in Table 2.

Table 2: GF-5 time line

Industry	2005	2006	2007	2008	2009	2010
Test Development						
Precision Matrix						
Test Registration						
Technology Demonstration						
ILSAC/Oil GF-5 Approve						
API Waiting Period						
API First License						

4. Summary

1. Fuel economy and fuel economy retention are important aspects of GF-5. So, the VI-D engine test has been developed to measure fuel economy in GF-5. Oronite understands the lubrication phenomena occurring in the VI-D engine test.

2. GF-5 will be used in North America and Japan. A big question is whether it will expand beyond Japan in the Asia Pacific region?

3. The automotive, oil, and additive industries are cooperating to develop high performance engine oils meeting the requirements of our customers. Legislation and customer demands are driving changes.

Acknowledgement

Thank you to the Oronite Global OEM team for their support.

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7. Oronite Data and Information

Ključne riječi	Keywords
Motorno ulje	Car engine oil
Benzinski motor	Gasoline engine
Osobno vozilo	Passenger car/vehicle
Međunarodni odbor za standardizaciju i odobravanje motornih ulja (ILSAC)	International Lubricant Standardization & Approval Committee (ILSAC)

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