



Spring 2019

Dear No-Rosion Customer,

After what was a pretty brutal winter for most of us, it's finally time to start thinking about getting our cars out.

In our Spring 2018 newsletter, we discussed seasonal fluctuations in fuel blends as required for fuel retailers to meet various state-by-state and federal emissions requirements. What we did not cover, however, is the wide variance in both the quality and quantity of detergent that they blend into gasoline.

In the late 1980s, automakers began building engines with more sophisticated types of fuel injectors. They soon realized these new injectors were sensitive to clogging, as a result of deposits originating from impurities in gasoline. A significant reason for this issue related to inadequate quantities of detergent being blended into most gasoline. They began to recommend specific brands that they determined to have adequate detergent. But some gas stations still weren't using ANY detergent. This prompted the auto industry to begin lobbying the federal government to mandate that certain minimum levels of detergent be blended into all gasoline. Their lobbying efforts were effective. In 1996, the EPA established the "**Lowest Additive Concentration**" (**LAC**) Law that requires certain minimum levels of detergent additives to be blended in all gasoline sold in the US.

Ironically, this resulted in some unfortunate, unintended consequences. The new EPA detergent requirement was actually LOWER than levels being used by a few major brands of gasoline. So these brands **REDUCED** the quantity of detergent they blended in their gasoline to "meet" (i.e. not exceed) the new government standard. The fact that they actually saved money by blending less detergent into fuel didn't make them unhappy. But it didn't take long before automakers recognized that the EPA's mandate was 100% focused on emissions, and paid little attention to the REAL problem which plagued automakers: Loss of performance. They continued to see persistent problems with clogged fuel injectors and combustion chambers contaminated with deposits.

And thus the seeds were sown for what would become a complex mega-million dollar battle of differing interests between the government, fuel retailers, and automakers that continues to this day. But let's not get ahead of ourselves – back to the story.

In 2002, automakers began lobbying the EPA to increase the mandated quantity of detergent blended into fuel, as their data indicated that engines were suffering deposit-related performance loss in the form of reduced fuel economy, detonation, rough idle, low speed pre-ignition, hesitation, etc. The EPA didn't listen. Automakers' voices became louder when the reality of the EPA's "Tier Two" environmental standards for reduced emissions came onto their radar screens. They feared that the ONLY way said standards would be achievable would be for commercially available gasoline to contain higher quantities of detergent. This would especially be the case for a then-new form of injector technology being prepared for introduction by a few high-end manufacturers, called "GDI," or Gasoline Direct Injection. Once again, the EPA didn't listen, as they cared only about emissions.

So in 2004, a few automakers took matters into their own hands. Engineers at GM, Honda, Toyota, and BMW worked together to determine a gasoline detergent specification that they felt would optimize and protect the performance of their engines. They collaboratively created a new, proprietary standard that they referred to as "**TOP TIER.**" This new standard called for higher quantities of detergent additives to be blended into gasoline. In 2007, the **TOP TIER** program picked up more steam when Volkswagen and Audi joined the group. Not wanting to miss the boat, Fiat Chrysler and Honda followed shortly thereafter.

Once fully-formed, the TOP TIER program allowed branded gasoline retailers to participate by being able to prove, through a specific test protocol, that their fuel met specific standards. They paid an annual fee for the right to be able to display the TOP TIER branding at the pump in gas stations. More on the test protocol in a minute – but first a word about blending detergent additives into branded gasoline.

You may have noticed that, thus far, gasoline sellers have been referred to as “retailers,” not “refiners.” This is because, whether you know it or not, most brands of gasoline sold at the pump actually come from the SAME refiners, through the SAME distribution channels. In this way, gasoline is actually a **commodity** that flows through the same, shared lines, regardless of brand. Once a branded retailer purchases the commoditized fuel, it is additized with their specific detergent package, thereby giving the fuel its brand identity. Depending on the performance specification of the additive package used, it may or may not qualify for the TOP TIER rating.



**Here is a list of branded retailers known to currently sell TOP TIER gasoline at some/all of their stations:** 76, Aloha Petroleum, Amoco, ARCO, Beacon, BP, Break Time, Cenex, Chevron, CITGO, Conoco, Co-op, Costco, CountryMark, Diamond Shamrock, Entec, Esso, Express, Exxon, Holiday, Kwik Star Stores, Kwik Trip, Mahalo, MFA, Mobil, Ohana Fuels, Petro-Canada, Phillips 66, PUMA, QT, Quik Trip, Road Ranger, Shamrock, Shell / Shell V-Power, Sinclair Standard, SuperAmerica, SuperFuels, Tempo, Texaco, Tri-Par, and Valero. Look for the “TOP TIER Detergent Gasoline” label at the pump – as shown in the image at left.

**Important note:** Not all gas stations under these brands necessarily sell TOP TIER gasoline. Individual gas stations have the choice as to whether they wish bear the extra cost of blending detergent at a TOP TIER level. The only way to know for sure is to look for the TOP TIER label on the pump, or inquire at the time of purchase.

Now, to the specifics of the test used in determining whether a gasoline blend qualifies for the TOP TIER rating. In general, the tests quantify whether the detergent in gasoline is sufficient to control deposits on intake valves, fuel injectors, and in combustion chambers, as well as preventing intake valves from sticking. The tests used are:

- 1) **ASTM D6201 Standard Test Method for Dynamometer Evaluation of Unleaded Spark-Ignition Engine Fuel for Intake Valve Deposit Formation.**
- 2) **Intake Valve Sticking Test in a GM Truck 5.0L V-8 Engine.**

As referenced in previous newsletters, ASTM stands for “American Society for Testing and Materials.” It is composed of 141 technical committees that act as leaders in the development of international test standards. Relative to fuels, the **ASTM D02 Petroleum Products and Lubricants Committee** includes refiners, fuel retailers, and automakers. They work together in attempting to establish test protocols and specifications that have a major impact on fuel and engine performance worldwide – including the aforementioned **D6201 Test.**

The **ASTM D6201 Test** simulates 4,000 miles of driving to determine intake valve and combustion chamber deposit formation. In the test, a 1994 Ford 2.3-L dual spark plug engine is put through a standardized test cycle on a dynamometer. The engine runs at 2,000 rpm and 230 mm Hg manifold pressure for 4 minutes. Then it ramps up (over a 30 second period) to 2,800 rpm and 540 mm Hg manifold pressure, and runs for 8 minutes. Then the engine is slowed down (over a 30 second period) and run again at 2000 rpm and 230 mm HG manifold pressure for 4 minutes. These cycles are repeated, non-stop, over a 100 hour test period.



After the test has concluded, the engine is dismantled, and deposit measurements are taken for intake valves and combustion chambers. A TOP TIER test is a PASS if the average intake valve deposit (IVD) weight is less than 50 mg per valve, and if the base fuel has demonstrated an average IVD weight of greater than 500 mg per valve. Also required for this standard is that the combustion chamber deposit (CCD) weight be no greater than 140% as compared to a base fuel result. **The image at left shows the 1994 Ford 2.3-L dual spark plug engine set up on the ASTM D6201 dynamometer test rig, ready to run.**

The purpose of the **Intake Valve Sticking Test** is to test fuel performance in the prevention of intake valve sticking at low temperature. The vehicle used in this test is a 1990-1995 GMC-1500 pickup truck with a 5.0 Liter V8 engine and automatic transmission. The 60-minute driving cycle consists of 56 minutes at 55 mph and a 3-minute idle period. The remaining 1-minute is required to accelerate and decelerate the engine and drivetrain during the driving period. The driving cycle is repeated three more times during each day, for an approximate total mileage accumulation of 200 miles. The driving cycle is followed by 16 hours of cold soak at -4°F. Cylinder pressures are measured during three cold cranks at cold temperature. Steps 1-3 are repeated during the next two days for a total test duration of two weeks.

A fuel **passes** the test if no valves stick during any of the three cold starts. A “stuck valve” is defined as one in which the cylinder pressure is less than 80% of the normal average cylinder compression pressure.

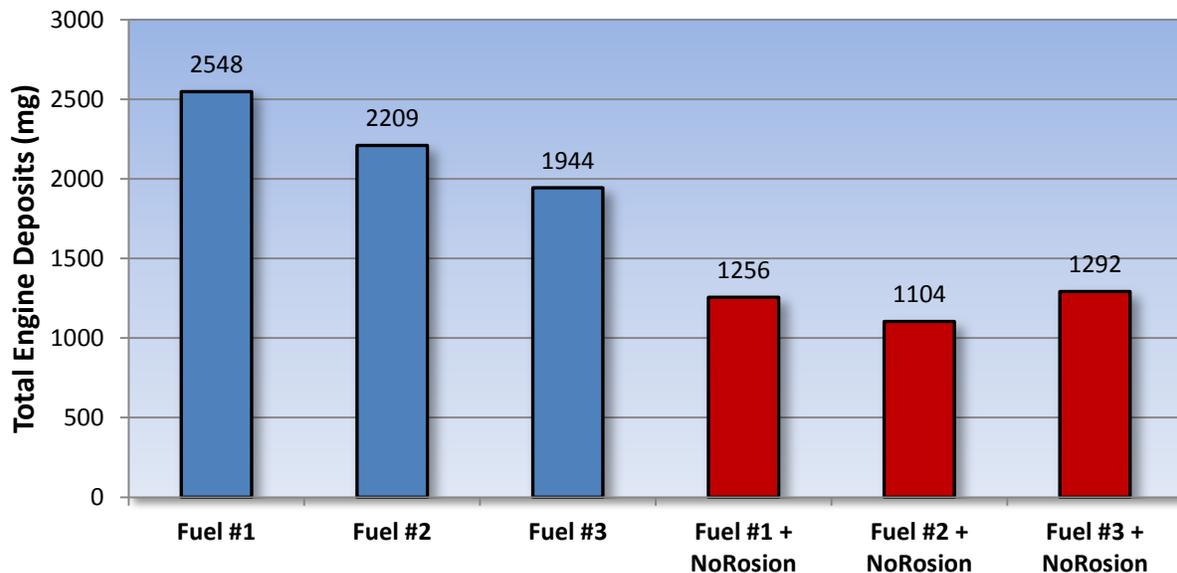
Now that we’ve covered what TOP TIER is, let’s explore why it is important. Since its introduction 15 years ago, engines in **new cars** have become significantly more sophisticated, with tighter tolerances and extremely precise fuel delivery systems. A good example is **GDI** (Gasoline Direct Injection) that is used in the majority of new cars today. Gasoline is injected directly into combustion chambers in carefully-timed, computer-varied millisecond intervals at very high pressures – in some cases up to 5,000 PSI! With such tight tolerances, especially within the context of continued government pressure for reduced emissions and fuel economy improvements, the need for deposit prevention inside engines has never been greater.

**But it’s just as important for older cars as new ones.** Maybe even **more**, actually. This is because engines in new cars have computerized knock sensors that dial back ignition timing if/when deposit-related detonation occurs. Although this results in slight reductions in performance and fuel economy, there’s little (if any) risk of engine damage. On the other hand, engines in older cars don’t have knock sensors. So deposit-related detonation not only reduces performance, it also has the possibility of damaging piston crowns, valves, etc.

Using non-TOP TIER gasoline regularly in your newer daily drivers will result in 2% to 5% average loss of fuel economy, costing you money in the long run, and reducing the performance of your engine. But as already identified, using it in your older, classic cars comes with possible risks – as well as harder starts, etc.

It is precisely for this reason that we offer **No-Rosion Fuel System Combustion Optimizer**. It contains a robust detergent package that performs well enough to exceed TOP TIER requirements by a margin of almost 50% in ASTM D6201 tests. This means that it not only keeps engines clean and prevents deposit-related performance loss, it actually removes deposits that may already have formed from previous use of non-TOP TIER gasoline. So it functions as both a keep-clean, as well as a clean-up – i.e. both a preventative, as well as a problem-solver.

## ASTM D6201 Test Results - Non TOP TIER Fuel



The chart above shows ASTM D6201 test results for non-TOP TIER gasoline that has been treated with No-Rosion Fuel System Combustion Optimizer. As you will note, No-Rosion effectively reduces the amount of total deposits formed on intake valves, and in combustion chambers, by almost 50%.

You may have noticed that some of our **No-Rosion** product labels include the statement: “**INDUSTRIAL GRADE.**” This isn’t marketing hype. Our industrial private label division supplies the same detergent that’s in No-Rosion to two blenders of boutique gasolines that are sold nationally at retail – one of which you may very well already use in your lawn mower or chainsaw. This small engine gasoline sells at retail for the equivalent of \$28.00 per gallon – a very high-quality fuel, which speaks to the high-quality nature of our detergent that is blended with it.

**No-Rosion Fuel System Combustion Optimizer** is an especially effective option if TOP TIER gasoline is not available in the area where you live. There are still thousands of gas stations that do not participate in the TOP TIER program. The main reasons are: (a) **cost**, and (b) **lack of demand**. Blending high-quality detergent into gasoline adds a few cents per gallon of cost. This equates to unnecessary “cannibalization” of profit for fuel retailers. Not only does blending extra detergent into gasoline add to their costs, it also reduces the total amount of fuel they sell in the long-run, since cleaner running engines consume less fuel.

Here are a few statistics from research performed by AAA: Only 12% of drivers select a gas station based on whether the fuel meets TOP TIER spec. Nearly half (47%) of drivers do not regularly buy TOP TIER gasoline. Men (44%) are more likely than women (26%) to regularly buy a TOP TIER gasoline, as are baby boomers (41%) compared to millennials (32%).

Thank you for being a customer. We appreciate your support, and look forward to continuing to be of service.

Sincerely,

Applied Chemical Specialties, Inc.