PRECISION PERFORMANCE
SINCE 2002

TECHNICAL LIBRARY

NICKIES™
PERFORMANCE AIR-COOLED CYLINDERS AND SLEEVES

UNDERSTANDING ETHANOL FUELS

BY CHARLES NAVARRO

With the introduction of E15 fuels containing up to 15% ethanol, owners of vehicles never designed for ethanol blend fuels must be ever aware of damage that can occur by not choosing the correct fuel for their classic or performance engine.

Thanks in part to lobbying groups like the National Marine Manufacturers Association, steps are being taken to protect consumers by limit the expansion of E15 sales which will eventually lead to what is coined as “misfueling” that will damage engines not compatible with these fuels.[1] Like with modern oils, it is up to the consumer to make informed decisions as to what fuel is correct for their vehicle and not rely on fuel suppliers to warn consumers as to possible engine damage if the wrong fuel is used.

Corn ethanol is used as an oxygenate and octane booster in the US to conform to ASTM D5798 ethanol fuel standards.[2] Looking beyond E10 or E15, testing has indicated that ethanol blended fuels, specifically E20, has shown a reduction of CO and HC emissions, even though a reduction of overall fuel economy of 6.5% was observed over non-ethanol blended gasoline.[3] It was further documented that even though gasoline has a higher specific heat energy, ethanol’s higher resistance to detonation does allow engines to run with higher spark advance which increases thermal efficiency and output, suggesting that older vehicles without modern ignition management and knock sensing may need adjustment to take advantage of ethanol blended fuels.[4]

Why is ethanol a bad thing? Aside from the argument that ethanol fuel production from typical sources such as corn is at best carbon neutral or a government subsidized industry, there are actual problems that can result from use of ethanol fuels both short and long term. Ethanol increases the water solubility of fuels, which can lead to corrosion of internal engine components. This oxidation occurs through the formation of aggressive chemicals like aldehydes and acids. As ethanol content increases, the corrosive properties of these fuels increases, having negative effects on steel, copper, aluminum, and brass, all materials common to older fuel systems.

Why is ethanol a bad thing? Aside from the argument that ethanol fuel production from typical sources such as corn is at best carbon neutral or a government subsidized industry, there are actual problems that can result from use of ethanol fuels both short and long term. Ethanol increases the water solubility of fuels, which can lead to corrosion of internal engine components. This oxidation occurs through the formation of aggressive chemicals like aldehydes and acids. As ethanol content increases, the corrosive properties of these fuels increases, having negative effects on steel, copper, aluminum, and brass, all materials common to older fuel systems.[5]

Although it has been sufficiently documented that modern vehicles can accept modern ethanol blend fuels with minimal negative issues when doped with corrosion inhibitors, it has been well known that older vehicles are susceptible to damage from these fuels. As early as in 1983, GM published a paper in the Society of Automotive Engineers (SAE) titled “Corrosion of Metals and the Effectiveness of Inhibitors in Ethanol Fuels.” The primary takeaways were that chloride ions were the most aggressive source of contamination in ethanol blended fuels and when combined with acetic acid and ethyl acetate, corrosion was significant. Water content in blended ethanol fuels is the largest concern when evaluating the negative effects of ethanol to fuel system and engine components because water is the carrier for the corrosive chlorides, sales, and other ions that lead to corrosion.[6] When choosing an ethanol blended fuel, using a Top Tier fuel supplier will ensure fuel dispensed meets or exceeds ASTM standards, including limits for moisture content.

On a positive note, they did document that available inhibitors could be added to reduce or eliminate corrosion of components in fuel systems and engines susceptible to ethanol blend fuels. Specifically, GM found corrosion of the carburetor, fuel pump, fuel line, fuel filter, and fuel tank becoming critical for example when small orifices in carburetors get blocked that can cause rough running or lean engine operation resulting in engine failure. Even in 1983, there were inhibitors available that could provide corrosion protection in the fuel system as well as in storage and transport of ethanol blended fuels, many developed for the Brazilian market where E100 fuels were sold.[7]

Doping with corrosion inhibitors (CI) can also lead to fuel filter, catalyst, and injector plugging as well as intake valve deposits or fuel pump failure, so excessive corrosion prevention can have unintended side effects.[8] Although there is no recommended specification in the ASTM D4806 for CI content, choosing a Top Tier fuel mitigates these problems with increased detergency to prevent these deposits and carbon buildup is recommended.[9] Where Top Tier or ethanol-free fuels are not available, products like Driven's Carb Defender can be added to any fuel to overcome the negative effects of ethanol blended fuels without any negative side effects.[10]

Outside of corrosion issues, the material compatibility of plastics and rubbers with ethanol blended fuels is another area of concern. Specifically, dry-out sample testing of Polychloroprene rubber hoses common in older fuel systems immersed in E10 found a 70% reduction in strength versus 10% in gasoline. In layman's terms, cars driven infrequently where lines might drain back to the tank are susceptible to failure with ethanol blended fuels. Replacing these fuel hoses with modern, fuel injection hoses that are flex fuel compatible are recommended for all vehicles that will be exposed to an ethanol blended fuel.[11]

Lastly, ethanol blended fuels also have reduced lubricity over non-ethanol fuels, directly effecting fuel system and engine component life for both vintage and modern engines, especially those with gasoline direct injection (GDI) or gasoline compression ignition (GCI). Elimination of sulfur from domestic fuels for emissions reasons has had an adverse, negative effect on the lubricity of fuels, increasing wear to high pressure injection pumps. Specifically, sulfur's interaction with metal surfaces to reduce friction on metal sliding surfaces lowers abrasive wear, requiring the addition of lubrication enhancers (LE) to overcome poor lubricity of ethanol blended fuels. Driven's Injector Defender can be used to provide added lubricity while providing protection from corrosion caused by ethanol. Even with proper dosing, acid based LE outperforms ester based LE, but with sufficient dosing, either LE additive can provide protection to all fuel system and engine components. Without knowing which LE is used and in what concentration, testing carried out by Total ACS found that premium fuels resulted in lower wear, so again, use of a Top Tier fuel in a premium grade where non-ethanol fuels are not available is highly recommended. [12]

Using quality fuel Top Tier or ethanol free premium fuels and selective use of fuel additives along with upgrading to fuel system and engine components that are compatible with modern ethanol blended fuels are steps that should be taken to prevent costly failures.

1. http://www.nmma.org/press/article/22273

2. Effects of Fuel Ethanol Quality on Vehicle System Components Jill Cummings, General Motors Corporation. Society of Automotive Engineers 2011-01-1200 – 04/12/2011

3. Systematic Evaluation of 20% Ethanol Gasoline Blend (E20) as a Potential Alternative Fuel. Moqtik Bawase and M R Saraf. Automotive Research Association of India. SAE International 2017-26-0072

4. Statistical Analysis of the Drivability Impacts with Ethanol. Edgard Marcelo Assis, Douglas Martini, Eduardo Nunes Da Silva, Lucas De Carvalho Kira. SAE Brasil 2014-36-0437 E.

5. https://pubs.acs.org/doi/abs/10.1021/acs.energyfuels.7b01682?journalCode=enfuem

6. Effects of Fuel Ethanol Quality on Vehicle System Components Jill Cummings, General Motors Corporation. Society of Automotive Engineers 2011-01-1200 – 04/12/2011

7. Corrosion of Metals and the Effectiveness of Inhibitors in Ethanol Fuels. Monte S. Walker and Robert L. Chance; General Motors Research Laboratories, Warren MI. Society of Automotive Engineers #831828. 1983.

8. Effects of Fuel Ethanol Quality on Vehicle System Components Jill Cummings, General Motors Corporation. Society of Automotive Engineers 2011-01-1200

9. https://www.consumerreports.org/car-maintenance/study-shows-top-tier-gasoline-worth-extra-price/

10. https://www.youtube.com/watch?v=wpF7PgCd72w&feature=youtu.be

11. Material Compatibility of Elastomers and Plastics in Ethanol-blended (E10) Gasoline. Moqtik Bawase, Amita Baikerikar, and M R Saraf. The Automotive Research Association of India (ARAI), India. SAE International 2013-26-0077

12. Investigating the Impact of Ethanol on the Lubricity of Gasoline and on the Lubricity Improving Efficiency. Thomas Dubois, Ludwine Abiad, and Pauline Caine. Total ACS. SAE International 2017-01-2297