

# ENGINE PERFORMANCE 101: WHY ETHANOL IS A CAR'S BEST FRIEND



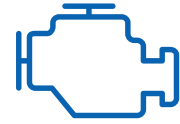
Burns cleaner and reduces emissions



Delivers more miles per dollar



Boosts octane for greater efficiency and horsepower



Improves engine performance

*Ethanol is a low-cost, high-octane biofuel that is added to nearly every gallon of gasoline sold in the U.S. The boost from ethanol's octane enhances engine performance and allows for more efficient engine designs. Ethanol delivers greater power, less pollution and more miles per dollar – a winning combination for American drivers.*

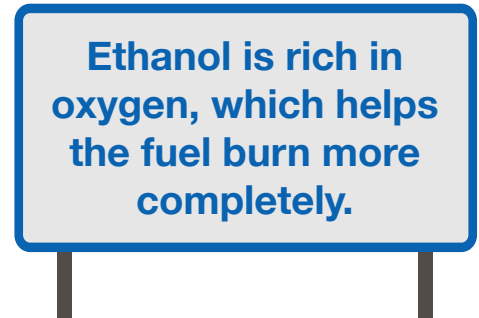
## A CLEANER-BURNING FUEL

Both air and fuel are required to power the combustion in an automotive engine. One will not burn without the other, and ethanol makes it easier to create a cleaner-burning mix, resulting in fewer unburned, unhealthy chemicals leaving the tailpipe.

When the mix of air and fuel is correct, a cleaner burn will generate maximum power from every drop of fuel, and tailpipe exhaust will contain less carbon monoxide and hydrocarbons – harmful toxins and greenhouse gas emissions.

All gasoline is made from petroleum, but most fuels sold today are blended with some amount of ethanol, a biofuel made from plants. Ethanol is rich in oxygen, which helps fuel burn more completely. During combustion, oxygen from ethanol and air binds to the hydrogen and carbon in fuels to create water and carbon dioxide. With the addition of oxygen from ethanol, harmful tailpipe emissions such as unburned hydrocarbons and carbon monoxide are significantly reduced.

Modern vehicles are equipped with emissions sensors and computer control systems that automatically adjust the fuel and air mixture for maximum performance. This allows nearly any vehicle to operate on a fuel blend containing the standard 10 percent ethanol (E10) or 15 percent ethanol (E15). Fuel systems in Flex Fuel vehicles allow operation on an even wider spectrum of fuel blends.



## A GREATER MILEAGE VALUE

Ethanol blends deliver more miles per dollar, even when accounting for the change in energy content between ethanol and conventional gasoline.

Burning a drop of ethanol will generate less heat than burning a drop of gasoline, but the difference in energy content has little or no impact on mileage. For example, E15 typically costs 3 to 5 percent less than standard E10 blends and contains only 1.5 percent less energy. Therefore, consumers can drive farther for less money when fueling up with a high ethanol blend.

Ethanol's high octane rating will also allow the design of more fuel-efficient engines, which will deliver even greater savings per mile by preserving fuel economy.



**Ethanol blends deliver more miles per dollar.**



## MORE OCTANE FOR MORE POWER

High-octane fuels, like ethanol, help engines deliver more horsepower and speed.

Most cars require fuel with a minimum octane rating of 87. Ethanol's octane rating is 113 and is added to petroleum-based fuels to create a blend with at least 87 octane for use in modern vehicles. In the past, chemicals like lead and MTBE were added to increase the octane of motor fuels, but those substances are highly toxic. Since ethanol is clean, renewable, abundant and inexpensive, it provides the needed boost and is mixed in 97 percent of U.S. motor fuels.



**Ethanol provides a high-octane boost to basic gasoline.**



## MORE OCTANE FOR GREATER EFFICIENCY

Smaller engines use less fuel, and the octane boost provided by ethanol makes it possible to reduce size without sacrificing performance.

Forcing more fuel and air into a smaller volume increases pressure (turbocharging). This compression can cause low-octane fuels to ignite at the wrong time, reducing efficiency and potentially damaging the engine.

High-octane fuels, like ethanol, are necessary for smaller, higher-compression, "turbocharged" or "supercharged" engines, which force more air into the mix, yielding more power.

Future fuel efficiency standards in the United States will prompt automakers to produce engines that require a more highly compressed fuel mix. As a result, our standard fuel mix will require higher octane. This can readily be provided by ethanol at a much lower cost than other octane boosters.

**"Ethanol has an inherently high octane number and would be an ideal octane booster for lower-octane petroleum blendstocks. ... In this way, high octane fuel can simultaneously help improve fuel economy while expanding the ethanol market in the United States via a growing market for an ethanol blend higher than E10."**

*Oak Ridge National Laboratory, July 2016*



## LESS WEAR AND LESS MOISTURE

Alcohols, including ethanol, help to remove oil-based grime from surfaces, not unlike dish detergents. That helps prevent the build-up of residues on key engine components.

Extensive testing by the Department of Energy has shown that all vehicles since 2001 are built with modern materials, allowing them to run on fuels containing up to 15 percent ethanol. This represents 9 out of 10 cars on the road today. Engines in Flex Fuel vehicles can operate on blends of up to 85 percent ethanol.

Ethanol also reduces the likelihood of moisture build-up in an engine.

On a cold night following a humid day, moisture in the air could condense on the inner chamber of a fuel tank. Water doesn't mix with pure gasoline, so it accumulates at the bottom of the tank. If that unmixed water gets into the engine, the engine will stall. It could also freeze in the fuel lines. Ethanol-blended fuels can absorb some water before they become saturated and experience "phase separation," the point at which enough water accumulates to harm engine performance. In essence, ethanol keeps the fuel dry.



**About Richard Childress Racing (RCR):** Richard Childress Racing is a renowned, performance-driven racing, marketing and manufacturing organization. RCR has earned more than 200 victories and 15 championships, including six in the NASCAR Sprint Cup Series with the legendary Dale Earnhardt. RCR was the first organization to win championships in the Sprint Cup Series, NASCAR XFINITY Series and NASCAR Camping World Truck Series.



**About ECR Engines:** ECR Engines is a high-performance research and development and engine production company at the Richard Childress Racing facility in Welcome, N.C. ECR provides engines for NASCAR teams including Richard Childress Racing, JTG Racing, Germain Racing, Circle Sport-Leavine Family Racing, Kaulig Racing, among others. ECR also produces engines used in all of the Cadillac DPi-V.R Prototype cars competing in the IMSA WeatherTech Series, as well as for teams in SCCA, dirt and asphalt short tracks, and sprint car racing.