Bell Performance, Inc. tel 407-831-5021
1340 Bennett Drive fax 407-331-1125
Longwood, FL 32750
www.bellperformance.com
www.WeFixFuel.com

Fuel Is Not What It Used To Be - Bell Performance White Paper

Nothing endures but change – Heraclitus (535 – 475 BC)

If there's one constant in the world, it's that everything changes. Cars today don't look like cars did back in the 50s, or even the 80s. Engines are smaller, yet more powerful and more efficient. The average new car gas mileage is pushing 25 mpg, whereas they were pushing only 15 mpg back in 1975.

The world is changing, (mostly) for the better.

But as you can guess from the title of this white paper, when it comes to fuels, the change has not been all good. Fuels are not what they used to be. As consumers, it's helpful to be aware of how things have changed for gasoline and diesel so you can know what implications it has for you and your vehicles.

The Need To Get More For Less

Changes in the composition of gasoline and diesel fuels have been driven by a couple of main factors.

First is the need for cleaner burning fuels that are better for the environment. In this context, this means the fuels break down into less-harmful components as they are burned in the engine.

Second is the demand for fuel driven by a growing world population. There is only a finite amount of oil in the ground and it's becoming more and more challenging to find it and extract it. At the same time, fuel demand is growing because third world countries like China, India and Indonesia have billions of new consumers coming online who are hungry for energy, fuel and resources that they did not have access to twenty years ago.

All of this means there's tremendous pressure to get the most fuel out of each barrel of crude oil, and pressure on refineries to maximize output to keep up with ever-growing demand.

Gasoline and Diesel – Not As Stable As Before

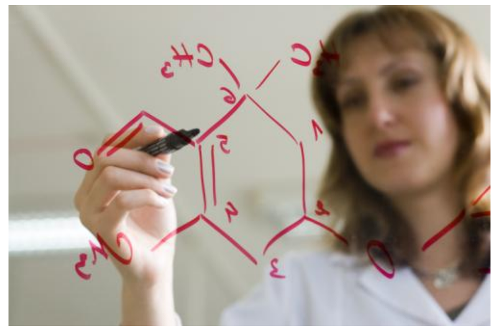
Traditionally, refiners could get 19 gallons of gasoline and another ten gallons or so of diesel from each 42-gallon barrel of crude oil. The rest goes to "residual" heavy fuels and things like tar and asphalt. Gasoline and diesel are the most in demand, for obvious reasons, and yield the highest profit for all involved.

But these refined or "distillate" fuels produced tend to not be as high quality as in the past because of a couple of factors.

First factor - the quality of the crude itself is lower. We've spent decades pulling out high volumes of crude oil from the ground, and not all crude is the same from different parts of the world. Some crude oils, such as the "sweet" crude from Saudi Arabia, is very high quality and highly desired. It's cheap and easy to refine, and yields very high quality fuels after it's been refined.

Bell Performance, Inc. tel 407-831-5021
1340 Bennett Drive fax 407-331-1125
Longwood, FL 32750
www.bellperformance.com
www.WeFixFuel.com

Compare that to the crudes pulled from Russia or Venezuela or the North Sea; those crude oils can be dirtier and harder to refine, which means less yield for gas and diesel. The bottom line here is that we've already gone through so much of the "good stuff" in the ground that we're trying to figure out how to refine the "bad stuff" without losing anything in terms of fuel volume produced.



Second factor - to maximize the gas and diesel from each barrel, refineries use cracking methods to split apart the heavier molecules of the crude oil into more of the smaller molecules that go into making up gas and diesel. Through cracking, refineries can get more gallons of gas and diesel out of each barrel of crude oil. But this comes at a cost because those molecules aren't "exactly" like conventional gas and diesel molecules. They're the same size, but because of the reactions needed to break them apart, they're not as stable as virgin fuel molecules.

The implication for today's fuels is that they have a shorter shelf-life than before, are more unstable, and more apt to react with things like air and water to go bad more quickly than before. The average person who remembers what gas and diesel were like in the 50s, 60s and 70s would probably describe today's fuels as "not burning as cleanly".

Gasoline Is Cleaner, But Only Because of Ethanol

Of course, hearing the average person describe today's fuel like that belies the fact that today's fuels are engineered to be cleaner, but only because of what's added to them that wasn't before. At least, if you're talking about gasoline.

The Clean Air Act of 1992 paved the way for mandates that created a slew of "reformulated" gasoline blends. These became required by law for use in areas of the country with particularly bad air quality. As part of this, oxygenates became required additions to on-road gasoline. An oxygenate is something that increases the amount of oxygen contained in the fuel. More oxygen in the fuel leads to better and more efficient combustion, but only in terms of the combustion products produced when it is burned. It doesn't mean better mileage for the machine using it. And that's really all the EPA was concerned about – improving air quality.

There are many kinds of chemicals that can function as oxygenates – alcohols, ethers, esters. Not all of them are feasible to actually be used in this manner, because any oxygenate to be used in billions of gallons of fuel across the country has to be inexpensive to produce and transport.

The first widespread oxygenate in this context was MTBE. At its peak in the mid-1990s, over two million gallons per day of MTBE were being blended into gasoline. But they soon found that it was contaminating ground water, thus causing it to be phased out. Something had to replace it, and that something was ethanol.

Ethanol is a small alcohol molecule (two carbons plus an oxygen) that contains a high amount of oxygen. When blended into gasoline at a given percentage, it increases the oxygen content of the gasoline and improves the emissions. Unfortunately, this also means lower mileage for consumers and a slew of other problems stemming from some of ethanol's less-desirable qualities:

Bell Performance, Inc. **tel** 407-831-5021
1340 Bennett Drive **fax** 407-331-1125
Longwood, FL 32750
www.bellperformance.com
www.WeFixFuel.com

- Corrosion to metal parts
- Dissolving of rubber and plastics
- Interference with fuel lubrication in small engines
- Water absorption

The last one is a big one when you're comparing how today's fuels aren't what they used to be. Ethanol absorbs water from the environment, and water is one of those things (along with oxygen, light and heat) that accelerates the breakdown of stored fuel. And not just breakdown – absorption of water by ethanol blends also leads to phase separation where the alcohol falls out of solution with the gasoline and strips the gas of its octane content, ruining its quality. Which means that the storage life of common ethanol gasoline is a lot closer now to 30 days than to the 6 months or one year that it used to be, 30 years ago.

This all appears to be a pretty raw deal for the consumer. Gas costs three or four times (or more) what it used to, and it used to last three or four times longer than it does now. And the mileage with E10 gas in 2014 is probably 10% less than it was in 1984 because the E10 gas has less energy content than pure gasoline fuel. The only consolation there is that vehicles are so much more efficient now – lighter weight, better designed, more efficient yet more powerful engines – that some of this mileage loss isn't really noticed. But imagine what kind of mileage you could get if you took a 2014 car and took it back to the gas station in 1984 for a fill-up.

Diesel Doesn't Last As Long, Either

Diesel fuel itself has undergone big changes like gasoline has, but diesel's change has more to do with what's not in it than what's in it. The big change for diesel happened around 2006 when EPA regulations led to the removal of most of the sulfur content of the fuel. Sulfur occurs naturally in crude oil (along with other metals like aluminum, calcium and iron). So, naturally, sulfur has always been a part of refined diesel fuel (gasoline is lighter than diesel and thus escapes sulfur content, by and large). And sulfur has always provided some benefits. Sulfur content helps contribute to diesel lubricity by lubricating moving parts like injectors and fuel pumps. And sulfur also acts like a natural biocide, meaning that its presence in the diesel fuel makes it very difficult for bacteria and fungus to infect the fuel and grow.

All of this went away in the mid-2000s as refineries were mandated to remove 97% of the sulfur content, down to just 15 ppm. This was following an initial sulfur reduction that happened in the early 1990s that took sulfur content in diesel from 5,000 ppm to just 500 ppm. A 99.7% reduction in harmful fuel sulfur over a 25 year period. Great for the environment.

How did the industry react to these mandates? Consumers were initially most concerned about the effects on the fuel's lubricity and how it would affect important parts like fuel pumps and injectors. These parts traditionally rely on lubrication from the fuel to keep them from burning out prematurely. Removing the fuel sulfur created great concern that these parts would be adversely affected. But the market responded to this problem by demanding that fuel suppliers add lubricity treatments to the fuel at the refinery – fuel additives that would essentially replace

Bell Performance, Inc. **tel** 407-831-5021
1340 Bennett Drive **fax** 407-331-1125
Longwood, FL 32750
www.bellperformance.com
www.WeFixFuel.com

the lost lubricity and take the fuel back to what it used to be. So while some consumers did experience burned injectors and lubricity problems, the nation as a whole escaped these problems.

Not so for microbe problems in stored fuel. Removing the sulfur removed the biggest thing that kept fuel microbes at bay. Even now, diesel fuel storage tanks around the country battle microbial infestations in their ultra-low sulfur diesel (ULSD). And the symptoms are hard to miss – plugged fuel filters, storage tank corrosion, and a reduction in the length of storage life for ULSD.

Bringing Fuel Back To The Way It Used To Be

Now that we see that fuels have changed for the worse, we need to seek solutions for the resulting problems. And the marketplace seems to have a remarkable ability to come up solutions to problems.

- Lubricity additives to restore diesel fuel lubricity to its former levels
- Biocides to kill and prevent costly microbial infestations in stored fuel
- Antioxidants to extend the storage life of diesel and gasoline shortened by refinery cracking methods
- Ethanol multi-functions that control water (to prevent phase separation) and protect metal, plastic and rubber parts from ethanol solvency

Most of these treatment options are preventive, being added when the fuel is fresh in order to prevent problems. A biocide is the only one that can be added after the (microbial) problems have manifested. All of these problem-solving treatments are created to be cost-effective enough so as to allow fuel treatment for pennies or fractions of a penny per gallon of fuel.

For more information on this topic, as well as fuel treatment options that prevent problems and put money back in your pocket, visit us at www.WeFixFuel.com.