FAQs

GASOLINE

1. What factors influence your mileage?

The main factor that influences mileage is the variability of the driving cycle. Mileage can vary because of several factors such as weather, driving speed, driving style, traffic conditions and road conditions. For example, EPA has estimated that poor road condition (gravel, curves, slush, snow, etc.) can reduce mileage by 4.3%, congested traffic can reduce mileage by 10.6%, acceleration rate can reduce mileage 11.8% and there are other factors that can combine to reduce mileage. Thus taking mileage measurements based on one tank of gas can give somewhat misleading results if that tank was used mostly for one type of driving (a highway trip, for example) as opposed to another type (like city driving).

Extra load on the engine can reduce mileage. Fuel economy decreases approximately 2.8 mpg (15%) for all cars when running the air conditioner. Towing a boat or trailer, loading with equipment and luggage and transporting a full load of passengers can lower mileage. Poor maintenance, improper tire inflation or poor tire condition can also affect mileage. If several of these negative factors combine, the reduction in mileage can be quite noticeable.

The energy content and therefore mileage of gasoline can vary somewhat, but this is a smaller factor that those mentioned above. If a customer uses conventional gasoline without oxygenates such as ethanol or ethers (i.e. MTBE) and switches to an oxygenated fuel, the energy content and mileage may be reduced by 2 to 3% depending on the amount of oxygenate in the gasoline. This amount of change would be difficult to measure tank to tank.

Energy content can also vary from summer to winter blends by a small amount, about 1%. Butane is blended in gasoline to help cold starts during the winter. Addition of butane lowers the density and the energy content.

2. Why do we blend oxygenates in gasoline?

In 1979 as lead in gasoline was being phased out oxygenates like methyl tertiary-butyl ether (MTBE) and ethanol have been added as octane enhancers. In 1990 the Clean Air Act Amendments (CAA) were enacted. One of its provisions was to require the use of oxygenates in the wintertime in cities that have high levels of carbon monoxide pollution. Oxygenates help to complete the combustion process in the engine to form carbon dioxide. Older engines, in particular, needed the additional oxygen to run leaner to reduce the amount of carbon monoxide that they produce.

The CAA also required reformulated gasoline (RFG) beginning in 1995 for cities that had substantial ozone pollution. The ozone is formed when pollutants react chemically in the presence of sunlight. Reformulated gasoline is designed to lower the emissions from automobiles that can add to the ozone formation. RFG is effective in reducing ozone, but the addition of oxygen does not appear to be essential for maintaining this benefit. Low sulfur levels and low vapor pressure are much more effective gasoline parameters for reducing ozone.

Ethanol and MTBE are the most widely used oxygenates. Ethanol may be blended up to 10 volume percent, and MTBE may be blended up to 15 volume percent.

Beginning in 1996 the automobiles sold in the United States had On Board Diagnostics-II (OBD-II). This technology is used to manage and monitor the operation of the engine, transmission, and emissions control components. Rather than monitor what is coming out of the tailpipe, the OBD-II reduces emissions caused by emission related malfunctions, by monitoring virtually every component and system that can affect emissions during normal driving. It controls the amount of gasoline that is added to the engine cylinders to optimize the air/fuel ratio for maximum engine efficiency and to reduce emissions. This optimum air/fuel ratio can readily be reached without the addition of oxygenates.

What is MTBE?

MTBE is methyl tertiary butyl ether. It is blended in gasoline because it is an octane enhancer and provides additional oxygen to help complete the combustion process. MTBE is banned in California, Connecticut and New York because of ground water contamination issues.

Why reduce the sulfur content of gasoline to 30 ppm?

The EPA traditionally divided automotive emissions into four broad areas: hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM). In gasoline engines, PM is relatively small, and the other three classes of emissions are reduced by use of catalytic converters, called (logically enough) "three-way catalysts" (TWC). Such catalysts work by:

1. Oxidizing carbon monoxide to carbon dioxide,
2. Oxidizing hydrocarbons to carbon dioxide and water,
3. Reducing nitrogen oxides to nitrogen and carbon dioxide and/or water.

As might be expected, the chemistry occurring within a catalytic converter can be quite complex. The simultaneous requirements for both an oxidizing and reducing atmosphere narrows the air/fuel ratio in which the engine operates, so that practically the best engine operation as far as emissions is concerned is when the air and fuel are present at stoichiometric quantities, or when there is just enough oxygen to combust the fuel, with neither an excess of fuel nor oxygen. Any air/fuel ratio outside this narrow band causes one or more of the three emissions to increase. In order to control the air/fuel ratio to this narrow band, cars built since the early 1980's have been equipped with on-board diagnostics (OBD), which include sensors such as oxygen sensors and the associated electronics. Vehicles since 1996 have been equipped with the more advance OBD II systems.

One of the effects of OBD ability to operate at correct stoichiometry has been the lessening of concern over CO emissions after the catalyst, as CO traditionally was formed at stoichiometry on the rich side (low air/fuel ratio). Accordingly, current automotive emissions regulations are chiefly concerned with three classes of emissions: NOx, Volatile Organic Compounds (VOC), and Toxics, which include such substances as benzene and various aldehydes.

Sulfur has a negative effect on several aspects of vehicle emissions.

1. Direct emissions, typically sulfur dioxide but also other oxides of sulfur or hydrogen sulfide, depending on conditions.

2. Catalyst effects, involving reaction of the combustion products to form sulfates and sulfides, which bond to the catalyst itself. These catalyst poisons physically block catalytic sites and reduce efficiency. Such poisoning, however, is a reversible phenomenon, so that typically a catalyst will be operate at steady state as the car goes through normal driving cycles.

3. OBD effects, wherein catalyst sensor poisoning can lead to OBD reaction delay time, further increasing emissions by causing a mismatch between what the OBD sees as the proper air/fuel ratio and the actual operating conditions. Further, as the OBD systems are calibrated using fuels

with a particular sulfur range, operation of the vehicle with fuels outside of that sulfur range may lead to false positive warnings from the OBD system.

Quantitatively, the effect of sulfur levels in fuel was studied in two wide-ranging programs during the mid-1990s: the U.S. Auto/Oil program and the European Program on Emissions, Fuels and Engine Technologies (EPEFE). Within the Auto/Oil program, a decrease of fuel sulfur from 466 to 49 ppm gave the following emissions changes:

HC decreased 13.9 %
CO decreased 11.4 %
NOx decreased 8.3 %

The EPEFE obtained similar results, whereby a decrease of fuel sulfur from 382 to 18 ppm gave the following emissions changes:

HC decreased 8.4 %
CO decreased 8.6 %
NOx decreased 10.1 %

In the U.S., regulatory activity has been designed to bring the fuel sulfur levels down in a stepwise fashion from a current maximum of 1000 ppm (500 ppm for Reformulated Gasoline) to a level of 30 ppm by the year 2006.

Why are octane ratings lower at high altitude areas?

Lower octane number is required for carbureted engines at high altitudes because the lower air density results in lower combustion pressures and temperatures, the fuel/air ratio becomes richer due to the lower air density, and the spark advance is less due to lower manifold vacuum.

Knock sensors and altitude compensators in fuel-injected engines have lowered the octane requirement reduction at increasing altitude. Studies show an average altitude difference of 0.2 and 0.5 (R+M)/2 per 1000 ft (300 m). Consumers may experience slight power and acceleration reductions.

Why add detergent additive in gasoline?

The Environmental Protection Agency (EPA) in 1995 required gasoline to contain deposit control additive. Deposits on port fuel injectors and intake valves may increase volatile organic compounds (VOC) exhaust emissions.

Conoco, Phillips 66 and Union 76 PROclean gasolines contain detergent additives that clean the engine’s fuel injectors and intake valves. PROclean gasoline additive levels far exceed the EPA standard that was adopted to control vehicle emissions. Continued use of PROclean gasoline will clean up deposits left by problematic gasolines over time. PROclean gasoline helps reduce hesitation, gives smooth acceleration, helps make your vehicle more responsive, and restores and maximizes performance.

PROclean gasoline is designed to meet gasoline detergency requirements of most vehicle manufacturers around the world.

What does octane rating mean?

The octane rating is the measurement of a gasoline's resistance to pinging or knocking. The antiknock index or (R+M)/2 is the average of the research octane number and the motor octane number. A single-cylinder engine measures the antiknock level. The research octane number indicates the fuel's antiknock performance in engines at wide-open throttle and low-to-medium speeds (mild operating conditions). The motor octane number indicates antiknock performance at wide-open throttle and high speeds (severe operating conditions) and at part-throttle, road-load conditions.

What causes knocking or pinging?

Knock or ping occurs during the gasoline burning process when combustion chamber temperature and pressures become very extreme and pockets of yet unburned gasoline and air explode. This tiny explosion sends shock waves that oppose the burning fuel flame front, causing an audible knock. An occasional knock or ping should not cause problems, but consistent or very loud knocking may cause serious engine damage.

How long can I store gasoline?

Gasoline may be stored for one year if it is properly kept in a container approved by the Underwriters Laboratories (UL). Plastic containers are preferred to avoid rust formation if the fuel gets contaminated with water or if the container is kept in a moist area.

The container should be 95% full and sealed tightly to reduce evaporation and water contamination. It should be kept out of direct sunlight and below 80 °F. Gasoline is flammable and must be kept away from spark or ignition sources. Consult with the local fire department for further safety and storage requirements.

Addition of fuel stabilizers and deposit-control additives may help prolong storage of gasoline. These additives may be purchased at the gas station or automotive stores. These additives work best when added into fresh gasoline. Follow the recommended dosage and mixing instructions provided by the manufacturer.

What is MMT?

MMT is methylcyclopentadienyl manganese tricarbonyl. It is an octane enhancer widely used in Canada. There is current debate regarding MMT as a potential contaminant in catalyst and other vehicle systems. ConocoPhillips does not add MMT in gasoline.

How does gasoline volatility affect vehicle performance?

Gasoline is seasonally blended for optimal performance during the summer and winter months. Gasoline volatility properties (vapor pressure, vapor-liquid ratio and distillation) affect cold and hot starts, acceleration, hesitation, stalls and other performance issues. These performance issues are typically experienced during the spring and fall seasons when gasoline supply is transitioning from winter to summer grade, and vice versa.

Vapor lock occurs during high operating temperatures when gasoline boils in the fuel pump, lines, or carburetor and forms vapor that decreases the gasoline flow to the engine. Loss of power, rough engine operation, hard hot starting may result because of this flow reduction. Vapor-liquid ratio (V/L) is the ratio of the volume of vapor formed at atmospheric temperature to the volume of fuel. Vapor lock tends to occur at the gasoline temperature at which the V/L is approximately 20.

Gasoline with low volatility properties during cold operating temperatures may cause hard starting and poor warm-up performance.

Driveability Index (DI), also called Distillation Index, is another parameter that describes gasoline volatility and is defined by the following equation:

$$DI = 1.5*T10 + 3.0*T50 + T90$$

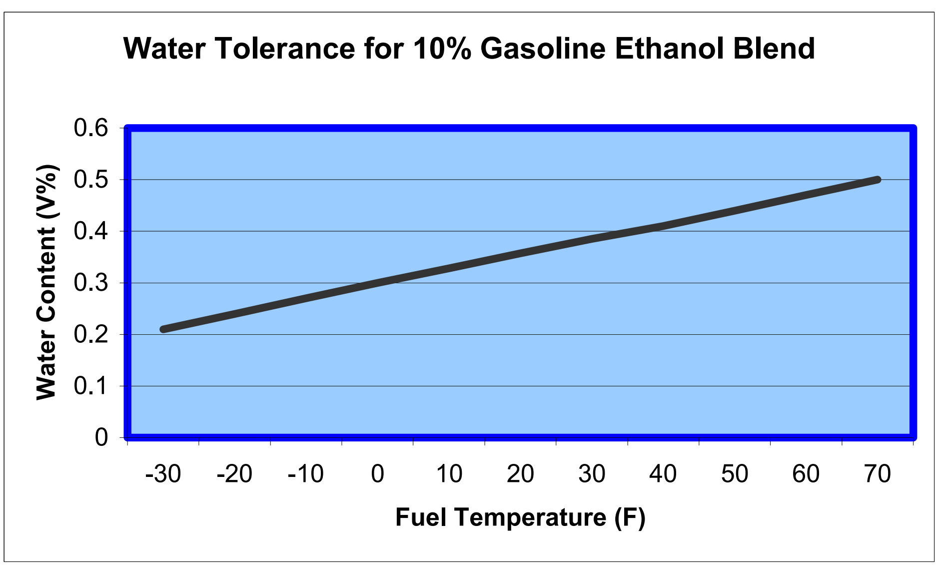
where T10 = temperature (°F) at which 10% of the fuel is vaporized
T50 = temperature (°F) at which 50% of the fuel is vaporized
T90 = temperature (°F) at which 90% of the fuel is vaporized

Driveability Index quantifies the relationship between driveability and gasoline distillation properties. T10 represents the fuel's ability to vaporize quickly and enable cold starting. T50 and T 90 represent the heavier gasoline components' ability to vaporize as the engine warms up and be burnt during combustion. Poor vaporization leans the vapor air-to-fuel ratio in the combustion chamber and leads to loss of engine power and roughness, and increases engine hydrocarbon emissions. The DI maximum allowed at the refinery gate will vary seasonally, up to the 1250 maximum that would be allowed in areas that have hot summers.

What is phase separation?

Phase separation occurs when the gasoline water content exceeds the maximum amount of water that the fuel can dissolve, and the excess water drops out of solution to form a gasoline layer and a water layer. Gasoline containing ethanol will dissolve more water than conventional gasoline because ethanol dissolves water readily. An ethanol-water layer is formed when an ethanol-blended gasoline undergoes phase separation. Phase separation is temperature sensitive as shown in Graph 1. Excess water will cause a phase separation significantly larger than the volume of water the gasoline / ethanol blend is exposed to. For instance, if a 10 V% gasoline ethanol blend is contaminated with 0.5 V% water at 60°F, the resulting water phase will be roughly equivalent to 9 V% of the original gasoline ethanol blend. This is why it is vitally important to keep water away from gasoline ethanol blended fuels.

GRAPH 1



DIESEL

What is cetane number?

Cetane number is a measure of the ignition quality of distillate fuels. It is measured using a single-cylinder engine that determines the compression-ignition quality. Higher cetane value improves cold start performance, reduces noise and may reduce emissions. An increase in cetane number above the engine's requirement may not improve performance. A cetane number of 40 is the current U.S. minimum requirement for diesel fuel.

What is lubricity?

The EPA mandate to reduce emissions from diesel engines by lowering the sulfur to 15 ppm has prompted studies in regards to fuel pump wear and fuel lubricity. Hydrogen treating (or hydrotreating) is the most common process used by many refineries to reduce the sulfur content of diesel fuels. Sulfur and nitrogen-containing compounds and heavier compounds including heavy aromatics that are natural lubricating agents are reduced or removed under severe hydrotreating. Fuels with reduced levels of these compounds can cause accelerated wear in pump and injection systems. Catastrophic fuel injection failure can occur as experienced in Sweden in 1991 when low sulfur and low aromatics diesel fuel was introduced. Although technology exists that can manufacture injection and pump systems that can tolerate lower lubricity fuels, it is essential that existing fleets that do not have these advanced systems be protected by providing fuel with sufficient lubricity.

Diesel fuel lubricity is a characteristic that has a significant effect on fuel pump wear. Since the pumps have to be designed with close clearances in the areas where the fuel is being pushed, there is some potential for the surfaces of the pumps to contact, causing wear. Since it is the fuel that is being pumped, the fuel must act as its own lubricant. It has been found that the lubricating properties of the fuel are somewhat enhanced by:

1. The sulfur-containing compounds in the fuel
2. The nitrogen-containing compounds in the fuel
3. Some of the heavier compounds in the fuel (including heavy aromatics)
4. The inherent viscosity (resistance to flow) of the fuel

Since Ultra-Low sulfur diesel fuel requirements affect some of these characteristics, the introduction of such fuels has caused lubricity concerns. However, it appears highly likely that greater use of lubricity additives will solve the lubricity problems resulting from diesel fuel hydrotreating.

What is "winterized" diesel?

Diesel is seasonally blended for optimal performance during winter. Diesel contains waxy components that may solidify or gel at low temperatures and plug fuel lines and filters. A diesel's cold flow performance is typically determined by measuring its cloud point. The cloud point is the temperature at which the first formation of wax is observed. The lower the cloud point the better the fuel will perform at colder temperatures. Addition of kerosene/No. 1 diesel is traditionally blended into diesel to improve the cold flow performance because kerosene has a cloud point below –40 °F and dilutes the diesel's wax components.

Cold flow improver (CFI) additives may be added to the fuel to improve its cold flow performance. These additives alter the size and formation of waxes, and allow the fuel to flow well below its cloud point. The performance of these additives is determined by measuring the fuel's Cold Filter Plugging Point (CFPP). CFPP is the temperature at which the fuel will no longer pass through stainless steel wire mesh gauze with a 45 μm (micrometer) nominal aperture size.

Diesel that contains a CFI additive may look hazy and show gelling characteristics at extremely low temperatures, but the additive will allow the fuel to flow.

Diesel that is contaminated with water may cause a "gelling problem" at or below 32 °F. The problem is actually an icing problem where the ice crystals plug fuel lines and filters. It is important to maintain a clean and water-free diesel tank.

Local marketers typically blend diesel with either kerosene/No. 1 diesel or cold flow improver additive to conform to the prevailing local weather conditions. Consumers may also add additional kerosene for added protection if traveling to a colder region or expecting abnormally low ambient temperature. Caution. Blending with additional kerosene/No. 1 diesel may lower the fuel's lubricity and may cause fuel pump wear.

Consumers may also add CFI additives that can be purchased at the gas station or automotive stores. These additives work best when added into fresh diesel. Follow the recommended dosage and mixing instructions provided by the manufacturer. Caution. Check if the off-the-shelf additive is compatible with the CFI additive package already in the fuel to avoid operability problems.

ConocoPhillips markets diesel with a cold flow improver additive package in certain markets. Table 1 lists the areas and CFPP targets. We cannot guarantee that the fuel will perform at lower than expected temperatures.

TABLE 1

LOCATION	STATE	CFPP TARGET, °F
DENVER	CO	-25
LA JUNTA	CO	-15
BETTENDORF	IA	-15
DES MOINES	IA	-15
DECATUR	IL	-15
EAST ST LOUIS	IL	-15
KANKAKEE	IL	-15
INDIANAPOLIS	IN	-15
KANSAS CITY	KS	-15
WICHITA	KS	-15
JEFFERSON CITY	MO	-15
RIVERSIDE	MO	-15
BILLINGS	MT	-25
MISSOULA	MT	-25
ALBUQUERQUE	NM	-15
BLOOMFIELD	NM	-15
AMARILLO	TX	-15
SPOKANE	WA	-25
ROCK SPRINGS	WY	-25
SHERIDAN	WY	-25