



USE OF REFORMULATED GASOLINE IN OFF-ROAD ENGINES

United States Environmental Protection Agency

The 1990 Clean Air Act (Act) requires the Environmental Protection Agency (EPA) to issue regulations that would require gasoline to be "reformulated" so as to result in significant reductions in vehicle emissions of ozone-forming and toxic air pollutants. The regulations were subsequently developed through negotiations with industry, federal and state governments, and environmental and consumer groups. The resulting gasoline, called reformulated gasoline (RFG) is cleaner burning and provides the same automotive engine performance characteristics as conventional gasoline.

The primary goal of the reformulated gasoline program is to reduce vehicle emissions that contribute to the formation of smog, a noxious pollutant that is harmful to human health and the environment, and reduce toxic emissions from vehicles such as benzene, a known human carcinogen. RFG is required to be used in nine major metropolitan areas of the United States with the worst ozone air pollution problems. In addition, many other areas with ozone levels exceeding the public health standard have recognized RFG as being a cost-effective measure for protecting public health and have voluntarily chosen to use RFG.

There are hundreds of different formulations for making gasoline. The composition of RFG represents a subset of those formulations and is essentially no different from conventional gasolines. RFG and conventional gasoline differ only in the average levels at which ingredients are used. Specifically, RFG has lower levels of certain compounds that contribute to air pollution, does not evaporate as readily as conventional gasoline during the summer months, and contains "chemical oxygen" (oxygenates).

Oxygenates have been used in some gasolines since the late 1970's and began seeing expanded use in the early 1980's. At that time, little technical data about the use of gasoline ethanol blends in off-road equipment (e.g., snowmobiles, snow blowers, boats, lawn and garden equipment) was available, and there was little field experience upon which to base decisions regarding its use in such applications. Rather than expending large sums of money testing a fuel that, at the time, comprised so little of the market, some manufacturers advised consumers to avoid it. However, by the late 1980's, certain regions of the country began adopting mandatory oxygenated fuels programs in the winter months to reduce carbon monoxide exhaust emissions, prompting many manufacturers to take a serious look at the

effects of oxygenated fuels on engine performance and durability. The results of several studies showed that oxygenated fuel had no apparent affect on engine performance or durability, and that certain oxygenates used at the legal limits will not have a detrimental affect on engine performance or durability as long as the engine is properly maintained.

Recently, EPA has had discussions with various manufacturers of off-road engines who have confirmed that using oxygenated fuels is acceptable, although some manufacturers offer special instructions when operating equipment on oxygenated fuels. While manufacturers' recommendations vary for the type of oxygenate that should be used in various applications, a report published in November 1994 by Downstream Alternatives, Inc. (DAI) of Bremen, Indiana, revealed that most off-road engine manufacturers permit the use of oxygenated fuels not to exceed 10% ethanol or 15% methyl tertiary butyl ether (MTBE) by volume.¹

The following are discussions of some concerns that have commonly surrounded the use of oxygenated fuels in off-road equipment:

Materials Compatibility: Materials compatibility is largely a concern with gasoline blends containing alcohols (i.e., ethanol and methanol, although methanol is not used as an oxygenate in RFG). As the use of oxygenated fuels began to expand in the early 1980's, some manufacturers found it necessary to upgrade a few of the materials used in their fuel systems so as to be compatible with the new alcohol blends of fuel. Although newer engines should be largely unaffected by proper oxygenated fuel formulations, some manufacturers are concerned that seals and gaskets on older equipment that have not been previously exposed to alcohol-oxygenated fuels could experience leakage. In any event, EPA recommends that equipment be maintained as specified by the manufacturer to ensure that seals and gaskets are in good condition.

Lubricity: In the past, there have been concerns that gasoline containing ethanol may not provide adequate lubricity, especially in two stroke engines/equipment. However, there is no technical data to support such a position. In fact, the limited data available indicates that properly formulated gasoline ethanol blends may provide slightly better lubricity.

Enleanment: The addition of oxygenates to gasoline has the effect of enleaning the air/fuel mixture slightly on engines that do not adjust to optimize the air/fuel ratio. Fuel metering components are sized to deliver an air/fuel mixture that optimize power output, fuel economy, and durability. Engine manufacturers are aware of the air/fuel sensitivity of their engines and in some cases, they recommend alterations to certain engine models when using oxygenated gasoline. For example, in engines set at an air/fuel ratio of 14.7:1 on all hydrocarbon fuel, the

By law, gasoline may not contain in excess of 10% ethanol by volume or 15% MTBE by volume. Therefore, gasolines containing oxygenates above the manufacturer's recommended level should not be available in the marketplace.

introduction of 2.7% weight oxygen² in the fuel would enlean the ratio to about 15.15:1, which is a relatively small change. If an engine operates at a mixture that is significantly leaner than it is designed for, it runs at a somewhat higher temperature, which has led to concerns that engine damage could result. Virtually all off-road engines are two-stroke and usually operate at air/fuel ratios that are rich enough to not be affected by the addition of oxygen. Some manufacturers of recreational vehicles, such as snowmobiles, offer recommendations for modifying engines when operated on oxygenated fuels. Consumers should be advised to consult their owners manual or servicing dealer to determine if any modifications are recommended.

Phase Separation: Years of experience on essentially identical fuels have resulted in this concern being minimized. Since gasoline and water do not mix, even small amounts of water in pure gasoline will result in a separate phase of water in a fuel tank which, if pumped into the engine, could cause damage. The oxygenated gasolines, primarily the alcohol blends, will tend to dry out fuel tanks by blending with the water allowing it to be combusted in the engine. This is the same principal behind the "dry gas" additives sold over the counter to prevent water in fuel from causing engine problems. Only with comparatively large amounts of water in alcohol-blended gasoline will a separate alcohol/water phase occur. Many manufacturers have specific recommendations for preparing equipment for storage during the off-season, especially if the equipment has been fueled with alcohol fuels.

In summary, there is a wide range of recommendations by manufacturers for the use of oxygenated fuels depending on the specific engine application. Consumers should focus primarily on what the equipment manufacturers recommend. However, since reformulated gasoline is no different from a sizeable portion of gasoline that has already been sold in the marketplace around the country for many years, the lack of problems in the past should provide great confidence with reformulated gasolines now and in the future. One thing is certain though-the reformulated gasoline program is a critical step toward EPA's goal to protect human health and the environment.

Reference

"The Use of Oxygenated Gasoline in Lawn & Garden Equipment, Motorcycles, Boats & Recreational Equipment," by Downstream Alternatives, Inc., DAI Informational Document #941101, November 1994.

2.7% oxygen by weight is the minimum requirement for gasoline sold in areas with a wintertime oxygenated fuels program as required in section 211(m) of the Clean Air Act. Reformulated gasoline has a lesser requirement for oxygen content with a minimum of 2.0% oxygen by weight.