Ethanol Compatibility with Fiberglass UST Systems

Sullivan (Sully) Curran P. E., Executive Director

I. Introduction and Background

The purpose of this paper is to provide Institute manufacturers of fiberglass tanks and piping compatibility information with oxygenated gasoline motor fuels i.e., Methyl tertiary butyl ether (MTBE) and alcohol. However, certain states banned the gasoline additive MTBE (e.g. California and New York), and expanded the use of E-10 ethanol motor fuel to a maximum of 10 percent ethyl alcohol in gasoline. In addition, other states, particularly in the Midwest, historically used ethyl alcohol blends in motor fuels. Thus, the market share of ethanol motor fuel grew from virtually zero in 1978 to 7 percent in 1986, and is 100 percent today for all gasoline motor vehicles including non-road engines such as consumer products (e.g., property care equipment) and non-road vehicles (e.g., marine vessels). Although this represents a significant volume of ethanol stored and dispensed through the pre-1978 population of underground storage tanks (USTs), experience shows that fiberglass USTs and piping that stored conventional gasoline or MTBE added gasoline should perform equally well when handling E-10 ethanol.

II. Other Considerations

However, the introduction of ethanol into the marketplace raises the following other considerations:

1. **Vehicle Turnover:** With vehicle turnover averaging 20 years or more, there are both old and new automobile fuel handling systems that must be compatible with oxygenated motor fuels and additives. For this reason, early on the U.S. Environmental Protection Agency (EPA) provided consumer protection by limiting the amount of ethyl alcohol in motor fuel to 10 percent. If this EPA limit is exceeded, automobile manufacturers may void their warranties for non-flexible fuel vehicles.
2. **Non-road Engines:** Fuel systems for non-road engines and non-road vehicles were originally designed for conventional or MTBE blended gasoline and such older engines are typically not compatible with ethanol blended fuels.
3. **Fuel Dispensing Systems:** The elastomers in fuel dispensing equipment, other than tanks and piping, are often more vulnerable to fuel base-stock and additive changes. This includes Buna-N gaskets, "O" rings, and submerged metals such as aluminum, copper, and black or cast iron. Thus, for older dispensing equipment it is prudent to consult the manufacturer of dispensers, pumps, monitoring systems, nozzles and swivels when making changes in stored fuels.
4. **Hazardous Substance Storage and Piping**: EPA requires that methanol blends exceeding 5 percent methyl alcohol meet hazardous substance storage and piping requirements and be secondarily contained. Thus, all double-wall fiberglass tanks and piping have been manufactured for storage of 100 percent ethyl and methyl alcohol since 1988 for piping and 1990 for tanks.
5. **Tank Truck Loading:** Ethyl alcohol, because of its affinity for water, is not blended into gasoline until it is loaded into the delivery tank truck. American Petroleum Institute member companies address the need to control the ethanol blend component in API RP 1626 *Storing and Handling Ethanol and Gasoline-Ethanol Blends at Distribution Terminals and Services Stations* that states: "In-truck blending is not recommended since complete blending may not occur." Thus, so-called "splash-blending" ethyl alcohol into gasoline (ethanol) in tank trucks is not recommended since the ethyl alcohol/gasoline components tend to stratify and remain stratified after delivery to the

refueling facility. As a result, the gasoline dispensing pump may pick up a high concentration of stratified ethyl alcohol, damage the automobile engine and not be covered under the vehicle warranty.

6. **Tank Bottom Bottoms:** The accumulation of water from condensation in the bulk gasoline transportation and storage system is absorbed by the ethanol blended fuel and, being heavier than the fuel, accumulates on the tank bottom. American Petroleum Institute (API) Recommended Practice (RP) 1621 *Bulk Liquid Stock Control at Retail Outlets* recommends the removal of tank water bottoms for such gasoline's when the water bottom level exceeds one inch.
7. **Microbial Induced Corrosion (MIC):** The affinity of ethyl alcohol for water is a strong reason to follow API RP 1626 and remove any water from tank bottoms. E-10 is known to absorb 0.5 percent water into a solution at room temperature or less when colder, the water reduces the motor fuel BTU content and octane rating, again affecting the consumer. When E-10 absorbs more than +/ - 0.5 percent of water, a "phase-separation" will occur as the ethyl alcohol begins to drop out of the gasohol solution into the bottom of the tank. This phase-separated alcohol/water bottom is oxygen rich and promotes the growth of aerobic bacteria colonies. Such bacteria colonies are detrimental to petroleum fuels and will cause Microbial Induced Corrosion (MIC) of certain fuel handling metallic components. This includes metallic striker plates that are not encapsulated in a corrosion resistant material such as fiberglass. In summary, while tank bottom water removal is a good housekeeping practice and there is a companion growth of bacteria colonies accompanied by MIC, experience has shown that this does not have an adverse long term effect on the fiberglass tank's lifespan.

II. Underwriters Laboratory

While E-10 ethanol entered the marketplace in 1978, Underwriters Laboratory (UL) did not include gasohol and methanol fuels in their material compatibility testing protocol, until later. As a result the UL Listing for fiberglass tanks and piping included ethanol in 1981 and 1988 respectively (i.e., UL 1316 and UL 971). Thus, in 1978, when E-10 gasohol was first introduced, there were some 100,000 fiberglass USTs in conventional gasoline service, before the UL listing process included gasohol in their compatibility testing protocol.

Therefore, the early users of fiberglass tanks and piping (i.e., major oil companies) and fiberglass tank and pipe manufacturers conducted independent studies to determine the effect of E-10 ethanol on the fiberglass material used to manufacturer in-service USTs. It was determined that the fiberglass components used in pre-1981 tanks and pre-1988 piping were essentially the same as those subjected to UL compatibility testing and there was no technical reason to believe that the older USTs were not E-10 compatible.

In 1992, Owens Corning, the manufacturer of the oldest UL Listed fiberglass tanks for petroleum service, advised certain major oil companies that some tanks were approaching 30 years in age and their 30-year warranties would expire. As a result, the affected companies conducted surveys of these older tanks, including tanks in E-10 ethanol service (e.g., in the Midwest) and confirmed that the tanks were performing satisfactorily for continued service. In summary, technical evaluations and historical experience demonstrated that there is no material or technical reason why properly installed pre-1988 piping and tanks in conventional gasoline or MTBE service should not perform equally as well when handling 10 percent ethanol blends.

III. E-10+ and E-85 Compatibility

1. **Fiberglass Piping:** Underground fiberglass piping and fittings installed in service stations have been compatible with up to 100%-percent ethanol for over 40 years.
2. **Fiberglass Tanks:**
   A. **1983** - The September 1983 issue of the Underwriters Laboratories (UL) Gas & Oil Equipment Directory includes multiple manufacturers with listings for fiberglass "non-metallic tanks for petroleum products, alcohol's and alcohol-gasoline mixtures." The UL use of the term "alcohol's and alcohol-gasoline mixtures" is defined in UL standard 1316 to include fuels with any level of ethanol or methanol up to and including 100%.
   B. **1988** - In 1988, UL began listing underground fiberglass piping for 100% ethanol and methanol.
   C. **1990** – By 1990, Institute member fiberglass tank manufacturers had modified their tanks constructions to handle gasoline with any level of ethanol or methanol up to 100% for all double-wall fiberglass tanks and in some cases single- wall fiberglass tanks.
   D. **2006** - UL did not include fiberglass piping or tanks in the 2004 suspension of UL markings for fuel dispensing devices that reference compatibility with alcohol-blended fuels containing greater than 15-percent alcohol.
   E. **2012** – In May, 2012 Oak Ridge National Laboratory published study results on dispensing material compatibility with ethanol blended gasolines including E-85. The test fuels included highly aromatic gasolines and aggressive fuel-grade ethanol i.e., found to contain water, sodium chloride, acetic and sulfuric acids. Terephthalic polyester and novolac vinyl ester resin (fiberglass tank and piping materials) remained intact after testing with all test fuels.
   F. **2012** – In July, 2013 Oak Ridge National Laboratory published study results on increasing E-10 to E-15 and if it would cause an increase in UST failures. For resins introduced by 1990 in tanks & piping (see above years 1988 and 1990) "…the risk associated with leaking when switching from E10 to E15 will be low."

Disclaimers:

1. This paper discusses the compatibility of alcohols and alcohol-gasoline blends with fiberglass storage tanks and piping systems manufactured by current members of the Institute, namely – NOV Fiber Glass Systems (including Ameron International Systems,) Containment Solutions Inc., and Xerxes Corporation. While this paper includes the Institute's understanding of products from former members, it is not an analysis of products by other non-Institute manufacturers.
2. Institute tank company plants may have changed manufacturing specifications at different times within the given years listed above. In addition, certain tanks were manufactured according to customer specifications. Thus, tank owners needing specific production information, will need to provide the manufacturer with the tank purchaser's company name, delivery date and delivery location.
3. Nothing in this paper alters the given piping or tank manufacturer's warranty for the product at the time of sale.

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