Three Fuels of Concern Today

Ultra Low Sulfur Diesel (ULSD)

Biodiesel

Ethanol Blends
Ethanol Studies


Ethanol Studies

Analysis of Underground Storage Tank System Materials to Increased Leak Potential Associated with E15 Fuel, EPA report

Compatibility Assessment of Metallic Dispenser Materials for Service in Ethanol Fuel Blends up to E85, ORNL Technical Memorandum

Analysis of Steel Underground Storage Tank failure storing Ethanol, 2013

Compilation of failure reports, ASTWMO, 2013
“UST fibers exposed due to chemical exposure.”
"The tanks were so brittle that they split in two when lifting lugs were used."

2013 study: 23-year old FRP tank storing E10
Exposure time, 2 months at ambient temperature.

95% Fuel grade ethanol (FGE) - nitrogen purge: corrosion rate: 0.008 to 0.02 mm/y

90% gasoline-10% FGE, nitrogen purge: 0.0025 mm/year

Corrosion below detection limit
- 70% gasoline-30%FGE, air purge
- 90% gasoline-10% FGE, air purge –
- 95% FGE, air purge
ORNL Ethanol Study

All materials which could be in UST system were tested

Metals – negligible corrosion

Elastomers (gaskets, seals, etc.) some not compatible with E15.
  ◦ Found that increased swelling caused important property loss.

Plastics included older and newer FRP resins
  ◦ Resins exhibited between 7% - 25% swell
  ◦ Volume swell corresponds to material softening
“Evaluated four resin types representative of those used in legacy and modern FRP UST construction:

• “The pre-1990 resin was severely damaged from exposure to CE25a, along with one of the post-1990 resins.
• “The addition of glass to the test samples may prevent swelling.”
Residual fuel in the polymer is likely responsible for the material softening.

Even after drying at 60°C for 65 hours, some level of fuel was retained within the plastics.

“The highest property changes observed were for nylon 11, nylon 12, PETG, PP, and vinyl and polyester resins”

“Volume and softening of PVDF, acetals, nyons, PBT, PETG, and thermoset resins increased to varying degrees with exposure to ethanol”.

“…mild steel...and stainless steel were found to be essentially immune to corrosion...”
“The study showed negligible corrosion of either steel or aluminum immersed in either CE10a or CE17a.” (Aggressive blend of 10% and 17% ethanol.)
Testing with mid-level ethanol/gasoline:

“In this study, there was no noted effect on metallic parts of equipment.”
Corrosion in Sumps
Steel Tank Interior – E85
Exterior Mold on Ethanol Tanks
Close-Up Area
Other Research

*Biodiesel and Steel Compatibility Study, 2007, SwRI*

*Biodiesel Handling Use Guide, NREL*

*DNV Material Compatibility in Biofuels, Gui, Beavers, James & Sridhar, 2011*

*Corrosion Behavior of Carbon Steel Coupons and Injection System Components in Soybean Methyl Biodiesel, Cavalcanti & Mansur*
Biodiesel

STI conducted a study with NBB in 2007

Steel found to be compatible with various types of biodiesel
  ◦ Soy
  ◦ Animal fat
  ◦ B5 thru B100

Both ULSD and 3500 ppm diesel fuel used
Steel Samples
Visual Inspection

Upon visual inspection of the test coupons, a small amount of surface rusting was observed.

Figure 4. Photographs of carbon steel specimens exposed to ULSD and soy-based biodiesel blends with and without the presence of water: (a) 100 % biodiesel, no water added; (b) 50 % biodiesel + 50 % ULSD, no water added; (c) 100 % petrodiesel, no water added; (d) 100 % biodiesel, 1 vol% water added; (e) 50% biodiesel + 50 % ULSD, 1 vol% water added and (f) 100 % ULSD, 1 vol% water added. Exposure time: 2 months.
Surface Rust

In most cases, the amount of surface rusting was slightly higher in 100 % ULSD than in biodiesel or biodiesel + ULSD blends.

This surface rusting was caused by a reaction between the surface oxide layer of the metal and the fuel blend.
Low magnification optical micrographs

100% Biodiesel

50% ULSD/50% Biodiesel

100% ULSD

No water added to any fuel
Typical Microscope Images

100% animal-based biodiesel, no water added
Sample 25

Greatest weight loss occurred with 5% animal based biodiesel/ ULSD/ 1% water

Optical examination indicated no measurable pits on this sample

Corrosion rate calculated at 0.09 mm/yr

Equates to Excellent Corrosion Resistance rating
Ultra Low Sulfur Diesel Issues

- Corrosion of metal components within tanks storing ULSD
Corrosion Occurring in Vapor, Product, and Tank Bottoms
STP column pipe inside FRP tank
Upper section of STP – vapor only
Pump connection corroded thru
In service less than one year
STP Column Pipe
Had to be pried out – Check Valve
STI conducted own study

Study included both fiberglass and steel tanks

USTs from five regions of the countries tested

One fiberglass and one steel tank in each region

Tanks were chosen randomly with no previous investigation of any corrosion issues

Both fuel and water bottom sample obtained
STI Research

- Las Vegas service stations tanks under same owner
- FRP tank vapor control fitting – top right photo
- Steel tank vapor control fitting – bottom right photo
Results

Ethanol found in all but one region of the country
- How is ethanol getting in diesel fuel
- Transporting trucks is one possibility
- Also possible for ethanol to be formed inside the tank

Acetic acid found in all but one region of the country
Steel Tank Top
Vapor Space is Clean
Best Management Practice

Improve Storage Tank Maintenance

HAVE YOU CHECKED YOUR TANK TODAY?

Inspect & Maintain
Inspection & Maintenance

STI R111
Storage Tank Maintenance

Check Your Fuel - ASTM