Storage Tank Maintenance for Today’s New Fuels

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Steel Tank Institute

- 28 Years Experience with Storage of Petroleum Fuels
- Professional Engineer
- Executive Vice-President of Steel Tank Institute
- Member of NFPA 30 Flammable & Combustible Liquids Storage Tank Committee since 1986
- Steel Tank Institute publishes Shop-Fabricated Tank Maintenance, Inspection & Repair Standards
- Over 450,000 Tanks constructed to STI specifications
Who and What is STI/SPFA?

- Association of 186 fabricating and affiliate companies of steel construction products – shop-fab tanks, field erect tanks, pipe, pressure vessels and other special fabricated products
- STI members build a significant majority of shop-fabricated underground and aboveground fuel storage tanks
What does Steel Tank Institute do?

- UST and AST tank technologies
- Industry standards, RP’s
- Quality control of tank fabricators who build tanks to STI specifications
- Information resource
  - TankTalk, Steel Facts
- Certification
This Week's Headline News

• 24 vehicle complaints
• Gunking up of engine leaving deposits in engine valves & injector system
• Officials trying to find out what chemical compound is causing the reaction
Fuel Cleanliness Important

- Newer Engines
- Changing Fuels
- Gov’t Regulations
- Industry Practices
Result

Increased Need for Storage Tank Maintenance
Air Quality Concerns

- To produce cleaner burning fuel, oxygenates were added to gasoline.
- To produce cleaner burning fuel, sulfur was removed from diesel.
- Note changes are for Air Quality, not fuel quality.
Gas Mileage Concerns

- Automobile manufacturers required to increase overall mileage
- Regulation resulted in engine changes
State Regulation Concerns

- Some states, like MO, regulate water bottoms in tanks
- 1 inch maximum water allowed
Clean Air & Newer Engines

- Engine exhaust must be cleaner to meet EPA Clean Air regulations
- Fuel injection systems instead of carburetors
- Particulates can clog injectors
- Reduced clearances in engines requires cleaner fuels
Fuels

New Engines

Revised Standards

Regs

Industry Practice
Fuel Production & Distribution

- US terminal capacity reduced, while fuel consumption increased.
- Therefore, more fuel moves distributed at faster rate = less time to settle out before final delivery.
- Industry moving to shared delivery infrastructure, so individual companies have less control over product.
New Fuels of the 21st Century

- Biodiesel
- Ethanol
- ULSD
- Additives
- Future Fuels
Changing Fuel Formulations

- Changing to ULSD (Ultra Low Sulfur Diesel) significantly changed fuel:
  - Had a significant impact on solids formation
  - Peroxide formation is more of a problem
  - Wax precursors and solids propagators more pronounced

- What does all this mean? Generally, there may be more particulate and sediment in ULSD compared to LSD
What is Going On with ULSD?

- Corrosion of metal components within underground storage tanks storing ULSD
- Strainer and filter photos on right
- Particulates often described as being similar to coffee grounds
ULSD Corrosion – UST Detail

(Diagram: Courtesy of Rick Chapman, Innospec)

Acetic acid in fuel-water bottoms

UST showing corrosion and possible microbial corrosion spots.
Common Observations of Filters Used in Ultra Low Sulfur Diesel Systems

Trash Inside Strainer

Filter Canister at FRP Tank Site
(One UST service provider estimates that he replaced 40 pumps in past 6 months alone, many 2-3 years old.)
Clean Diesel Fuel Alliance

- Report of first year study was published Sept 2012
- CDFA interested parties met in Chicago Oct 3, 2013
- Agreed to several goals and projects
- Presented to CRC to assume further research
Conclusions are in Hypothesis Status

- Among other contaminants, acetic acid was found in all samples taken (fuel, water bottoms, vapor and corrosion scrapings).
- Acetobacter microorganisms and traces of ethanol were found in the majority of water bottom samples.
- Combined, the two are known to create acetic acid.
- Battelle has identified this as the most likely mechanism for the cause of the corrosion.
- **Conclusions are still in hypothesis stage**
ULSD Research Ongoing

- **Coordinating Research Council**
  - Diesel Performance Group
  - Oil & Vehicle Industries
  - Developing an RFP for further research to achieve better understanding of this issue

- **Example: STI Research**
  - Tanknology hired to visually examine the insides of underground steel and FRP ULSD tanks at service stations
  - Fuel samples extracted and tested
  - Las Vegas service station tanks under same owner
    - FRP tank vapor control fitting – top right photo
    - Steel tank vapor control fitting – bottom right photo
About Changing Fuels: Ethanol Blended Gasoline

- 96% of all gas today is blended with 10% ethanol
- EPA has approved E15 in cars 2007 and newer
- Per US DOE EERE, 2399 ethanol stations dispense E85
- Plants can produce over 14 billion gallons/year
Ethanol Blended Fuels

- **Sumps Used Atop UST’s**
  - EPA ORD Research
  - NIST Research
- **ASTSWMO Publications**
  - “Compatibility of UST Systems with Biofuels,”
  - Case Studies
- **Research and Work Groups**
  - Underground tanks storing E85
UST Sumps *(slide courtesy of NIST)*

- **E10 STP, unknown grade (Florida) – Feb. 2011**
- **91 octane STP (California) – August 2010**
- **Same sump!**
- **Premium/E10 STP (Tennessee) – March 2010**
- **Premium/E10 STP (Tennessee) – August 2010**
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26 Year Old FRP Tank- ASTSWMO Study (Screen Shot from Publication)

Tank Issues:
Tank Construction: Single Walled  Tank Material: FRP
Tank Capacity: 10,000 gallons  Installation Date: 1986  Current Tank Age: 26 years

Description of Issue:
Prior to the storing of blended fuels, the USTs stored unleaded 87 and 92 octane as well as diesel. It was believed that the tanks had had been properly cleaned prior to the switching of products. The premium UST was placed in temporary out of use (TOU) status on 12/18/2008 and was put back in service on 2/25/2009. The ATG detected the presence of water in the tank and as a result, the tank was placed back into TOU status on 2/18/2009. In 9/2009, an internal inspection of the tank was conducted. The results indicated a crack in the bottom of the tank.

Supporting Pictures:
92 Octane UST - breaches observed during pre-blast inspection
92 Octane UST interior - major areas found through cracks
Fiberglass (FRP) UST Lining System Installation
Oct 28, 2013 02:40 pm | admin

NW Tank Lining & Inspections

In September 2013, a large California based petroleum distributor and convenience store chain contracted NW Tank Lining & Inspection, Inc. to install an interior lining system in its fiberglass (FRP) USTs at its site in Redwood City, CA.

The resin and the gelcoat were peeling away from the interior surface of the FRP USTs, leaving the UST shells completely exposed leading to probable deterioration.

The NWTLI crew sandblasted away the flaking resin and gelcoat and proceeded to sandblast the entire interior of the shell to properly prepare the UST for the installation of the lining system.
Service Provider Observations of an Older FRP Tank (Screen Shot from Presentation)
Gasoline and diesel fuel contain many additives essential for good fuel quality and necessary for good fuel stability and performance:

- **Stability additives** -- prolongs fuel life, limits oxidation/degradation and metal interaction reactions;
- **Corrosion inhibitors** -- protects metal in fuel systems;
- **Conductivity improvers** – lessens static electricity, prevents fires/explosions;
Fuel Additives – Are They Necessary?

- Lubricity improvers – provides needed lubrication in diesel injection systems;
- Biocides – preventive use minimizes bugs which may lead to corrosion;
- Anti-foulant additives – counteract fuel degradation & contaminant inter-actions that lead to filter/injector plugging
- Additives generally added at terminals
- May get “used up” along the way
Fuel Degradation

- All fuel tends to degrade in storage (this is normal) – degradation causes some fuel contaminants. Use of stability additive slows the degradation process;
Fuel Degradation

- Water is fuel’s enemy and must be managed – it carries contaminants that can lead to bug problems and corrosion; fuel filter and injector deposit issues.
Fuels

New Engines

Industry Practice

Revised Standards

Regs
ASTM International - American Society for Testing and Materials

- ASTM is the primary organization in the US for developing fuel standards
- Other international organizations exist in Canada, Europe (ISO, BSI, etc.)
Consensus Organizations

- Members work together to produce Fuel Specifications such as ASTM D975 for diesel fuel and ASTM D4814 for gasoline.

- Standard Test Methods (STM’s) are needed so testing for properties is done consistently
  - D7548 STM for Determination of Accelerated Iron Corrosion in Petroleum Product

- Majority vote required, and all concerns and negative votes are thoroughly discussed. Consensus process can be lengthy!
ASTM Ethanol Standards

- Fuel grade ethanol must meet ASTM standard D4806
- Mid-level ethanol, 51% - 83% D5798
ASTM Requirements

- ASTM requirements intended to be met at terminals
- A few have discussed developing standards for fuel as it is to be used
- New proposals emphasize industry practice:
  - A good industry practice is to drain any free water from a storage tank before the fuel is transferred further
Water and Sediment Limits

- **D975**
  - Diesel fuel shall be visually free of undissolved water, sediment, and suspended matter.
  - Max 0.05% dissolved water & sediment

- **4806 Ethanol**
  - Visibly free of suspended or precipitated contaminants (clear & bright)
Cleanliness Emphasized

- One proposal to update informational language on water and sediment states,
  - “Water is virtually everywhere and exists in multiple forms from solid, to liquid, to vapor”
  - “it is critically important that fuel be as free from water (and particulates) as possible prior to its introduction into the engine’s fuel system.”
Available fuel additives can improve the suitability of marginal fuels for long-term storage and thermal stability, ... Most additives should be added at the refinery or during the early weeks of storage to obtain maximum benefits.
Biocides or biostats destroy or inhibit the growth of fungi and bacteria, which can grow at fuel-water interfaces to give high particulate concentrations in the fuel. Available biocides are soluble in both the fuel and water or in the water phase only.

Contamination levels in fuel can be reduced by storage in tanks kept free of water,
Factors Affecting Water & Sediment

- **Temperature**
  - Water drops out at higher temperatures
  - Sediment can also form at different temps

- **Humidity**
  - Biofuels absorb water from air
Factors Affecting Water & Sediment

- As fuels age, degradation occurs and sediment forms.
Monitoring Water in Fuel Tanks

- Operations and maintenance procedures for water monitoring and removal have been a recommended practice for over thirty years.
STI’s Recommended Practice R111
STI R111, Storage Tank Maintenance

- Recordkeeping
- Changing Fuels
- How to Monitor Tanks
- How to Remove Water and Contaminants
- Change of Service
- Checklist
Today’s Factors Affecting Tank Maintenance

• Common installation and maintenance procedures contribute to water accumulation:
  ◦ Open vents
  ◦ Low fill areas
  ◦ Sloped tank installations
Today's Factors Affecting Tank Maintenance

- Water enters tanks through spill buckets
Microbial Contamination

- Reddish, scaly, gritty deposits: corrosion and/or silt in tank
- Black or brown deposits: water contamination has degraded the fuel
- Sludge build-up in tank bottom can be caused by the breakdown of the fuel itself.
Microbial Contamination

- As microorganisms grow and thrive, they form a slime
- Over time, sludge is formed from the slime
- Clogs may not be visible, unlike mold growth
- Sludge breaks off and clogs fuel filters and small openings throughout entire system
Microbial Activity Warning Signs

- Short filter life or flow slowed to 3-5 gpm
- Erratic tank gauge readings
- Frequent replacement of valves, hoses, etc.
- Rotten-egg odor from digestion of fuel by microorganisms
- Chemically-altered fuel components attack:
  - Rubber
  - Fiberglass reinforced plastic
  - Tank linings & coatings
  - Metal
Contamination

Contaminants like salts in water may:

- Degrade fuel chemical structure, yielding substances detrimental to system components
- Cause fuel additives to leave fuel and enter water
Monitoring Tanks: All Fuels

- Inspect tanks at least monthly
- Check for water as often as possible
- If 1 inch+ water is present, must be removed within 30 days
- Best monitoring: automatic tank gauging (ATG) system
  - Some floats may not work with alcohol fuels
- Simpler, less expensive: appropriate water paste on gauge stick
- Water-sensitive filters and watch for slow fueling
Monitoring Tanks: Ethanol

- When ethanol’s water absorption capacity is reached, excess water separates, causing two distinct layers of product:
  - Top layer: lower octane gasoline, possibly out of spec
  - Bottom layer: ethanol/water mix, dispose of

- Resulting water bottom:
  - Allows microbes to proliferate
  - Storage system exposed to ethanol concentrations greater than 10%
Monitoring Tanks: Ethanol

- The bottom line for storage systems and ethanol:
  - Clean the tank system before introducing ethanol blended fuels
  - Monitor frequently for water and contaminants
  - Promptly remove water and contaminants from tank when identified
Monitoring Tanks: Biodiesel

- Material incompatibility with both diesel & biodiesel fuels:
  - Brass, bronze, copper, lead, tin or zinc oxidize and create sediments, leading to clogged fuel filters
  - Pure biodiesel (B100) or blends higher than B20 cause problems with rubber seals, gaskets and hoses—use biodiesel resistant materials
Monitoring Tanks: Biodiesel

- Higher concentrations = reduced stability
- Use biodiesel within lifetime
- The bottom line for storage tanks and biodiesel:
  - Check for compatibility (steel is compatible)
  - Clean tanks before introducing biodiesel fuels
  - Monitor frequently for water and contaminants
  - Promptly remove water and contaminants from tank when identified
Monitoring & Detection Methods

- Tank bottom sampling
  - “Bacon bombs” collect samples from tank bottom
- Fuel filters
  - Use water absorbing filters to detect slowed fuel dispensing; filters expand when absorbing water
Monitoring & Detection Methods

- Fuel samples from nozzle
  - Visual evaluation by examining fuel caught in clear glass container
Monitoring & Detection Methods

- Use recommended inspection and maintenance schedules
- Daily monitoring of tanks with ATGs and water level sensors
  - If gauge shows water one day but not the next, may indicate water has been absorbed into ethanol-blend or biodiesel fuel
  - If ATG records are inconsistent, test with water paste or bottom sample
- If one inch or more of water is found, it must be removed within 30 days.
How to Remove Water and Contaminants from Storage Tanks

• Multipoint water pumping
• Fuel filtration/polishing
• Non-entry tank cleaning
• Physical entry tank cleaning
• Dispose of tank bottom water properly
Preparing Tanks for Changes in Fuel Storage

- Changing between gasoline and diesel fuels
  - Tank and related dispensing equipment must be thoroughly cleaned
  - Tank must be inspected and verified compatible with new fuel to be stored
  - Ensure gasoline is not commingled with any diesel product
Change in Service to Ethanol

- Ethanol acts as a cleaning agent: loosens any sludge, slime and scale already present in tank
- Therefore, tank must be cleaned before ethanol blended fuel is introduced
Change in Service to Ethanol

- Cleaning prevents excessive filter clogging and potential engine damage from contaminants
Change in Service to Biodiesel

- Problems with tanks that formerly held Number 2 diesel
  - Existing tank likely to have sludge & sediments
  - Biodiesel dissolves these sediments and carries them into vehicle fuel systems
  - Can rupture filters and clog fuel injectors
  - Tanks should be cleaned before switching to any biodiesel blend
R111’s monthly inspection checklist

- Inspect tanks monthly
- Checklist on pages 12-13 of R111 document
  - Covers all inspection recommendations
  - Your record of tank inspection and maintenance
Inspection and Maintenance of Tank Systems – Need to Inform Others???

STI Webinar of December 18, 2013
Posted on line at www.steeltank.com
OTHER INDUSTRY RPS

- Clean Diesel Fuel Alliance
  - Guidance for Underground Storage Tank Management at ULSD Dispensing Facilities
    - www.clean-diesel.org

- Petroleum Equipment Institute
  - RP900: UST Inspection and Maintenance
  - www.pei.org

- US EPA
STI On-Line Tank Integrity Management

- Establishes a basic knowledge of shop-fabricated steel storage tanks
- Review topical sessions
  - Tank Fabrication, AST Standards, Codes & Regulations, SP001 Inspection, Tank Integrity Management, Tank Maintenance
- Take a 10 question test on each unit
- Earn additional PDH’s from home or office at your convenience
- Obtain TIM Certificate
Thank you!

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