Corrosion in Ultra Low Sulfur Diesel Underground Storage Systems

Presented by:
Prentiss Searles
Chairman CDFA
American Petroleum Institute
searlesp@api.org
&
Lorri Grainawi
Steel Tank Institute
lgrainawi@steeltank.com

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How was the issue raised?

- **December 2007 - A post on the PEI website identified a concern with rust and corrosion of STPs and pump castings**
- **Input received from additional persons with concerns and presentations made to ASTM in June and December 2009 by STI**
- **January 2010 PEI arranged meeting with interested parties (EPA OUST, ASTs, Clean Air, PMAA, ATA, NBB, Truck Stop, API, Fuel Additive Companies, others)**
- **Issue brought to attention of CDFA**

> Highway ULSD Fuel
> Non-Road ULSD Fuel
> Vehicle Performance
> Environment & Health
> Frequently Asked Questions
> Quicklinks to Member Web Sites

Ultra Low Sulfur Diesel (ULSD) fuel and new engines and vehicles with advanced emissions control systems offer significant air quality improvement.

Highway ULSD Fuel

EPA standards have led to a major reduction in the sulfur content of diesel fuels.
Highway Diesel

New Diesel Technology

Ultra Low Sulfur Diesel (ULSD) is a cleaner-burning diesel fuel containing a maximum 15 parts-per-million (ppm) sulfur.
Vehicle Performance

Non-Road ULSD Fuel

New EPA fuel standards for diesel fuel also apply to locomotive, marine and non-road engines and equipment, such as farm or construction equipment.
Non-Road Diesel

Environmental Benefits

ULSD fuel along with new engine and emission control system technologies have an important role in improving air quality and providing human health benefits by significantly reducing current emissions.
Environment and Health

Para leer en español el folleto sobre diesel ultra bajo en azufre

Energy Tomorrow Radio Podcast on ULSD

Clean Diesel Fuel Alliance

- Created in early 2006 to address the introduction of ULSD
- ULSD phased in over several years
- More than 95% of all diesel is ULSD
- Website: www.clean-diesel.org
- Participants include:
  - Government
  - Engine and vehicle manufacturers
  - Marketers
  - Refiners
  - Equipment producers

- AAA, www.aaa.com
- Alliance of Automobile Manufacturers, www.autoalliance.org
- American Petroleum Institute, www.api.org
- American Trucking Associations, www.truckline.com
- Association of International Automobile Manufacturers, www.aiam.org
- Association of Oil Pipe Lines, www.aopl.org
- Diesel Technology Forum, http://www.dieselforum.org/meet-clean-diesel
- Engine Manufacturers Association, www.enginemanufacturers.org
- Independent Liquid Terminals Association, www.ilta.org
- Manufacturers of Emission Controls Association, www.meca.org
- National Automobile Dealers Association, www.nada.org
- National Association of Convenience Stores, www.nacsonline.com
- National Association of Fleet Administrators, www.nafa.org
- NATSO, Inc., representing Truck Stops & Travel Plazas, www.natso.com
- National Petrochemical & Refiners Association, www.npra.org
- National Tank Truck Carriers, Inc., www.tanktruck.org
- Petroleum Equipment Institute, www.pei.org
- Petroleum Marketers Association of America, www.pmaa.org
- Society of Independent Gasoline Marketers of America, www.sigma.org
- Steel Tank Institute, www.steeltank.com
- Truck Renting and Leasing Association, www.trala.org
- U.S. Environmental Protection Agency, www.epa.gov
- U.S. Department of Energy, www.doe.gov
- U.S. Energy Information Administration, www.eia.doe.gov
- Western States Petroleum Association, www.wspa.org


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Who and What is STI/SPFA?

- Trade Association representing fabricators of steel construction products
  - Shop-Fab and Field Erect Tanks
  - Pipe
  - Pressure vessels and other special fabrication
- Approximately 180 Members
  - 120 Active Fabricating Members
  - 60 Affiliate Members who provide equipment, materials, and services
- History
  - STI formed in 1916
  - SPFA formed in 1934
  - STI & SPFA merged in 2004

Services Provided

- Networking for steel fabricators
- Education
- Technical services – fuel, energy, & water
- Industry liaison
- R&D and 3rd-party testing laboratories
- QC inspection & audit services

STI Standards & RPs

- SP001 ®, Inspection of ASTs
- R972 ®, Supplemental Anodes for sti-P3 tanks
- Keeping Water out of your UST System
- Tank Standards include:
  - Sti-P3®
  - Permatank®
  - ACT-100®
  - Fireguard ®

How did I get involved in this?

- Education, BSME
- Chair NACE Underground Storage Tank Committee
- ASTM D02.14 Co-Chair Fuel Corrosivity Committee
- STI serves as technical expert in storage industry
- We receive numerous inquiries on variety of topics

History

- Presentation to ASTM D02 committee in June ‘09 and second in Dec ‘09
- Problems being reported by contractors
- Excessive corrosion on equipment
- Photos sent to me are of tank accessories inside FRP tanks
- Equipment in dispensers also were reported as failing

What's Happening?

- After June meeting, ASTM committee members suggested collecting more details
- Goal to determine if there are patterns
- Are problems associated with
  - One brand of eqpt?
  - One refinery?
  - Type of diesel?
  - Any other factors?

What did we learn?

- Problems reported from all regions of the country
  - That means it's not one refinery
  - And it's not one pipeline
  - And it's not one brand of fuel

What did we learn?

- Not enough data to know if there is relationship between:
  - Tank volume
  - Throughput of the system
  - Tank maintenance
- We do know:
  - Not related to age of equipment
  - Corrosion occurs both in liquid and vapor areas

Resultant Problems

- Flow rate reduced below level needed for nozzles to automatically shut off
  - Product spilled from vehicle overfill
- Threads corroded, seal not maintained
  - Product Release

#1 Question - Why? Lots of Theories

- Decreased sulfur led to increased microbes
- Microbiological corrosion for unknown reasons
- Diesel fuel not properly processed
- Fuel additive causing an unexpected reaction
- Galvanic reaction from dissimilar metals
- Reaction from increased biodiesel use
- Increased water bottoms due to ULSD
- Dispenser grounding issues

#1 Question - Why? More Theories discussed at ASTM fuels meeting

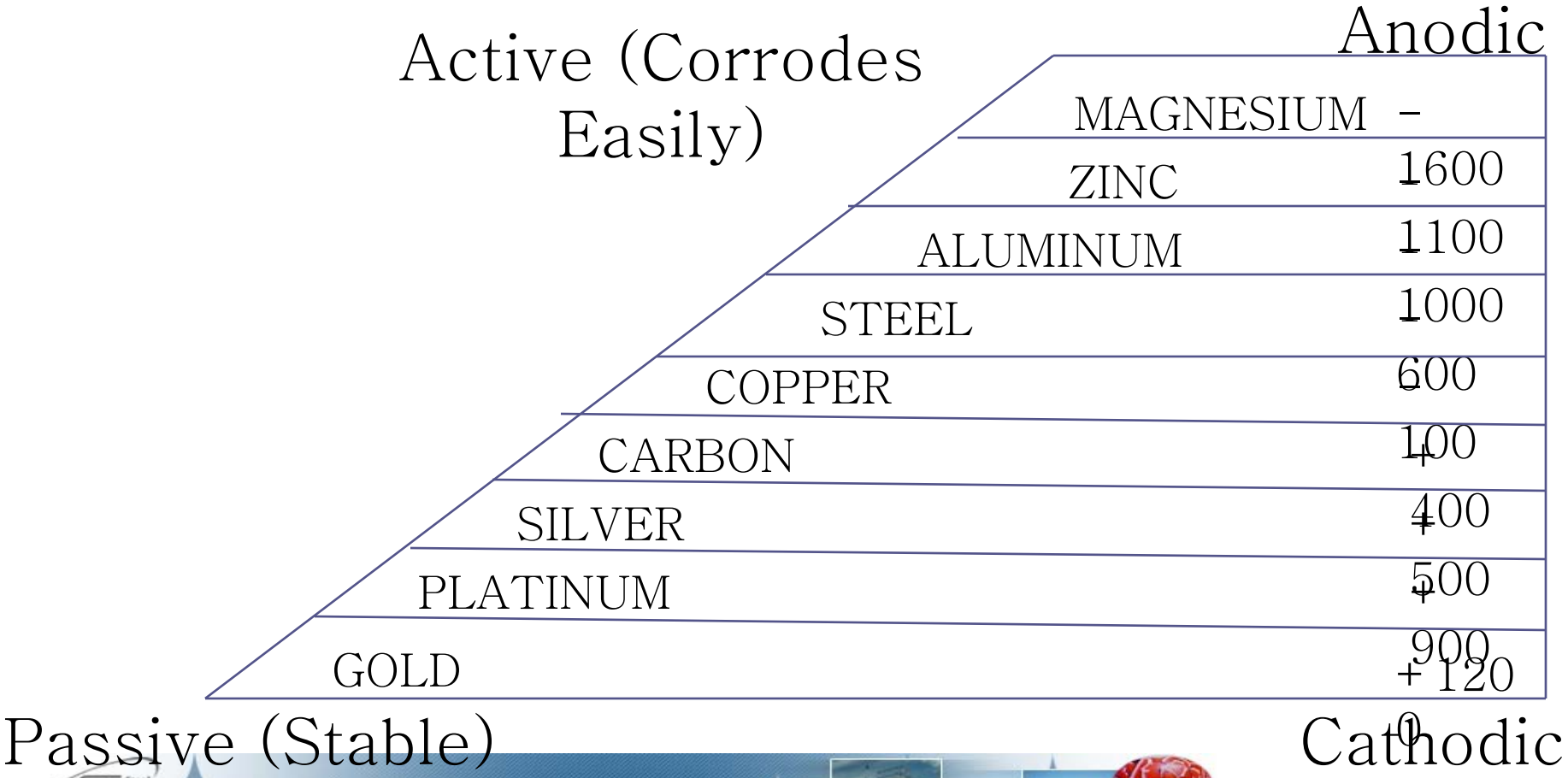
- Hydrogen Sulfide present in fuel in extremely small quantities
- Caustic carryover when refining fuel?
- Acetic acid has been shown to be present in fuel, but not known why

Can we rule any of them out?

- Information gathered to date mainly inconclusive, but
- We can rule out galvanic reaction as the main cause
- It could be one, a combination of two or more, or none of these reasons

Galvanic Corrosion?

Relative Energy Levels of Metals Relative to a Cu/CuSO reference cell



Microbes – what do they need?

- Liquid water is needed for all forms of life
- In addition all organisms require
  - carbon, nitrogen, phosphorus, sulfur, and other trace elements
- Microorganisms can use many organic and inorganic materials as sources of nutrients and energy
- Can be either aerobic or non-aerobic

Why are microbes a problem

- When eating, or decomposing, a hydrocarbon by-products are formed which may be
  - alcohols,
  - aldehydes,
  - aliphatic acids,
  - ammonia
  - hydroxy acids …

Why are microbes a problem

- “Acids produced by fungi are damaging to metals, glass, masonry, & other materials.”

- Water and nutrient availability are greatest at the fuel-water interface where biological growth tends to be the heaviest.

“Typical” MIC

ULSD Screening Survey

- Task force led by PEI to develop survey
- Electronic survey, just 5 questions
- Purpose to determine to understand if more work was needed

Responses received from

- Tank Owner
- Fuel Suppliers
- Service Provider
- Equipment Manufacturer
- Tank or Equipment Regulator/Inspector
- Cargo Tank Motor Vehicle Owner
- Others
- 250 people agreed to provide additional information if needed

Survey Results

- Issue happens in many regions of the country
- Single owners to multiple site owners
- Types of issues identified
  - Filters clogging/requiring more frequent replacement
  - Seal/gasket/O-ring deterioration
  - STP replacement /motor problems and column pipe wear
  - Tanks rusting/leaking (includes tanks on vehicles)
  - Meter failure
  - Damaged or broken line leak detectors
  - Automatic nozzle shutoff failure/shorter lifespan
  - Tank probes malfunctioning
  - Check valves not seating
  - Shear valves not sealing/failing tests
  - Swivels failing/shorter lifespan
  - Dispenser leaks/failure/premature replacement
  - Solenoid valves clogged/failing
  - Corrosion on the riser pipe
  - Pipe failure

Where are we now?

- CDFA released request for proposals
  - Review and assess existing data on issues that may be associated with the storage and dispensing of ULSD.
  - Design and conduct a study to better understand the issues and determine whether there is any relationship between ULSD and corrosion. Particular attention will be paid to data involving failure of safety and leak detection equipment.
  - Prepare a report that explores the data, describes commonalities and differences between sites and systems related to this issue, distinguishes between normal and abnormal wear, draws conclusions where possible, and theorizes where conclusions are not possible. Identify possible next steps.
  - Proposals in response to this RFP were due July 6, 2010.

Where are we now (cont.)?

- RFP sent to 14 companies
- Received responses from 5
- CDFA meeting held July 8
  - Reviewed responses and narrowed to three
  - Identified follow-on questions

Next steps

- CDFA call set for end of this month to review final submittals
- Expect to initiate work in Fall with completion in Spring 2011
- Develop guidance document – Goal to provide information that may help improve UST systems
  - GUIDANCE FOR UNDERGROUND STORAGE TANK MANAGEMENT AT FUEL DISPENSING FACILITIES
    - IDENTIFICATION OF SYMPTOMS (**Microorganisms, Solid Contaminants,**
    - LIQUID CONTROL MEASURES (Inspections, Fuel Monitoring, Records, Water, Preventing Microbial Growth)
    - TANK CLEANING
    - CONVERSION OF TANKS TO NEW SERVICE

    (SOURCES: API, ATA, STI, EPA, OTHER DOCS)
  - Document under review will be posted on clean-diesel.org website.

Conclusions

- Work is ongoing to understand the issue
- Federal government and industry working together to understand issue
- Questions?