Safety and Environmental Risk Minimization

Automatic Tank Gauges
A Brief History And Overview of Technology
Agenda

- A History of ATGs
- What ATGs Do Well
- Static In-Tank Testing
- Continuous In-Tank Testing
- Interstitial Sensor Monitoring
- What ATGs Do Not Do Well
A History of ATGs

The ATG and Wet-Stock Management

- Originally developed to address the need for a more accurate means of wet stock management - Late 1970s. Not a leak detection method

- “Predictive inventory control” using statistical analysis of historical data:
  - Product Deliveries
  - Product Sales
  - Product Inventories
A History of ATGs

Fuel Delivery & Payment Process Prior to 1988

- Fuel delivered to facility
- Fuel was paid for by the Dealer at end-of-month
- Financial liability to the petroleum marketer was enormous
A History of ATGs

AMOCO Oil Company

•~3,000 CODO (“Company Owned Dealer Operated”) facilities
•$536 Million monthly credit!
•This was made worse by problems of theft, co-mingling and runouts
•How to turn-around money quicker
•Solution - Own the fuel in the tanks???
A History of ATGs

AMOCO Oil Company

• EPICS (Electronic Processing Information & Cash Sales)
  • Schlumberger - “Micro-Max” point-of-sale console
  • 2,000 - 2,500 Veeder-Root TLS-250s (1987-1990) - $25MM
  • Dedicated AT&T JC Penney’s Network
  • End-of-Day C-Store Sales and Fuel Sales & Inventory Processing
  • 30X quicker turnaround - Significantly improved cash flow >$500 MM / Mo
A History of ATGs

AMOCO Oil Company

- LOADS (Light Oil Automatic Dispatch System)
  - Used EPICS data for analysis to determine scheduling for product deliveries
- ARSTA (Amoco Retail Satellite Transmission Architecture) - Hughes satellite network
A History of ATGs

Tank Leak Detection

- First ATGs
  - *Veeder-Root TLS-100 (1978-1979)*
  - *TLS-150 (1982-1984)*
- Tank leak detection methods not fully developed until the early 1990s.
  - *CSLD, SCALD, other*
  - *WRA SIRA, etc.*
- Probe technology
  - *Capacitance (not good for fuels)*
  - *Ultrasonic (early application issues)*
  - *Magnetostrictive*

![Leak Test Report](image)
A History of ATGs

• Line Leak Detection
  • Ongoing development
    • 1st Line Leak Detector - 1961 (Mechanical - Red Jacket);
    • Electronic LLDs (volumetric, pressure and flow) developed in the late 1980s through the 1990s;
    • Hybrid (Electro-mechanical) developed around 2000 (Vaporless)

• What’s Next - Dynamic LD?

Vaporless Manufacturing, Inc.
A History of ATGs

New Systems

• Newer systems incorporating multiple features including some with touch screens continue to be developed.
  • Simmons Wilco
  • WRA PetroNetwork S3
  • Franklin Fueling “Colibri”
  • Veeder-Root “TLS-450”
  • Franklin Fueling TS-550 “EVO” State of the art “one-touch” interface
• NACS / PEI Convention
What ATGs Do Well?

Fuel Management Study performed in 2000

- Total Deliveries - 39,328
  (12 months - 400+ sites - TLS-350s)
- 90% fill target
- # Above 90% - 1,136 (2.88%)
- # Above 98% - 8 (0.02%)
- >97% Efficiency Rating
How Do ATGs Detect Leaks?

Tanks

• Static In-Tank
• Continuous In-Tank ("On-site Statistician")
• Interstitial (Double-wall)
How Do ATGs Detect Leaks?

Factors & Effects That Impact ATG Performance

• Tanks
  • Temperature [Δ Volume]
  • Vapor Recovery [>500M GaIs / Mo]
  • Type & Material [Deflection]
  • Size & Capacity [Volume – Strapping]
  • Tilt [Level] - Not an issue if probe is at the middle of the tank
  • Thermal Coefficient of Expansion [Rate of Change in Volume – Fluid]

• Piping
  • Temperature [Δ Pressure]
  • Type & Material [Elasticity – Bulk Modulus]
  • Length & Diameter [Volume]
  • Thermal Coefficient of Expansion [Rate of Change in Volume – HDPE Systems]
How Do ATGs Detect Leaks?

TANKS: Static In-Tank
(During operating hours)

• Should shutdown STP
  • Lockout/tagout at breaker panel
• Should lockout dispenser nozzles
• Console polls probe for fuel level and temperature data
  • Polling time = 1 - 3 Minutes between readings
• Converts level readings to volume measurements based on strapping charts
How Do ATGs Detect Leaks?

TANKS: Static In-Tank

- Adjusts for temperature changes based on data from thermisters inside the probe
- Calculates rate of volume change over time to arrive at calculated leak rates
- Each manufacturer uses proprietary protocols to verify changes are due to a leak or other error sources
- At end of test calculates overall leak rate and signals results based on threshold value (0.17 GPH - 95%)
How Do ATGs Detect Leaks?

TANKS: Static In-Tank

• Disadvantages
  • Depends upon the type of site (very challenging for 24-Hour facility)
  • 0.2 GPH leak rate tests typically require a minimum of 2-Hours to complete
  • A 24-hour facility should shutdown dispensing (may be a regulatory requirement)
  • Typically requires a minimum of 8-Hours after delivery before the test can start
  • Limitations on capacity of tank- varies by manufacturer (e.g. 30K Gals)
  • Requires periodic human interaction (reduced with automated testing)

• Advantages
  • Works well for sites that can be shutdown in evenings or on weekends
  • Can do multiple tests per month (e.g. Once per week)
  • 0.2 GPH leak rate test completed in less than 4-Hours
  • No added cost – Other than the time involved to run the test
How Do ATGs Detect Leaks?

TANKS: Continuous In-Tank

- Quiet-Period
- Console polls probe for fuel level and temp data
  - Frequency varies by manufacturer (e.g. 30 sec - several minutes)
  - Timing dependent upon several criteria
    - Diameter & length of tank (capacity)
    - Resolution & accuracy of probe
How Do ATGs Detect Leaks?

TANKS: Continuous In-Tank

- Compares changes in product level over time
- Converts level to volume based on tank strapping (diameter x length)
- Accounts for temperature changes using thermisters in the probe
How Do ATGs Detect Leaks?

TANKS: Continuous In-Tank

• What must happen?
  
  • Determine the start of quiet period inside the tank (e.g. when no activity such as dispensing or delivery is occurring)
  
  • During quiet period collect fuel level and temperature data over pre-programmed time intervals
  
  • Convert fuel levels to volumes - adjusting for temperature
How Do ATGs Detect Leaks?

TANKS: Continuous In-Tank

• What must happen?
  
  • Optional - Assess data for quality ("adequacy") based on pre-determined error sources (e.g. fuel stratification, fuel evaporation, etc.)
  
  • Determine whether sufficient data has been collected to calculate a leak rate that will meet the minimum 95% Pd / 5% Pfa requirement
    
    • This may involve combining data that had been collected from several consecutive time periods that vary in length
How Do ATGs Detect Leaks?

TANKS: Continuous In-Tank

• What must happen?
  
  • Sufficient data - Calculate the leak rate for the full time period (e.g. it may be hours, daily, or a period of days) over which data was collected from the shorter time periods
  
  • Determine the leak rate for the entire month (e.g. 28- to 30-days) and post results - pass or fail (e.g. printout, display, alarm, etc.)
How Do ATGs Detect Leaks?

Data Quality Analysis

- The quality of the quiet period data is determined by the sources of error impacting the data
  - Thermal contraction / expansion
  - Fuel evaporation
  - Fuel density stratification
  - Others (Proprietary)
- Data with the least number of error sources is collected for further analysis
How Do ATGs Detect Leaks?

End-of-Day (24-Hours)

- Performs statistical analysis on all accumulated data to determine leak rate
  - Enters leak rate into a rolling window whose time-span varies with each manufacturer (e.g. 28 days)
  - Performs quality check on leak rate values
    - Outliers
    - Length of quiet time
  - Calculates accumulative leak rate
- Prints TEST RESULTS report
  - PASS - Issues report
  - FAIL - Issues report & triggers alarm
How Do ATGs Detect Leaks?

TANKS: Continuous In-Tank

- Advantages
  - Does not require the site to be shutdown
  - Requires minimal interaction of personnel
  - Capable of providing a calculated leak rate as frequently as each day

- Disadvantages
  - Limited by monthly throughput of site
  - May be limited by CITLDS testing protocol
  - Higher cost than static in-tank testing (requires module and/or software)
  - Only issues one qualified 0.2 GPH test per month
How Do ATGs Detect Leaks?

TANKS: Interstitial

- Superior protection versus all other methods
- Contains leaks from the primary tank
  - Pressure (Transducer)
  - Vacuum (Gauge)
  - Dry (4-20ma signal)
  - Brine (float)
- Tanks cost more than single-wall (STI-P3 or ACT-100)
  - Steel, FRP or Composite
How Do ATGs Detect Leaks?

Pressure

• Not used in the US - CA???

Vacuum

• Extremely sensitive (0.001 GPH leak rate)
  - O₂ molecule smaller than the hydrogen-carbon chain molecules that are in Gasoline or the H₂O molecule
  - Steel Tank Institute PermaTank®
  - Difficult to maintain vacuum for extended periods if not replenished automatically
  - 100% continuous monitoring
  - Vacuum degrades over time
  - Complex, costly, and frustrating to manage
  - 0.2 GPH leak rate = Extremely rapid failure
How Do ATGs Detect Leaks?

Dry (4-20ma signal)

- Problems can be hidden by tank tilt
- Response time dependent upon travel of liquid to sensor
- Not continuous like vacuum or brine
- Cheap and easy to replace
- Requires periodic inspection
- Outer wall must be tested for integrity
- Average cost
How Do ATGs Detect Leaks?

Brine (float)

- Most accurate interstitial method
- 100% continuous monitoring
- Quickest response time
- Can detect a 0.2 GPH leak rate in as little as 9-Hours
- Very reliable
- Higher cost (tanks)
- Very easy to maintain
- Float-switch in brine column
- Monitors movement of float
- Specific gravity of brine = 1.3
- Minimal human interface (SAFETY ISSUES)
What ATGs Do Not Do Well?

- Do not prevent leaks from occurring
- Cannot tell the difference between a real leak and a false positive
- High volume throughput facilities
  - >250,000 Gals/Mo/Tank
  - Truck-Stops
  - Vapor recovery - volume
- Multiple manifolded tanks (e.g. >2)
- Tanks limited to <30,000 Gals capacity
- Flexible plastic piping systems
- 0.1 GPH leak rate = Best performance