Leak Detection Systems.

Tank Storage Conference - Istanbul

Mohit Agarwal –
Regional Manager( India & ME)
Slow Leaks Lead to Big Spills Over Time

- Most underground leaks are detected only after they are large enough to reach the surface.

- Unfortunately ‘Out of site – Out of mind’ can lead to very expensive clean-up costs:
  - 1 hour of undetected leak is 315 liters
  - 1 day is 7560 liters
  - 1 week is 53,000 liters

(Spill estimates based on a 0.2% leak from an 8” transfer line)
The need for a new leak detection technology

- The need is to detect a fuel leak when the leak size is very small.
- Real liquid hydrocarbon sensors based detection and no interpretation.
**Fractured tank**

Fractured bottom plate, => large spill
=> Ground subsidence => bund explosion / fire => tank fire

**Prevention measure:**
- liquid detection systems under the bottom plate or in the service void: sensing cables buried within slotted pipes
Leak detection for tanks:
Visual detection or gauging systems?

- Detection after 1 month for small tanks (+/- 8 m of diameter)
- Detection after 1.5 year for larger tanks (> 38 m of diameter)
Detection of fuel leaks before the tank collapses…

Pictures from the VRT internet website.
Applications for Direct Contact Sensors

- Overfill Detection in UK

- New tanks have ring moats to catch and temporarily hold any over-fill
- A Fast Fuel sensor probe has been fitted inside of moat
- Sensor ignores rain water if there is no floating fuel
Leak detection for tanks: 
Visual detection or tank gauging systems?
Quickly detect a fuel spill in time to activate the emergency response plan

Pictures from the Buncefield Investigation Information Desk internet website. Courtesy of Royal Chiltern Air Support Unit
The Solution
Cables for buried applications

- Real liquid hydrocarbon sensor
- No false alarms with rain water even dissolved hydrocarbons
- Suitable for all buried applications
- Continuous sensing
- Can be installed in Ex zone 0
External Direct Measurement

Installed into PVC screen pipe

High Sensitivity sensor cable

Positioned under tank bottom, beneath valves or along side a pipeline
Tank monitoring

Typical plan view

Interconnect conduit & alarm panel (optional)
TraceTek 5000 Series

Outer braid diameter
0.28 in. (7 mm)

Sensor Wires (black)

Continuity Wires (red and yellow)

Filler Wire
Thick Wall / Cable technology

Cable Wall Material: PE, EPDM, Carbon + radiation cross linking

Liquid Hydrocarbons
Jet, Diesel, Gasoline, Crude Oil, etc
Thick Wall / Cable Technology

Cable Wall Material
Still conductive, but now
Volume is 200% original
TT5000 before fuel contact

- H₂O
- Jet A
- Gasoline
- Diesel

Note air gap between inner wall of jacket and black electrode wires
TT5000 after fuel contact
TT5000 after fuel contact
TT5000 after fuel contact
TT5000 after fuel contact

Air gap between inner wall of jacket and black electrode wires has collapsed. Detection occurs !!!
**TT5000 after fuel contact**

- Detection current flows through jacket.
- Leak is detected and located.
- Elapsed time since initial contact < 60 min (Jet-A @ 20 C).
- Fuel needed for detection < 1 ml.
TT5000 Detection and Location

I (current) is monitored to detect a leak event

V (voltage drop along the cable) is measured to locate the leak point of contact
Cables Operating Principle
TraceTek TT5000 monitoring
Underground leak scenario

Detection after 30 days

Animation based on 3.8 liter/hour leak rate
TTDM-128 Alarm Panel
TTDM-128 Features

- Stand Alone Alarm Panel and User Interface
- Local Display of all Leak Detection Parameters: Leak Location, Time of Detection etc.
- Capacity to manage up to 128 TTSIM channels
- Event History: leaks, trouble alarms, set-up changes, etc.
- Summary Relay outputs:
  - Leak Detected
  - Service Needed
  - Trouble
- Complete Modbus interface via RS232/RS485 to Host Computer for remote monitoring.
TT-SIM 1A control unit

- Can be included in a “ATEX d Flameproof enclosure” to reduce the Intrinsic safe network length
- Compatible with MTL7767+ Zener barrier
- Can be installed in zone 1 with a “ATEX d enclosure”
- ATEX Intrinsic Safe system certificate
- Compatible with a redundant secure network: RS485, fiber optic…
TTDM-128 with TTSIM-1A or TTSIM-2

TTDM-PLUS
Network Master

TTSIM-1A
Sensor Interface

RS-232 or
RS-485 modbus
link to host

Sensing Cable

RS-485 2 wire network

TTSIM-1A
Sensor Interface

(additional TTDM, TTSIM, or TT-NRM)

Sensing Cable

Condensate Drain Valve

Private and Confidential
Local Dedicated PC Monitoring
TT-Supervisor Features

- Windows application directly connected to TraceTek system
- Monitors up to 31 TTDM-128 panels with or without attached SIM networks
- Direct monitoring up to 124 TTSIM units
- All events logged on local disk
- Screens for:
  - Real Time Status Display by Channel
  - Active Alarms
  - Event History
  - Links to graphic files (system maps) and text files
AST Tank Floor monitoring
Hidden leaks under control

- The major risk is to have an undetected leak under one of the four crude oil tanks in a French refinery.
- The solution has been to bury one kilometer (4 times 250 meters) of TT5000 cable around the perimeter of the tanks.
- Benefits: the tanks will be monitored 24h a day, 7 days a week.
Less Expensive Perimeter Monitoring

- Used when the cost of horizontal boring beneath existing tanks is too expensive or too risky.

- Solution: Sensor cable is placed in a trench around the perimeter of each tank.

- Benefits: the tanks will be monitored 24h a day, 7 days a week – but only leaks reaching perimeter are detected.

Private and Confidential
Hidden leaks under control
Hidden leaks under control
Buried Valves – Large or Small

• Sensor cable is installed in slotted PVC “J” tube under valve body to detect leaks from flanges and valve stem and drain tubes
Buried Valves and Manifolds
Thick Wall / Cable Type Sensors

- Long circuit, continuous sensor
- Excellent under tanks, along pipelines, in-soil applications
- Location of spill reported along with detection
- Ignores ground water
Fast Fuel Sensor
Fast Fuel Sensors (FFS)

Sensor/Circuit Board Fits Inside PVC Housing

Leader Cable to Control Unit

Component Area Encapsulated in Epoxy

Top Electrode

Sensor Area

Bottom Electrode

Slots for liquid

PVC Housing

Protection Screen

Front Side

Back Side

Side View

Private and Confidential
Fast Fuel Sensors (FFS)

Normal (Dry) Condition >> Output to TraceTek system is high resistance = NO LEAK

Wet Condition >> Output to TraceTek system is high resistance = NO LEAK

Resistance path through sensor material is low

Water
Fast Fuel Sensors (FFS)

Fuel Spill >> Output to TraceTek system is low resistance = LEAK

Fuel on Water Condition >> Output to TraceTek system is low resistance = LEAK

Resistance path through sensor material is high
Floating hydrocarbons detection

- Real liquid hydrocarbon sensor
  - No false alarms with water even with heavy rain
  - No anti wave system needed
  - 10 or 20 cm height sensors
  - Fast reaction time
  - Can be reset, reusable
  - Industrial floats available
  - Can be installed in Ex zone 0

Can be used in a SIL2 loop
Tank critical scenarios

1. Overfill

2. Floating Roofs

3. Leaks (mixer, flange, valve or pipework)

4. Roof drain and tank drain failure

Large spill => explosion => fire

Protection measures: collecting system and liquid detection on collecting system: TT-FFS
Quickly detect a fuel spill in time to activate the emergency response plan

Pictures from the Buncefield Investigation Information Desk internet website. Courtesy of Royal Chiltern Air Support Unit
Floating Roof Leaks

- The need:
  - Detect fuel on roof surface after failure of ring seal
  - Detect fuel backing up through rain drain and accumulating on roof
Plot Plan PARADIP REFINERY – Core Processing Units
Thin Film / Point Sensors

- Fast
- Reusable, easy to test
TT-FFS  Fast Fuel Sensor – Drip Pan Installation in UK
Supervising network

- Digital network between sensing cables interfaces and central processing units
- Compatible with Fast fuel sensors
Battery Powered Flasher

- Uses 3 high efficiency LED’s
- Good visibility in the dark and day light
- When the sensor cable is contacted by the appropriate liquid, the LED’s will begin to flash
- Flashing will continue for at least 30 days
- Each unit comes equipped with a “TEST” key that can be turned on to verify
  - batteries and
  - Undamaged sensor cable is connected
- The batteries need to be replaced once a year
- Low batteries indication show a “double flash” pattern for at least 1 month,
TT-Flashers with TT5000 in Canada and US
TraceTek Approvals and Certifications

- ISO 9001
- Products have American, Canadian and European agency approvals
- Florida State EPA Approval
- NWGLDE Listing
Managing System Integrity for Hazardous Liquid Pipelines

API STANDARD 1160
FIRST EDITION, NOVEMBER 2001

A chemical tracer is not a component of the pipeline contents and does not occur naturally in the soil. After inoculation of the pipeline with the tracer chemical, samples of the vapor contained in the soil outside the pipeline are collected. The soil vapor samples are obtained from probes or other devices installed intermittently along the pipeline. The vapor samples are analyzed by a gas chromatograph for the specific chemical that was mixed with the pipeline contents. Presence of the tracer chemical in the sample can only occur through an active release of pipeline product mixed with the tracer with the soil. These systems are able to provide single or continuous leak tightness tests and will provide release location information.

Release detection cable. Release detection sensing cables are designed to alarm after contact with liquid hydrocarbons at any point along their length. The presence of hydrocarbons creates a circuit between two sensing wires and triggers an alarm. Typically, leak detection cable is installed in slotted PVC conduit that is buried in the pipe trench along or below the pipeline. These systems provide continuous monitoring via electronic control units capable of interfacing with SCADA technology and are able to provide leak location support information.

Spill-in (static) release detection. This technique basically
Evaluation of the TraceTek™ TT5000 Product Sensitive Cable For use as a Leak Detection System For Buried Pipelines

Final Report

PREPARED FOR: Tyco Thermal Controls

November 21, 2002

Ken Wilcox Associates, Inc.
1125 Valley Ridge Drive, O'Fallon Valley, MO 64029, USA
Voice (816) 443-2484, Fax (816) 443-2495
E-mail info@kwassociates.com, Web http://www.kwassociates.com

Private and Confidential
February 16, 1996

Sarul K. Roy
TraceTek Products Group
Raychem Corp.
306 Quakerbridge Rd.
Moose Park, CA 94025-1164

Dear Sarul:

Enclosed are the test results, signed test result form, and the equipment calibration statement from the TT5000 hydrocarbon sensing cable.

The TraceTek TT5000 hydrocarbon sensing cables and TTDM monitor will be packed and shipped next week.

Please call if you have any questions.

Sincerely,

Marc Pasternack
Manager
Environmental Monitoring Technologies

---

<table>
<thead>
<tr>
<th></th>
<th>Detection Accuracy %</th>
<th>Activation Height cm (in)</th>
<th>Detection Length ft (cm)</th>
<th>Response Time at a Flow Rate of 0.128 gal/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Flow was stopped after 1.0 ft/10.5 min of sensor cable was covered.</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>12 in (30.5 cm)</td>
<td>12.42 ± 1.64 min</td>
</tr>
<tr>
<td>1/8 MER Cable Test Length: 340 ft</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>12 in (30.5 cm)</td>
<td>9.18 ± 3.20 min</td>
</tr>
<tr>
<td>1/4 MER Cable Test Length: 334 ft</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>12 in (30.5 cm)</td>
<td>7.91 ± 3.00 min</td>
</tr>
<tr>
<td>1/8 MER Cable Test Length: 500 ft</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>12 in (30.5 cm)</td>
<td>8.60 ± 1.42 min</td>
</tr>
<tr>
<td>Lower Detection Limit (L.D.L) Unleaded Gasoline (8 tests)</td>
<td>100%</td>
<td>0.74 cm ** (0.29 in)</td>
<td>12 in (30.5 cm)</td>
<td>11.33 ± 1.82 min</td>
</tr>
<tr>
<td>Synthetic Fuel</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>[100.0%] (30.5 cm)</td>
<td>12.60 ± 1.42 min</td>
</tr>
<tr>
<td>Diesel Fuel</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>[100.0%] (30.5 cm)</td>
<td>108.77 ± 10.19 min</td>
</tr>
<tr>
<td>Home Heating Oil #2</td>
<td>100%</td>
<td>0.74 cm (0.29 in)</td>
<td>[100.0%] (30.5 cm)</td>
<td>93.42 ± 29.72 min</td>
</tr>
<tr>
<td>Water</td>
<td>0%</td>
<td>not applicable</td>
<td>not applicable</td>
<td>not applicable</td>
</tr>
</tbody>
</table>

*Specificity Reference: Regular Unleaded Commercial Gasoline
**Product Flow was stopped after 6.0 in/19.0 cm of sensor cable was covered.

(No signature)  December 20, 1995
"EXPERIENCE WITH CABLE-SENSOR-TYPE LEAK DETECTION SYSTEMS FOR ABOVEGROUND STORAGE TANKS"

by

Rudy S. Hogg
Senior Project Manager
Kinder Morgan Energy Partners, L.P.
Orange, California

Presented at the
NINETEENTH ANNUAL
ILTA INTERNATIONAL OPERATING
CONFERENCE
Adams Mark Hotel
Houston, TX
June 14-17, 1999

For the Conference Session Entitled:
"IN PURSUIT OF STOPPING LEAKS AND SPILLS #2"

"EXPERIENCE WITH CABLE-SENSOR-TYPE LEAK DETECTION SYSTEMS FOR ABOVEGROUND STORAGE TANKS"

Rudy S. Hogg
Senior Project Manager
Kinder Morgan Energy Partners, L.P.

***PERSONAL PROFILE***

Mr. Hogg has a Bachelor of Science Degree in Electrical Engineering from Colorado State University. He had early experience in water and power with the Bureau of Reclamation, followed by experience in SCADA system design with Morrison-Knudsen Engineers. The last nine years of experience has been in petroleum transportation and storage with Chevron Pipe Line Co. and Kinder Morgan Energy Partners, L.P. (formerly Santa Fe Pacific Pipelines). He is currently a Senior Project Manager handling multidisciplinary construction projects for refined product pipelines, pumping stations, storage facilities, and loading terminals. One key element of his current assignment is to handle all leak detection installations at storage and terminal facilities in the Pacific Operations Area of Kinder Morgan.

***PRESENTATION ABSTRACT***

The paper discusses experiences of Kinder Morgan Energy Partners in developing a cost effective leak detection program for implementation on aboveground storage tanks. Discussion includes leak detection technologies evaluated and reasons for the selection of a cable-type sensor system. The leak detection system that was selected will be described, along with the advantages, disadvantages, and costs. Methods for installing 2-inch screened PVC pipe under existing tanks will be discussed, including the use of impact and rotary-type horizontal drilling. Some of the problems encountered will be identified, as well as the criteria for location and spacing of the 2-inch PVC sensor pipes. Background data will be provided on leakage plume migration studies that were performed during the evaluation process.
References
References

Kinder Morgan – USA

Above Ground Storage Tanks – Approximately 125 large above ground storage tanks are fitted with TT5000 in slotted conduit. These above ground storage tanks and buried cutout valves are part of the California pipeline network supplying jet fuel to major airports in San Francisco and Los Angeles as well as gasoline and diesel fuel for other transportation needs.

Detailed Document
Other References

U.S.A

- TRANSMONTAIGNE -- TAMPA – 3 tanks
- TRANSMONTAIGNE -- Port Everglades 4 tanks
- TRANSMONTAIGNE -- Pensacola – 4 tanks
- MOTIVA -- Tampa – 1 tank
- MOTIVA -- Port Everglades 1 tank
- HESS -- Port Everglades 1 tank
- City of Tallahassee -- Tallahassee – 1 tank
- City of Tallahassee -- St. Marks – 2 tanks
- NU-STAR -- Jacksonville – 4 tanks
Other References

France and Belgium:
- TOTAL and TOTAL Chemical – several refinery and tank farm sites throughout France and Belgium

UK:
- BP Oil UK Limited – Buncefield, Hamble, Dalston and Northhampton,
- CONOCO-PHILLIPS – Humberside refinery and Tank Farm
- ROYAL PORTBURY DOCKS – Bristol

China:
- Guangzhou Expressway Fuel Operations – 6 gas station tank vaults along new expressway

Shaklin Island, Russia:
- Exxon Mobile
TraceTek benefits

- System protects the environment against any hazard
- High sensitivity
- Listed in API standard 1160
- Real Physical detection (no interpretation)
- Pinpoint the leaks
- 24/7 monitoring system
- Tested by many third party companies (Wilcox, CMRI, API, TUV…)
- Intrinsic safe
Questions
Thank You