Cellular-based ultrasonic corrosion measurement system

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SNI & E2G

Inspection/NDE Track
Paper 41

7TH BIENNIAL INSPECTION SUMMIT
JAN. 30-FEB. 02 | GALVESTON ISLAND | TEXAS

ASSET INTEGRITY THROUGH CORROSION MANAGEMENT, INSPECTION AND ENGINEERING TECHNOLOGY
Abstract

Recent technological advances in precision, fully-digital ultrasonic wall-thickness measurement systems coupled with cellular backhaul data communication protocols are enabling very accurate, easily deployable and more cost-effective corrosion monitoring systems that can compete with more traditional manual NDT methods. Some comparisons with improved data accuracy of installed sensors in lieu of larger quantities of manual spot data is presented. This paper will include the design principles used in the creation of this next-generation platform, end-user input used to refine the design and recent installation and operational experiences.
Outline

• Project Motivation
• Customer input and requirements
• System Architecture
• Cellular good/bad?
• Applications
• Conclusion
Corrosion Damage Accounts for the Cost of one Major Facility Annually

- Pipeline, Oil/Gas Production $8 B
- Refining & Petrochemical $1.7 B

* 2002 NACE Cost of Corrosion Study
What Asset Managers Want?

- New technology which will provide them with more current data regarding the condition of their assets.
- They do not want to wait for annual inspections or shutdowns to get this data.
- They want on-line monitoring versus periodic data collection.
- They say “we want more and better data”
- Data must be high quality

“INDUSTRIAL CLIENTS ARE INTERESTED IN COLLECTING MORE CURRENT AND MEANINGFUL DATA ABOUT THE CONDITION OF THEIR ASSETS”
Inaccessible Equipment is a Challenge

- In plant environments, some equipment cannot be accessed even during shutdowns.
- Data still must be obtained for these assets, which can be even more critical to overall plant integrity.
- Every plant manager interviewed is interested in knowing the condition of his plant every day, regardless of service or location of these assets.

Challenge = expensive!
Technology Investments to Improve Information

- Most end users are interested in investing in new technology to overcome these concerns.
- In the process side of the business, all critical processes are measured in real time.
- Obtaining information on flow, temperature, Pressure, PH, equipment upsets or unusual conditions are monitored and reported on a continuing basis: KPI’s (Key Performance Indicators)
- Plant Manager feels he is in control!

We are in the information age – is NDT technology keeping up?
Remote sensors leverage low-cost ubiquitous communication infrastructure:

- Modbus / RS-485
- Cellular
- Satellite
- WiFi
- Etc.

24/7 asset health monitoring
Data to desk to decision in minutes
Mobile access by multiple parties
Seven System Attributes via Voice Of Customer

1. Modular
2. Portable / battery operation
3. Non-reliant on IT depts. and/or plant infrastructure.
4. Non-intrusive, Versatile & Safe
5. Accurate including Temp Sensing
6. Easy access to the data
7. Cost effective
System Topology

- Wired or wireless.
- Common back-end data management software.
- Many sensors-points per system.
- Technology is the enabler.
Web-based Data Management

- Auto archiving & record retention simplicity
- Alarms & Warnings via e-mail
  - Min T and Max rate
  - Ex. < 1.1 mm or > 0.01 mm / week
- Corrosion-rate calculation
- Automated reporting and e-mail alerts
- Google Maps & GPS asset location
- Accessible from any web-browser device
Cellular Lessons Learned

• The good:
  – Radios are small, low-cost
  – IT free solution?
  – Wide coverage area
  – Easy deployment as long as you have coverage

• The less than good
  – Not really free of the IT department..
  – Not an “in the fence” solution
  – Consume much more energy (battery life) than the UT system – manage with choice of measurement/transmission schedule.
  – Coverage is not uniform and varies by carrier, weather, leaves
  – Bidirectional data flow hard to achieve
Big benefits of installed UT via Cellular

- UT Data accuracy and repeatability significantly enhanced
- Many variables eliminated or auto-corrected (temp changes)
- Very high data-collection frequencies are possible. 1x / day
- Ability to capture episodic metal-loss events
- Easily transportable and can be used as a diagnostic tool
- Data archiving and storage is simplified without human intervention
- Non-reliant on plant power or IT infrastructure
### Data/Cyber Security

<table>
<thead>
<tr>
<th></th>
<th>Proprietary (In-House) Network</th>
<th>Public Network</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Expensive (To purchase, manage &amp; maintain)</td>
<td>Cheap</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>Managed internally (good &amp; bad)</td>
<td>Rely on outside data repository (cloud) ... Amazon Web Services, Google Cloud, etc., standard encryption schemes: HTTPS</td>
</tr>
<tr>
<td><strong>Compromise-ability</strong></td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Data Relevancy</strong></td>
<td>Confidential / regulated: Ex. SSNs, medical records, salaries, banking information etc.</td>
<td>Not Relevant: Ex. Thickness data, asset temperatures &amp; pressures</td>
</tr>
<tr>
<td><strong>Access</strong></td>
<td>Within Site or through VPN</td>
<td>Global</td>
</tr>
</tbody>
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Atmospheric Gas-Oil Line Monitoring

Overview: Customer wants to extend life to next turnaround and make sure that line is no longer corroding.

Application: Atmospheric gas-oil, ~270°C
- 3” Sch 40, subject to severe but uniform corrosion, most piping is < ½” nominal wall

Product Used:
- smartPIMS HT Cellular w/ 4 HT probes temporarily attached, managed by on-site service provider
- Monitoring interval: 4 hours
- Data is monitored & trended daily using webPIMS
- Installation time: 6 hours

Outcome: Refinery able to safely monitor process piping which was not scheduled to be repaired during outage and trend for future metal loss conditions
The Future for Installed Sensors

- Internet of Things (IoT) is fueling the flame
  - In the next 5 years*:
    - $6 trillion will be spend on equipment and infrastructure
    - IoT will connect over 20 billion assets
    - Projected revenues from IoT are estimated at $14.4 trillion

- Communication / Data Transmission
  - Internal vs. public networks (trending to public)
  - Why public?
    - Cheaper
    - More widespread, data accessibility
    - Google/Amazon/etc. are getting better at security/managing data
    - Faster acquisition, higher bandwidth, longer range

- Lower cost per point sensors
- Longer battery life / further reaching
- Other?

*Source: BusinessInsider 2016
Conclusions

• Cellular corrosion monitoring systems offer several benefits including:
  – IT “free” solution with no plant infrastructure requirement
  – Lower cost deployment
  – Improved visibility to asset health – current and future state, RM&D
  – Easily accessible data via the cloud

• Field trial and customer installations have shown the accuracy, precision and value of monitoring.

• Flexible system can be deployed in many different applications: low temp to high temp, wireless or wired, etc.

• Collection at multiple points has shown that corrosion rate is not constant at all areas of a piping circuit.
Questions?

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