SENSOR ENABLED WATER QUALITY AND CORROSION DEGRADATION ASSESSMENT SYSTEMS FOR WATER DISTRIBUTION NETWORKS

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Report Documentation Page

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Standard Form 298 (Rev. 8-98)
Prepared by ANSI Std Z39-18
OSD Corrosion Control Program

- Congressional Directive to DoD
  - Public Law 107-314, December 2002 Sec: 1067: Prevention and mitigation of corrosion of military equipment and infrastructure

- Tri-Service in nature

- Army facilities projects are co-funded with ACSIM-IMA

- We greatly appreciate their sponsorship, visibility, and support
Components of Water System Quality and Corrosion Monitoring and Analysis

Detection with Wireless Sensors
- Corrosion Rate Sensors
- HACH Pipe-Sonde Water Quality Sensors
- HACH Guardian Blue Water Distribution Monitoring Process Sensor

Dynamic Modeling
- Hydraulic Modeling
- Chemical Fate and Transport

Integration of Sensors and Models in Support of Water Distribution Networks
- System Assessment
- Trend Analysis
- Specifically designed for use by operations
  - Simple to use - engineering schematic like interface
  - Multiple views - Schematic and Physical (GIS-like)
Typical Water Distribution Systems

- Potential corrosion problems
- Threat to Water Potability
- Threat to Fire Suppression
- Lack of system redundancy
- Large area subtended by the system
- Treatment chemicals
- Control systems (SCADA)
Degradation of water quality in the distribution system can result in undetected localized corrosion problems.

- Corrosion inhibitors and disinfectants are consumed
- Residence time controlled by system hydraulics
- Remote and low-use areas are especially problematic
Sensors
Corrosion Rate Sensor

- Measures linear polarization resistance (LPR) or electrical resistance (ER)
- Calculates instantaneous corrosion rate (LPR)
- Rate can be integrated over time for cumulative metal loss
- "Corrosion imbalance" provides qualitative indication of pitting tendency
- Can be tied in with SCADA systems/ 4-20 mA output
A wide variation in general corrosion rates was observed. The lowest rate consistent occurred in one of the water storage tanks at the site. The highest rate occurred at a pressure reducing valve with intermittent flow.
HACH Water Quality Sensor (Pipe Sonde)

- Multi-parameter sensor that measures
  - pH
  - Conductivity
  - Turbidity
  - Dissolved oxygen
  - ORP
  - Water pressure & temperature

- Water and debris-tight for long-term field use

- Additional benefits for water security

- Can be tied in with SCADA systems/ MODBUS output
HACH Guardian Blue Water Distribution Monitoring Process

- The System is used to detect and preliminarily classify anomalous events in the drinking water distribution system, increasing security and streamlining operations.
HACH Water Quality Distribution Monitoring Process (Event Monitor) Trigger System

- View all measurements and trigger signal from the main screen.
HACH Water Quality Distribution Monitoring Process (Event Monitor) Overview

Input Five Parameter Signals

Output Single Signal

The Event Monitor analyzes plant data, alarms on significant deviations from baseline, reports the Event Name if found, and learns the event fingerprint if not already in the Plant Event Library.
36 Inch Main Break
Road work near a distribution line dislodged biomass and other particulate matter from the lining of the pipe. There was a massive increase in turbidity, which not only showed up on the turbidimeter, but also showed up as an interference in the chlorine measurement (optical). As expected, the conductivity and pH also showed minor changes. The increase in biomass in the water was indicated by the TOC analyzer. This event illustrates the ability of the Event Monitor to detect and alarm on unanticipated events. This event also provides a signature for the materials adhering to the walls of the pipes in this location.
Integration of Sensors and Dynamic Models to Support Water Distribution Networks
Schematic of Corrosion Detection and Management System

- Flow sensor
- Corrosivity sensor
- Water system outfitted with sensors and RTUs
- Chemical feed system
- Master computer for SCADA system
- Connection via LAN and/or radio
- Utility system models + analysis
- RTU = Remote Terminal Unit
- SCADA = Supervisory Control and Data Acquisition
- LAN = Local Area Network

Alarm

Pressure

Time

Predictive

03:00 - 67m

Current
We Have a Vision: A “Smart” Utility Network

- Notifies the operator when something is wrong.
- Diagnoses the problem
- Solves the problem or recommends corrective action to the operator
- Allows operator to “experiment” with alternative solutions

“There is a problem at the main plant. Turbidity is 12 and chlorine residual is zero.”

“Contamination is suspected”

“Recommendation: Close valves at main plant. Do you want to do that?”

“Do you want to simulate what will happen if we do that? Do you want to try something else?”
Sensor monitoring via SCADA

- Utilized army installation’s existing Bristol Babcock SCADA system
- Corrosion rate and water quality sensors are monitored
- Data transmitted to Public Works office
Monitoring at an Army Installation
Best Approach is a Network Approach
Not a choice of just one, or two instruments
System Overview

Real-Time Model

Hydraulics
- Pressure
- Flow
- Control

Water Quality
- Measures
- Constituents

Corrosion
- Measures
- Indexes
- History

SCADA System
Field Reports
Lab Data
Color model by selected variable

Pressure (PSI)
Simulation combined with analysis algorithms provides proactive identification of problems
Highlight components with analysis values that violate constraints

High Ryznar Index
User can select variables to display at every component

System highlights constraint violations

Ryznar Index
Water System Quality and Corrosion Monitoring and Analysis Benefits

- Enhance system operation and reduce downtime
- Improved customer satisfaction and relations
- Satisfy regulatory record keeping and reporting requirements
- Reduce labor costs associated with time and travel.
- Alert operators and managers to undesirable changes in water quality
- Distribution and plant personnel can troubleshoot remotely
- Distribution and plant personnel can identify trends and adjust operating parameters more efficiently

The EPA website lists a number of benefits of remote monitoring in the distribution system.
Summary

This is a system that consists of:

- Corrosion Rate Sensors
- Water Quality Sensors (HACH Pipe-Sonde)
- Water Distribution Monitoring Process Sensors (HACH Guardian Blue)

Tying it all together:

- Each of these technologies contributes to improved corrosion control and water quality management for water distribution systems
Project Status

- All major components modeled from tanks, sources and water treatment plant, pipes and valves down to individual buildings
  - Loaded from GIS
- Running model using live data feed from SCADA
  - ODBC connection between Bristol Babcock Open Enterprise SCADA Server and Distributed Engineering Workstation (Dew) model
- Can hand enter lab and field data at components in model
- Generating hydraulic, water quality and corrosion data and index information using component installation data and attached measurements
- System highlights high and low limit violations
- Completed initial installation test and review in December
- Running and refining as regular part of water system operations
  - December 2008 through June 2009
Review constraint violations as a list

- Select component from list
- Window pans to selected component