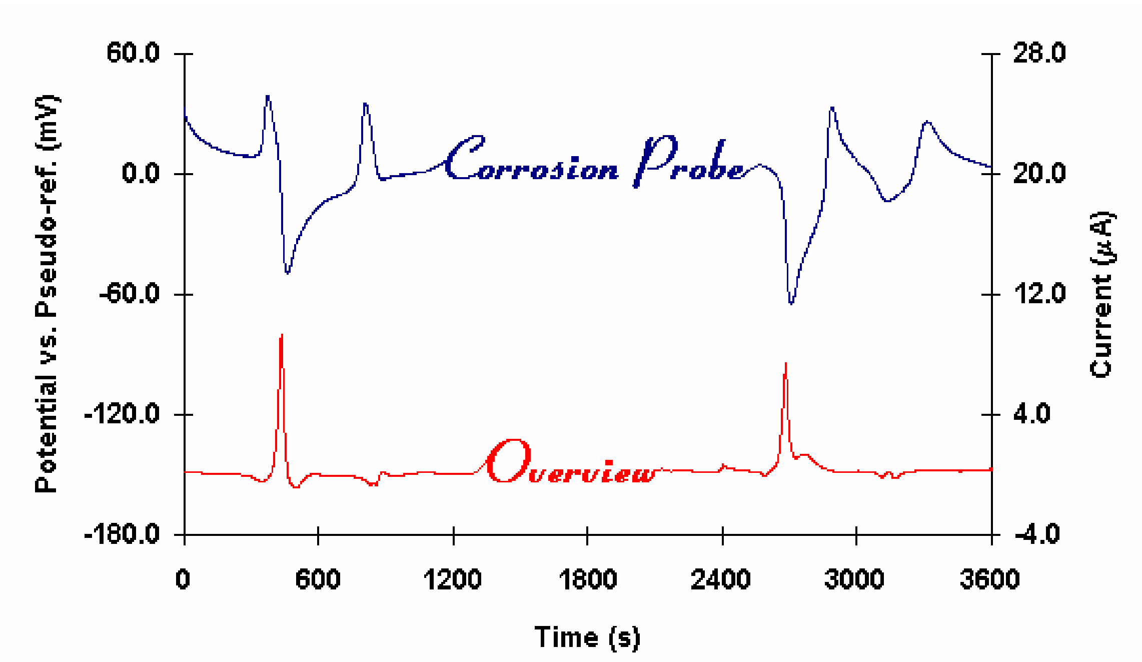
Corrosion Probe Development for Nuclear Defense Water Storage Tanks



Introduction:

The Lockheed-Martin Hanford Site has 177 underground waste tanks that store approximately 253 million liters of radioactive waste from 50 years of weapons production. Twenty-eight (28) tanks have a double-shell and are constructed of welded mild steel. The inner tanks of the double-shell tanks were stress relieved following fabrication. One hundred and forty-nine (149) tanks have a single shell constructed of welded mild steel, but were not stress relieved following fabrication. Tank waste is in liquid, solid, and sludge forms. Tanks also contain a vapor space above the solid and liquid waste regions. The composition of the waste varies from tank to tank but generally has a high pH (12) and contains sodium nitrate, sodium hydroxide, sodium nitrite, and other minor radioactive constituents resulting from plutonium separation processes. Leaks began to appear in the single-shell tanks shortly after the introduction of untreated nitrate-based wastes in the 1950s. Leaks are now suspected to be present in a significant number of single-shell tanks. The probable modes of corrosion failures are reported as nitrate stress corrosion cracking (SCC) and pitting. Previous efforts to monitor internal corrosion of waste tank systems have included linear polarization resistance and electrical resistance techniques. These techniques are most effective for monitoring uniform corrosion, but are not well-suited for detection of localized corrosion (pitting and SCC).

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Description:

Corrosion monitoring of double shell tanks (DSTs) is currently provided by process knowledge and tank sampling. Tanks found to be within chemistry specification limits are considered to be not at risk for excessive corrosion damage. There are no direct corrosion monitoring systems for DSTs in use at the Hanford Site. The recent discovery of 5 low hydroxide (out of corrosion specification) tanks indicates that this system is inadequate to support corrosion control. Tank samples are infrequent and their analysis difficult and expensive. In-tank, real-time measurement of the corrosive characteristics of the tank wastes is needed to provide an acceptable level of corrosion control information.

Available technology for corrosion monitoring has progressed to a point where it is now feasible to monitor and control corrosion by on-line monitoring of the corrosion process and direct addition of corrosion inhibitors. The potential benefits of a corrosion monitoring system include:

- Safer operation and reduced risk of tank liner failure.
- Corrosion will be monitored directly, versus monitoring species.
- Assumptions about tank waste homogeneity and corrosion chemistry specification will be reduced or removed.
- Significant potential for cost reduction.
- Increased tank life due to more rapid identification and resolution of off-normal conditions.
- Avoidance of unnecessary chemical additions due to unknown corrosion conditions.
- Potential cost savings through the reduction of the required corrosion inhibitor concentrations as corrosion behavior becomes better understood.

The electrical noise technique has been selected for preliminary evaluation at the Hanford Site. Analysis by EN involves the monitoring of instantaneous fluctuations in corrosion current and corrosion potential between nominally identical electrodes during corrosion process. Waste tank electrodes are manufactured from archived waste tank wall material. The technique is unique from most electrochemical corrosion monitoring methods in that it does not depend on externally applied currents or voltages to generate corrosion information. Thus, uncertainties in data due to unknown effects of applying an outside signal to a specimen are removed.

The use of electrochemical noise based corrosion monitoring systems in Hanford waste tanks will allow for real-time monitoring of both corrosion processes and corrosion inhibitor addition. Real-time data collection would facilitate identification of the precise time when a corrosion process begins to occur in a tank. This, coupled with corrosion rate

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information also generated, would help in determining the extent of design life lost due to degradation by abnormal corrosion conditions. Similarly, real-time corrosion monitoring during inhibitor addition would allow one to observe corrosion conditions return to an acceptable level. Therefore, unnecessary inhibitor addition could be eliminated. The current system of corrosion control at the Hanford Site cannot offer this capability.

Electrochemical noise offers the unprecedented ability to distinguish between inform corrosion, stress corrosion cracking, pitting, and other forms of localized corrosion as they occur. This technique also generates uniform corrosion rate data similar to what is currently derived from chemical sampling. Other resistance probes are not capable of distinguishing between uniform and localized forms of corrosion. Base on the 1995 report, *Hanford Waste Tank System Degradation Mechanisms*, the most likely cause of failure in DSTs is degradation due to some form of localized corrosion. Electrochemical noise offers the ability to detect the onset of localized attack.

Description:

Proof of principle testing of electrochemical noise technology was conducted by Schiff Associates and Westinghouse Hanford Company (WHC) personnel at Oak Ridge National Laboratory in October of 1994. The testing demonstrated conclusively that electrochemical noise can be used to uniquely identify pitting, stress corrosion cracking, and uniform corrosion in simple aqueous nitrate/steel systems under laboratory conditions. This evidence was strong enough that WHC proceeded directly into prototype development for actual in-tank use. An electrochemical noise based corrosion monitoring system was procured in late 1995. A laboratory evaluation program involving over 6000 hours of testing was conducted in 1996. Details of the laboratory work performed in evaluating the electrochemical noise technique can be found in: *Technical Basis for Electrochemical Noise Based Corrosion Monitoring of Underground Nuclear Waste Storage Tanks*. A probe assembly was designed and fabricated in early 1996. This assembly was installed into DST 241-AZ-101 in August, 1996. Details of the probe design and its first four months of Fabrication of a fully operational, eight-channel corrosion probe was started in April, 1997 with installation in a DST expected by late 1997.

For more information, visit Hanford's Site ECN Program