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CORROSION MITIGATION AT THE GEYSERS

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KEYWORDS

corrosion protection, polymers, composites, pre-ceramics, piping, well casing, cooling towers, vent gas blowers, acid condensate.

PROJECT BACKGROUND AND STATUS

Corrosion problems at The Geysers have increased as steam pressures decline. These have contributed to decreases in electric power generation, increased operating costs, and safety and environmental concerns. In FY 1990, BNL initiated cost-shared work with geothermal companies active at The Geysers which focuses on low cost solutions to these difficult materials problems. The identification of needs, performance of prototype and full-scale field evaluations, and subsequent economic studies are performed as cost-shared activities with firms active at The Geysers.

As of October 1996, one cooperative test program was completed, and several others were in progress. The former was with the Central California Power Agency (CCPA) to evaluate coating systems for well casing exposed to low pH steam condensate. Ongoing efforts include composite coating materials systems for pipelines with the Northern California Power Agency (NCPA), and with Pacific Gas and Electric (PG&E) for dry cooling towers, turbine components and vent gas blowers.

PROJECT OBJECTIVES

The objective of the research is to decrease the operating costs of steam production, transmission and utilization at The Geysers by the identification and subsequent demonstration of low cost materials of construction that will withstand the highly corrosive acidic environments being encountered in some areas of the geothermal field.

Technical Objectives

The technical objective is to select and optimize materials systems previously developed under DOE/OGT sponsorship, for specific end-use applications at The Geysers.

Expected Outcomes

Attainment of the project objectives will result in the following:

- Wells that presently cannot be operated due to excessive maintenance costs or environmental/safety concern may be restarted.

- Service life expectancies of fluid production, transmission and electric generation components will be increased.

- Cost-effective methods for water conservation will be available, thereby resulting in reservoir life extensions due to increased fluid reinjection.

APPROACH

The approach being used to meet the project objectives is to optimize polymer, polymer cement composite and pre-ceramic formulations, previously developed under DOE/OGT sponsorship, for specific end-use applications at The Geysers. The identification of need, performance of prototype and full-scale field evaluations, and subsequent economic studies are performed as cost-shared activities with firms active at The Geysers. In FY1996, engineering ceramics and metal alloys were added to the types of materials under investigation.

The Project consists of three phases:

Phase 1 consists of the identification of specific materials problems, elucidation of the fluid environments, and the selection of candidate materials systems. Laboratory testing under simulated process conditions is then conducted to establish technical feasibility. Based upon these results, modifications to the systems are made to maximize corrosion resistance.

Phase 2 consists of small-scale field testing, and contingent upon the results, prototype component testing.

Phase 3 consists of design studies to incorporate the technology into components, cost estimates, documentation, and the identification of potential commercial suppliers of the new technology.

RESEARCH RESULTS

Laboratory and field testing efforts being performed as cost-shared activities with geothermal companies active at The Geysers were continued. Current industrial participants are the Pacific Gas and Electric Company (PG&E) and the Northern California Power Agency (NCPA). Of interest to PG&E are corrosion protective coatings for turbine components, dry cooling towers and vent gas blowers. Polymer-matrix composite-lined steam transmission piping tees are being evaluated by NCPA. Details of these activities are summarized below:

Piping Systems

In March 1992, two polymer cement (PC) lined 30-cm diameter pipe tees were installed by NCPA in a steam transmission line where the conditions are as follows: flow rate 13,640 kg/hr, temperature 173°C and pressure 0.83 MPa. Both tees were visually inspected after approximately 12 months exposure. At that time, some fine cracks and small regions of disbondment of the liner were noted, but in general both tees were in good condition. Therefore, the test was resumed and it has continued without interruption for a total exposure time of 53 months as of October 1996. Since filters located downstream of the tees which are monitored routinely have not collected any pieces of the PC liner, it is expected that no gross erosion or delamination has occurred.

Dry Cooling Tower Components

Prototype sections of polymer coated finned-tube heat exchanger tubing were placed into test by PG&E at The Geysers in June 1994. In the test environment, the corrosion rate of carbon steel is approximately 15 mpy. Aluminum corrodes at a lesser but unacceptable rate. Two metal systems, aluminum fins on stainless steel tubing and electrogalvanized steel on carbon steel tubing are being evaluated. Polyphenylene sulfide(PPS) and vinyl ester resin - trimethylolpropane trimethacrylate, applied to surface modified and "as-received" metal surfaces, were used for corrosion protection. Visual inspections were made after approximately 2, 5, and 10 months, and no signs of blistering, chalking or delamination were apparent on any of the coated samples. All of the samples were reported to be in an "as new" condition. These test are continuing.

Turbine Components

Work to evaluate the usefulness of nickel aluminide (NiAl) alloys and high temperature polymers as corrosion resistive coatings on turbine components is being performed as a cooperative effort with PG&E. In April 1996, samples of turbine blade materials coated with PPS that was chemically bonded to the substrate by use of a zinc phosphate coupling system, were prepared for evaluation in a turbine simulator at PG&E. These tests are in progress.

Vent Gas Blowers

A program was started to identify corrosion resistant coatings for use on the cast iron casings of the PG&E vent gas blowers at The Geysers. Failure of these components due to corrosion and erosion frequently occurs within 2 years. Several potential systems were identified and field testing is scheduled to start in December 1996. An exposure time of 7 to 8 months is anticipated. The coating systems selected for evaluation are NiAl, PPS, ethylene methacrylic acid, and ethylene tetrafluoroethylene.

FUTURE PLANS

Field testing at NCPA and PG&E will be continued. Laboratory work to select promising systems for possible use on turbine blades and rotor housings will be completed. Contingent upon these results, larger-scale tests for these applications will be initiated at PG&E. Other corrosion-related projects will be started as their needs are identified by the DOE/Industry Geysers Working Group.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

Organization	Type and Extent of Interest
NCPA	Research collaborators for corrosion protection for transmission piping. Potential user of technology.
PG&E	Research collaborators for corrosion protection of vent gas blowers, dry cooling tower components, turbine blades, rotor housings. Potential user of technology.

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