EVALUATIONS OF ADVANCED COATING MATERIALS

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PROJECT BACKGROUND AND STATUS

Corrosion and scale deposition continue to adversely affect geothermal plant operating costs, energy conversion efficiency, and utilization factors. To combat corrosion, portland cement-based materials are sometimes used as liners on brine piping systems, but the alkaline nature of the cements prevents their use with acidic fluids. Other conventional protective barrier materials such as epoxies, polyesters and acrylics, or metallic claddings, are limited by the thermal and/or hydrolytic stability of the plastics, and the costs for the latter.

Since the general utilization of high alloy steels is cost prohibitive for most geothermal plants, current practice is to attempt to minimize corrosion and the scale deposition rate by plant design and subsequent operation that may not be optimum for energy conversion and fluid injection. For example, it is well known that lowering the pH of hypersaline brines can significantly reduce silica scale deposition. This would allow greater temperature differentials across the heat exchangers, reduce plant size and complexity by elimination of the clarifiers, and decrease the amount of potentially toxic waste sludges that must be disposed of at ever increasing costs. Unfortunately, the lowering pH option is constrained by increased corrosion problems which can only be solved by the use of prohibitively expensive construction materials. Low cost, acid resistant and hydrothermally stable coating systems that can be used for new plant construction and for the retrofit of existing plants are needed.

Another, but lower priority, materials need which if solved would reduce plant operating costs, is for insulative corrosion resistant liners which could be factory applied on the inside of pipe sections. Materials meeting these criteria would provide corrosion protection and reduce the required amount of external insulation. Installing insulation is a labor intensive, expensive operation. A secondary benefit would be that heat losses to the pipe wall would be reduced. The resulting higher temperature at the brine/liner interface may result in reduced susceptibility to scale deposition and its adherence to the liner may be lower, thereby decreasing descaling costs.

This task was started in FY 1995 and is being performed as a cooperative cost-shared effort with geothermal energy firms.

PROJECT OBJECTIVES

The objective of this task is to optimize and field test polymer and polymer matrix composites, developed in other Geothermal Materials Development tasks, as corrosion protection systems for geothermal energy processes.

Technical Objectives

- Develop and field test low cost, acid resistant and hydrothermally stable corrosion protective coating systems that can be used for the retrofit of existing plants and for new plant construction.

Expected Outcomes

- Significant reductions in plant construction costs and complexity by elimination of the need for clarifiers.
- Increased electric generation efficiency and plant utilization factors.
- Enhanced environmental acceptance due to reductions in solid waste generation rates.

APPROACH

The project objectives are being met by the performance of a multi-phase effort that is cost-shared with geothermal energy and/or other industrial partners. In Phase 1, specific coating needs will be identified and performance specifications defined. Phase 2 will consist of the selection of potential candidate polymer and composite systems developed in other program tasks, and optimization of them for the specified end-use application. Field testing of coupon size samples will also be conducted in this phase of the effort. Contingent upon these results, Phase 3 will identify potential commercial sources and development partners for the technology. Field testing of coated prototype and full-scale process components at the Salton Sea KGRA and other locations will be conducted in Phase 4. Contingent upon these results, Phase 5 will consist of economic studies and the completion of technology transfer.

RESEARCH RESULTS

A cost-shared effort with the Magma Operating Company (presently owned by California Energy) for the testing of advanced coating systems at one or more of their Salton Sea geothermal plants was initiated.

In preliminary tests to determine the technical feasibility of using flame spray techniques as a means for applying polyaryl-type polymer coatings, metal coupons representing piping and turbine housing materials were supplied to the Flame Spray Laboratory operated by the Materials

Sciences Department at the State University of NY at Stony Brook (SUNY-SB). Two polymers, polyphenylene sulfide (PPS) and polyphenyletheretherketone (PEEK) are being used in these initial tests. Initial experiments to determine the optimum PPS particle size for spraying and to evaluate application techniques are underway. The work to date has shown that PPS can be sprayed with a butane torch, flame spray torch, and plasma. Parameters such as substrate preheat temperature, flame temperature and particle size are being evaluated. Based on the results obtained, it appears that high quality coatings suitable for demonstration are achievable. One major stumbling block has been the particle size of the PPS feedstock. A size distribution between 50 and 100 microns appears necessary, and this has been obtained by laboriously grinding larger particles. A major supplier of PPS resins is cooperating with us in our attempt to obtain larger quantities of properly sized material.

Work to prepare coated pipe sections for field testing commenced. Four 60-cm lengths of 25-cm diam carbon steel pipe will be used in these tests. One of the pipe sections contains a welded joint so that the ability to protect welds from corrosion can be ascertained. At BNL it is planned to dip-coat one section with PPS and another with PEEK. At SUNY-SB, PPS will be applied on two sections including the welded one. Flame spray technology will be used.

FUTURE PLANS

FY 1995 initiated laboratory testing of industry-supplied metal coupons that were coated with BNL selected corrosion protection systems will be completed. Based upon these results, field testing of coated pipe sections and other components will be initiated at the Salton Sea and The Geysers.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

Organization(s)	Type and Extent of Interest
California Energy Co.	Research collaborators for corrosion protection for plant components. Potential user of technology.
Pacific Gas & Electric	Research collaborators for corrosion protection of dry cooling tower components, turbine blades and rotor housings. Potential user of technology.

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