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DEVELOPMENT AND TESTING OF ADVANCED DIRECT-CONTACT CONDENSERS

Desikan Bharathan
National Renewable Energy Laboratory (NREL)

KEY WORDS

direct-contact condensers, hydrogen sulfide abatement, back pressure, non-condensable gas handling

PROJECT BACKGROUND AND STATUS

Pacific Gas and Electric Company (PG&E) owns and operates a set of approximately 14 power plants at the Geysers, utilizing the geothermal steam resource. PG&E produces about 750 MW_e from the Geyser steam resource, making the power available to California consumers. On some of the power systems (called Units), PG&E has experienced performance problems from existing condensers as evidenced by increased operating back pressures and a high carry-over of steam with the non-condensable gases which must be vented. Over the years, PG&E has pursued different approaches to improve condenser performance with limited success. PG&E recognized the potential merit of NREL-developed condenser concepts for gaining substantial improvement in the condenser performance and is interested in developing those concepts into workable hardware.

NREL, the Department of Energy (DOE), and PG&E have a mutual interest in carrying out a collaborative research and development effort to develop field test equipment and test data which will quantify the potential heat-transfer performance and non-condensable gas handling characteristics of these advanced condenser concepts. These condenser developments will be applicable to all steam power plants. The potential for improvement of plant heat rate is as much as five percent.

NREL and PG&E are working under a CRADA (Cooperative Research and Development Agreement) to demonstrate the use of advanced design techniques and designs to improve thermal performance and scavenging of non-condensable gases in direct-contact steam condensers thereby improving the utilization of geothermal steam resource and reducing emission of non-condensable gases.

The work to be carried out was divided in three Phases, with the indicated subtasks:

I. Conceptual Design Development
   A. Condenser code upgrade for geothermal applications
   B. Selection of packing
   C. Performance projections

D. Conceptual design
E. Decision analyses for proceeding to the following phases

II. Engineering Design and Installation (pending Go/No go decision)
A. Steam, gas and water chemistry acceptability analyses
B. Engineering design
C. Procurement and Installation

III. Operational Tests
A. Instrumentation
B. Operational tests
C. Model validation
D. Reporting

The schedule for the project is matched to accommodate the installation at the time of the next scheduled major overhaul and maintenance of the selected unit. The next opening of the condenser is now scheduled to occur in April 1996.

Phase I was carried out in FY 1994 by NREL. Phase II was implemented in FY 1995, with the definition of design and costs by March 1995, and the Go/No go decision for this project was made in July 1995, by PG&E with a go ahead for the project.

PROJECT OBJECTIVES

In pursuit of its goal of reducing the cost of electricity from various geothermal resources, the Department of Energy (DOE) is conducting investigations to improve the performance and economic viability of geothermal power cycles. One of the DOE tasks, carried out by NREL, is the development and implementation of advanced direct-contact condensers, developed at NREL, which offer a potential for reduced condenser back pressure and improved non-condensable gas handling in geothermal power systems.

Technical Objectives

- Develop analytical and design methods for improving the performance of existing direct-contact condensers at the Geysers and to retrofit one of the Units at the Geysers for performance verification.

Expected Outcomes

- Upon retrofit of the existing condenser, the condenser back pressure will be lowered significantly; this retrofit is estimated to have a pay-back period of less than two years.

APPROACH

Phase III. Engineering Design and Installation

Initial efforts in this Phase will allow PG&E to undertake a detailed engineering design of the proposed modifications, and initiate procurement and schedule installation. NREL will participate in a continuing series of meetings with PG&E to provide technical guidance and allow uninterrupted progression of the project from the conceptual stage to the engineering stage.

This third phase will be carried out during FY 1996.

During Phase III, NREL will evaluate the requirements for instrumentation to allow model validation when data can be gathered.

RESEARCH RESULTS

A working version of a computer code for modeling the direct-contact condenser together with the accompanying chemical reactions has been developed by NREL. This code has been exercised to evaluate the operation of Unit #11 of the PG&E power plant at the Geysers. These results are being used to develop designs for the retrofit. The project is progressing according to the original plan with no significant variances thus far.

FUTURE PLANS

Upon successful demonstration of the improvements at one particular unit at the Geysers, modifications to other units may be pursued depending upon the established economic viability of the system.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

This project was initiated upon expressed interest of PG&E. Upon completion of the project with validated results, substantial interest from other power producing organizations may be expected.

REFERENCES

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CONTACTS

DOE Program Manager:

Raymond LaSala
U. S. Department of Energy
Geothermal Division, EE-122
1000 Independence Ave., SW
Washington, D. C. 20585
Tel: (202) 586-4198
Fax: (202) 586-8185

Principal Investigators:

Desikan Bharathan
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado
Tel: (303) 384-7418
Fax: (303) 384-7495