GEOTHERMAL DISTRICT HEATING SYSTEM CITY OF KLAMATH FALLS

Paul J. Lienau
Kevin Rafferty, P.E.
Geo-Heat Center

INTRODUCTION

The city of Klamath Falls became interested in the possibility of a establishing geothermal district heating system for downtown government buildings in January 1977. Since that time, the project has undergone some controversial and interesting developments that may be of educational value to other communities contemplating such a project. The purpose and content of this article is to identify the historical development of the project; including the design of the system, well owner objections to the project, aquifer testing, piping failure, and future expansion and marketing incentives.

The shallow geothermal reservoir in Klamath falls extends for at least 6.8 miles in a northwest-southeast direction, as shown on Figure 1, with a width of about 2 miles. More than 550 thermal wells ranging in depth from about 10 to 2,000 ft, and obtaining or contacting water from 70 to 230°F, have been drilled into the reservoir. The system is not geologically homogeneous. Great variations in horizontal permeability and many vertical discontinuities exist because of stratigraphy and structure of the area. Basalt flows, eruptive centers, fluvial and lacustrine deposits, diatomite and pyroclastic materials alternate in the rock column. Normal faults with large throw (estimated up to 1,700 ft) are spaced less than 3,300 ft apart and appear to be the main avenue of vertical movement of hot fluids.

In order to more effectively utilize this resource, the city of Klamath Falls decided in 1978 to apply for a federal grant (Program Opportunity Notice to cost share field experiment projects) to construct a geothermal district heating system that would deliver geothermal fluids to areas not located on the resource.

In 1977, several Geo-Heat Center staff members visited Reykjavik, Iceland, to study the design of their geothermal district heating systems. This was in part the basis for the conceptual design and feasibility study (Lund, 1979) of a downtown commercial district. The main difference between the Icelandic systems and the Klamath Falls design was that the Icelanders used an open-type system delivering geothermal fluids directly to the customers; whereas, the Klamath Falls type was a closed-system design employing a central heat exchanger.

SYSTEM DESIGN

The conceptual design involved determining production field locations and characteristics, identifying boundaries of market areas and determining the heat load of the commercial district, development of the commercial district distribution design for geothermal fluid delivery and disposal, evaluation of potential economic impacts and costs. During the design process, a three-phase approach was developed. The first phase (Phase I: 12.1 x 10^6 Btu/hr) consisted of supplying heat to 14 government buildings. Subsequent phases would expand the customer base to commercial buildings adjacent to the main pipeline (Phase II: 34.8 x 10^6 Btu/hr) and finally, the entire downtown commercial area (Phase III: 143 x 10^6 Btu/hr). To date, only Phase I has been completed.

The engineer of record for the project was James K. Balzhiser, Balzhiser/Hubbard & Associates, 860 McKinley Street, Eugene, OR 97402. In 1989, the Geo-Heat Center reviewed the materials and equipment (Rafferty, 1989) for the completed system. Description of the design was primarily taken from that report.

Production

The first of two production wells for the district heating project was spudded on August 21, 1979, in the area of Old Fort Road and Laguna Street, Figure 2. Figure 3 shows the temperature gradient for City Well-1 (CW-1) production well. This is a classic example of a temperature reversal after drilling through the shallow geothermal aquifer. The well was originally drilled to 90 ft and cased to 334 ft. during the first pump test, produced 60 gal/min of 190°F water with a drawdown of 170 ft or specific capacity of 0.35 gpm/ft. after perforating between 190 and 245 ft, the well produced 720 gpm of 212°F water with a specific capacity of 100 gpm/ft. This isolated example may not be typical; but, simple logic tells us the difference in transmissivity between the geothermal aquifer and zones above and below must be significant else those zones would be part of the geothermal aquifer. The second well, CW-2, was drilled to 367 ft and produced 770 gpm at 219°F with 77 ft drawdown (specific capacity of 10 gpm/ft).

After completion of the wells, tests were conducted on September 29 and 30, 1981, and preliminary indications were that the water level decline in the area of the production wells would be small, 2 to 3 ft when pumping large volumes of water. However, long-term testing was proposed to determine whether or not the two production wells could be used without causing negative impacts on the nearby private wells for Phase I or the project.

The production well pumps are vertical lineshaft turbines with variable-speed fluid drives. The variable-speed drive provides continuous operation of the pumps for constant