

THE MULTI-PURPOSE GEOTHERMAL TEST AND EXPERIMENTAL ACTIVITIES AT RAFT RIVER, IDAHO

Robert N. Chappell
DOE-IDJohn L. Griffith
DOE-IDWayne R. Knowles
DOE-IDRobert J. Schultz
EG&G Idaho, Inc.Department of Energy
Idaho Falls, Idaho 83401SUMMARY

The largest variety of geothermal tests and experimental activities at any single location in the world are underway or developing at a remote geothermal test site in south-central Idaho. The majority of the DOE sponsored research conducted by scientists from the Idaho National Engineering Laboratory (principally EG&G Idaho employees) is devoted to investigating many uses of moderate temperature hydrothermal resources. The work also includes a significant environmental baseline and long-term effects program; resource discovery, production, control and disposal; fluid handling techniques from downhole pump to the miles of buried surface lines moving fluids between the production wells and the experimental facilities.

Work was initiated at the Raft River Test site in 1973 when the Raft River Electric Coop hired a geologist to investigate the geothermal resource which was manifested through a variety of 200 to 500 foot irrigation wells which had been drilled over a large section of the valley and had produced near boiling water for many years. A small group of farmers representing the Coop visited the DOE/INEL Idaho Office and arrangements were made for the Geothermal Guidance Committee to visit Raft River in August 1973. DOE sponsored work was first funded in December 1973 and 1974 was spent with a team from the U. S. Geological Survey and scientists from the INEL performing extensive geophysical exploration in the upper portions of the valley. In January 1975 deep drilling for geothermal water began near the narrows, a site just six miles north of the Utah border. The valley has Tectonic features characteristic of both the Snake River Plain volcanic rift zones with which it intersects and the older sedimentary characteristics of the Salt Lake - Old Lake Bonneville formations.

The site selected for the first exploratory drilling was approximately between two irrigation wells which have been producing boiling water from the 400 foot level for about 40 years. These shallow wells had been drilled for agricultural purposes and evidently had intersected faults along the edge of the valley. The geochemistry of wells predicted maximum reservoir temperatures between 140 to 150°C.

The scientists involved in this geothermal effort concluded that the Raft River reservoir characteristics would be ideal to determine the lower level of temperature for hydrothermal resources which may be utilized to produce economical electric energy and also would provide an excellent source of fluid to be used to conduct direct use experiments. In addition, the remote valley was essentially unmolested by any man-made developments with only a few farms and ranches in the area, which was advantageous for measuring environmental baseline conditions and the impact of geothermal development.

Now, four years later, the site contains a total of 17 geothermal wells. Every well drilled to date has encountered geothermal fluids -- even wells drilled exclusively for monitoring purposes unexpectedly have been producing geothermal fluids. Four of the wells drilled to about the 4,000 to 5,000 foot level are being used to produce the fluid, three wells drilled (or currently being completed) are being used as injection wells and five wells are being used to monitor the effects on the reservoir of producing and injecting fluids.

The test and experimental programs which are being conducted include facilities for testing advanced heat exchangers, a corrosion/deposition mobile test trailer, data collecting equipment and general laboratories. Figure 1. is a list of the activities at Raft River.

A large number of experiments have evolved from the requirements to produce and handle the geothermal fluids. These experiments have provided new insights on a variety of problems such as the use of transite pipe for transporting geothermal fluid. Tests indicate successful use of transite pipe for 150°C geothermal fluids at 1/2 the cost of steel lines. These lines have inherent expansion capability in the joints and can be buried for reduced heat loss. Another cost savings was realized with the use of polyurethane insulation on above ground steel pipe, as well as on the buried transite. The heat loss with 2" polyurethane insulation on a 10" transite pipe flowing 1,000 gpm is less than 1°C per mile of line. This becomes extremely important in using moderate temperature geothermal fluid for producing electrical energy where one degree loss in the

transportation lines results in about one percent loss in plant efficiency. Another significant experiment in fluid handling was the use of submersible pumps. The submersible pumps have been found to be reliable for 150°C, with low salinity fluids. Cost of procuring and installing submersible pumps is about half the cost of lineshaft pumps and they are generally available for delivery in less time.

A large portion of the testing at Raft River is aimed towards the economic production of electricity from the moderate-temperature resource. The electrical power-related facilities now under development or on-line are a 60-kW binary test power plant, a 500-kW direct contact pilot plant, a 5 MW(e) geothermal pilot power plant, and a second advanced 5 MW(e) power plant. The 60-kW binary unit is now on-line and has been operating successfully for several months. The first 5 MW(e) pilot power plant is now scheduled for full-power operations in early 1980. In addition to the electrical power facilities, a comprehensive testing program is being undertaken for utilization of the moderate temperature resource in direct applications.

The direct applications program is divided into three elements: the beneficial uses element, the hardware systems element, and the heat dissipation/soil warming element. Since most of the known moderate-temperature geothermal resources of the United States are located in areas which frequently experience water shortages, the beneficial use of hydrothermal fluids, after energy extraction, may enhance the competitive economic position of geothermal energy. Geothermal water is being applied on a 25-acre agricultural plot at Raft River by sprinkler and flood irrigation to field crops of alfalfa, barley, and sugar beets. Results are being compared with control crops watered from existing shallow irrigation wells and from the Raft River. Analyses are being made of comparative yields, nutritional value, accumulation of fluorides and heavy metals, salt tolerance, and changes in soil chemistry. In the aquaculture facility at Raft River, channel catfish, tilapia, and freshwater shrimp are being cultured in a grow-out cycle in which the species are reared to marketable size in geothermal water. A subsequent phase of the work will study the reproduction and spawning phase of the species' life cycle. The three culture species will be evaluated for growth rates and biomass accumulation of minerals and fluoride. An intensive aquaculture program has the potential to economically produce high-quality protein on a year-round basis in temperature-controlled geothermal fluids. Future expansion of the direct applications of geothermal energy may, in some cases, depend upon advanced concepts in refrigeration, in heat exchangers, and also modification of industrial processes to operate at lower temperatures. Figure 2. is a partial list of the current Raft River experiments.

At the Raft River Test Site, work is being undertaken on a variety of projects aimed at developing technology which will enhance the possibility

of geothermal energy usage.

- Lithium bromide refrigeration units and ammonia absorption refrigeration/deep cooling units will be operated at the site using 140°C to 150°C fluids.
- Fluidized bed drying techniques using geothermal heat are undergoing tests with potato waste products, sugar beet pulp drying, grain drying, and alfalfa drying.
- Low-temperature heat exchangers are being tested to evaluate their use in domestic and commercial space heating.

A more unique series of tests being conducted at Raft River involve heat dissipation directly to the soil through soil warming using an underground cooling grid. Cooling low temperature geothermal power plants with conventional cooling towers would use three to ten times the amount of water needed for a high temperature fossil fired plant. This, of course, is inherent in the thermodynamics of heat engines. At Raft River heat is being dissipated into the top five to six feet of soil under tree and field crops. The objective is first to determine the economics of heat dissipation into the soil and second to determine the enhancement of plant growth as a result of the warmer soil. Success of this experiment will have far-reaching effects in arid parts of the world where hydrothermal reservoirs are often located.

As one can see, the Raft River facility is truly a multi-purpose facility. The attached summary details the current through 1984 test plans, including the number of engineering and direct applications experiments on-line.

Figure 1.

SUMMARY OF RAFT RIVER ACTIVITY							
	78	79	80	81	82	83	84
NEW WELLS DRILLED	3	3	4				
OPERATIONAL PRODUCTION WELLS	4	6	8	8	8	8	8
OPERATIONAL INJECTION WELLS	3	4	6	6	5	6	6
MONITOR WELLS	7	10	10	10	10	10	10
ENGINEERING DEVELOPMENT EXPERIMENTS	24	27	35	35	30	28	22
DIRECT APPLICATION EXPERIMENTS	5	6	5	5	4	3	2
OPERATIONAL POWER SYSTEMS	1	2	3	3	3	4	4

Figure 2.

PRINCIPAL EXPERIMENTS AT RAFT RIVER

Soil Cooling
Soil Heating Agriculture
Aquaculture
Agriculture
Fluidized Bed Drying
Gas Air Conditioning
Component Testing
Tube & Shell Heat Exchanger
Direct Contact Heat Exchanger
60-kW Turbine-Generator
Environmental
Reservoir Engineering
Heat Dissipation (Pond Cooling)
Supply Well Mixing Tests
Injection Testing
Aerated Geothermal Water Corrosion
Cooling Tower Chemistry of Brine as Makeup Water
Sulfide Oxygen Scavenge Test
Asbestos Cement Pipe
Downhole Pump Test
500-kW Turbine-Generator Direct Contact