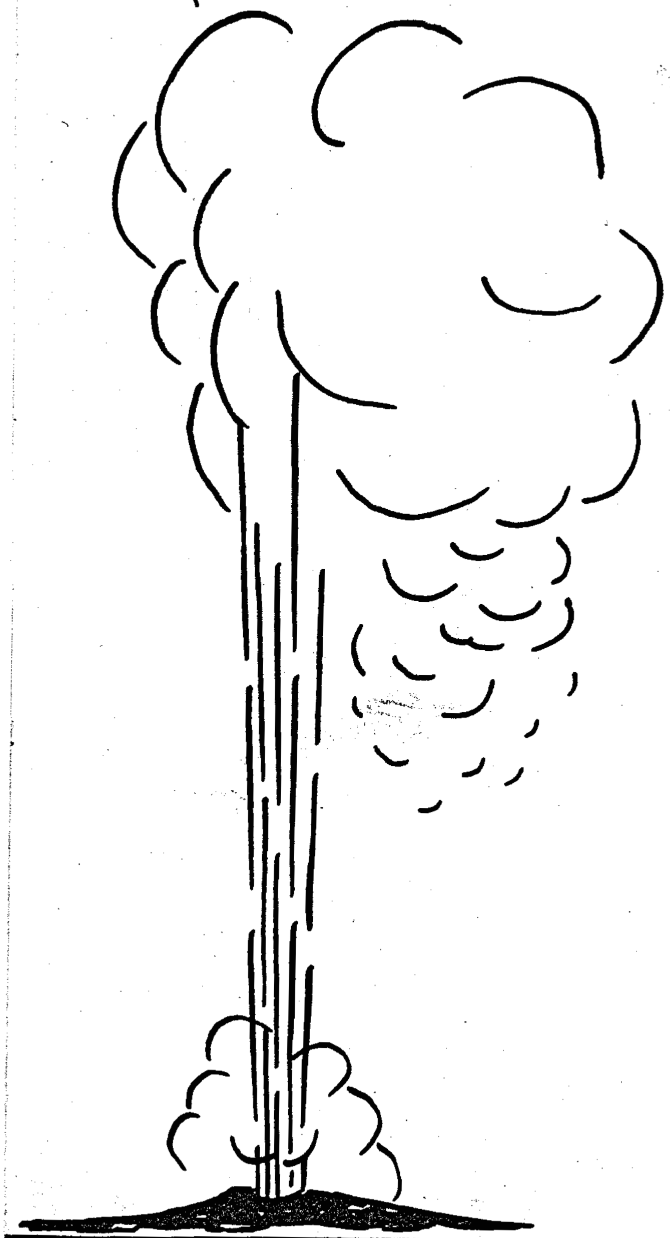
CONF-7805211--

COO-3904-1

COO-3904-1--3



GEOTHERMAL SYSTEMS MATERIALS: A WORKSHOP/SYMPOSIUM

Proceedings, May 23–25, 1978

Work Performed Under Contract No. EG-77-C-04-3904

Radian Corporation
Austin, Texas

MASTER

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

CORROSION PROBLEMS IN KLAMATH FALLS, OREGON

by

Gene Culver
Geo-Heat Utilization Center
Oregon Institute of Technology
Klamath Falls, Oregon 97601

There are approximately 450 geothermal wells in Klamath Falls, used primarily for space heating of 500-550 homes. Most of the home heating wells have downhole heat exchangers installed, (Figure 1) the first one being installed in about 1930.

Other applications include seven schools, a hospital and nursing home, the Oregon Institute of Technology college campus, several small business and office buildings and a few industrial applications. Three of the schools also utilize downhole heat exchangers. Two schools and the hospital have shell and tube exchangers and most of the remainder, including the Oregon Institute of Technology campus, use geothermal water directly in the heating system.

Plate heat exchangers are just beginning to be utilized with three presently on-line and several more planned for completion within a year.

Until very recently, corrosion has not been considered a major problem and no formal studies were made. Local plumbers and heating contractors handled problems.

The average useful life of a black iron pipe downhole heat exchanger is approximately 14 years, although lives ranging from as few as three years to over 30 years have been noted. Total replacement cost of the average downhole heat exchanger is about $600 but many are repaired for considerably less. Since this is the only major cost for operation and maintenance of the systems

DISCLAIMER

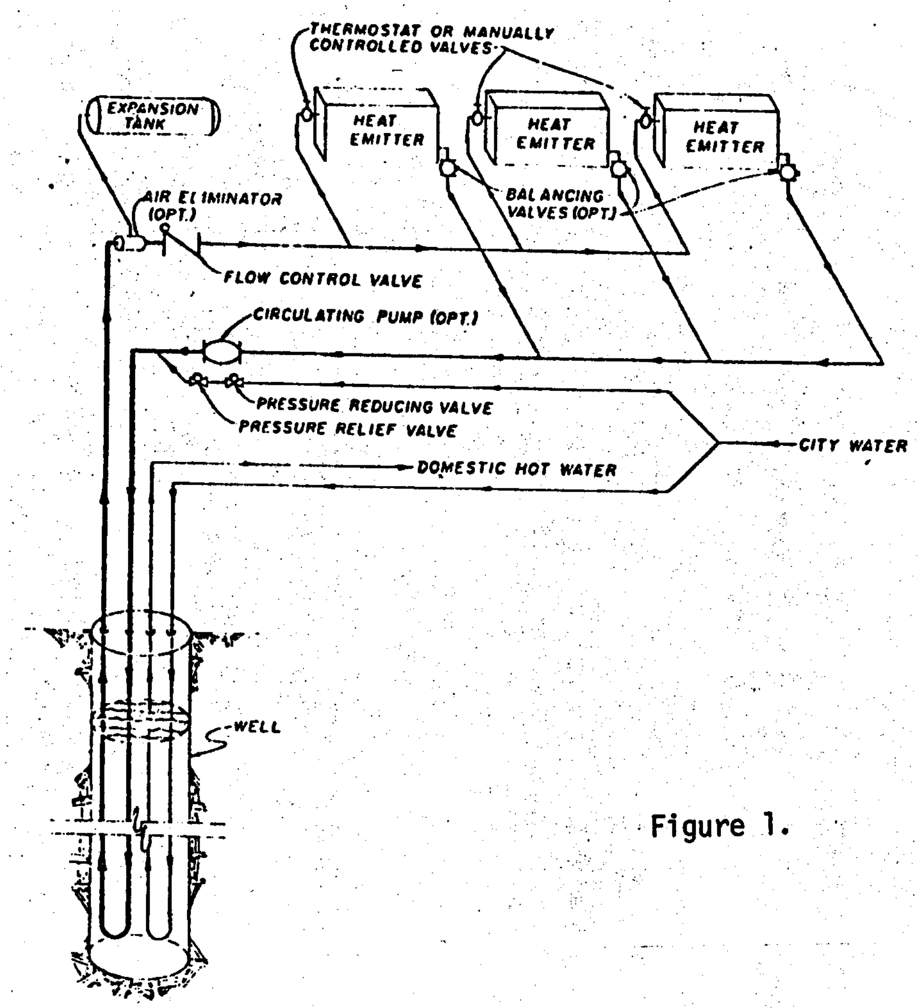

THERMOSTAT OR MANUALLY CONTROLLED VALVES
EXPANSION TANK
HEAT EMITTER
HEAT EMITTER
HEAT EMITTER
AIR ELIMINATOR (OPT.)
BALANCING VALVES (OPT.)
FLOW CONTROL VALVE
CIRCULATING PUMP (OPT.)
PRESSURE REDUCING VALVE
PRESSURE RELIEF VALVE
CITY WATER
DOMESTIC HOT WATER
WELL

Figure 1.

they were generally considered very economical after the initial cost of drilling and installation.

Because of the wide range of useful life and the fact that a few wells consistently had short lived downhole heat exchangers, a study was initiated in 1976. (Corrosion of Downhole Heat Exchangers; Lund et.al., Geo-Heat Utilization Center, Oregon Institute of Technology.) The results of the study were inconclusive in that the reasons for the variations in life were not pinpointed, however stray electrical currents are suggested. The source and nature of these currents is unknown. Further analysis and cross correlation of the data gathered during that study may provide more information.

There have been no major problems with the tube and shell exchangers, either with corrosion or sealing although the installations are all less than 20 years old. Exchangers are designed to carry geothermal waters in naval brass or bronze, straight through tubes and the tubes are rodded for cleaning about every three years. Little scale build-up is noted and as far as is known no tubes have been replaced.

Previous to 1964 most of the systems using geothermal water in the heating systems, used iron or steel in the plumbing and radiating devices, either cast iron radiators or steel finned tubes or fan coil units. Although problems were encountered with non-ferrous valves, and occassionally in radiators or fan coil unit heaters, the systems were still generally considered more economical than conventional fuels. Most failures were considered to be associated with air leaks somewhere in the system.

In 1964, the major direct use application, the Oregon Institute of Technology campus, went on-line with predominately steel piping and copper tube fan coil units. Although some problems were noted with automatic valves scaling and seizing, no major problems were noted for several years.

Although there had been some failures in fan coil units on the campus this did not become a major concern until the last year when fan coil failures became more frequent and larger coil units failed, and there were distribution pipeline failures.

During the past year, several distribution lines have failed; predominately at changes in direction. The lines are steel pipe field insulated with foam glass sections wrapped with an asphaltic and cloth mesh material. It appears (although still inconclusive) that failure is due to external corrosion where thermal expansion has caused failure of the covering allowing ground water to come into contact with the hot steel piping. Sections of distribution line that have been removed where the insulation and asphaltic material have remained intact showed no evidence of external or internal corrosion and about 1-1/16 inch or less of a modular scale build-up. We presently believe that internal corrosion of the steel distribution lines is not a major problem.

Leaks in the copper tube fan coil units have been predominately at or near solder joints and where copper tubes connect to iron headers although a few failures have occurred in the body of the coils. At this time the cause of failures is not known and a study is under way to determine the exact cause and to suggest remedies.

Unfortunately (or perhaps fortunately from an investigative point of view) two systems were designed after the Oregon Institute of Technology system, but before problems with the OIT system were noted. These systems both utilize geothermal water directly in the heating system and both use individual small copper tube fan coil units in apartments. Both are relatively low-temperature applications and utilize coils originally designed for cooling applications where the tubes are made of thinner material. Failures in these systems appeared in two-three years again at solder joints and where tubes are connected to heaters. One of these systems has been converted to use a plate type heat exchanger between the geothermal water and heating system water, the other is being studied in an attempt to determine the exact cause of failure but no progress can be reported at this time.