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TWO PHASE FLOW IN GEOTHERMAL SYSTEMS

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BI-MONTHLY PROGRESS REPORT

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for the period

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Co-Principal Investigators:
P. F. Maeder and J. Kestin
Brown University
Providence, Rhode Island 02912

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U. S. Department of Energy
San Francisco Operations Office
Oakland, California 94612

Report prepared by
R. DiPippo and R. N. Laoulache

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I. RESEARCH STAFF

During the reporting period, the project team consisted of the following individuals:

Dr. Paul F. Maeder, Professor of Engineering

Dr. Joseph Kestin, Professor of Engineering (Research)

Dr. Ronald DiPippo, Adjunct Professor of Engineering (Research)

Mr. Dimitris E. Nikitopoulos, Research Assistant

Mr. Raymond N. Laoulache, Research Assistant

Mr. Roger Follansbee, Senior Technical Assistant

II. TEST PLAN

The test plan is proceeding on schedule. The two newly constructed quick-closing valves (QCVs) have been installed in the test section following their successful bench tests. The arrangement is shown in Fig. 1 and photographs 1-6.

Flow tests are underway to prove the integrity and performance of the QCVs. To date, only a few preliminary runs have been carried out.

III. EXPERIMENTAL RESULTS

We present here the preliminary findings of one of the early test runs. The purpose was to see whether the QCVs could be activated simultaneously and closed rapidly without causing excessive over-pressure in the test section. Such an over-pressure might cause damage to the instrumentation or give rise to leaks of R-114. The test was conducted with a minimum of instrumentation: one absolute pressure probe (point P* in Fig. 1) was kept in place just below the upstream QCV. Dummy probes were placed in all other fittings.

The flow characteristics during the test were as follows:

mass flow rate	=	2.33 kg/s
stagnation pressure	=	306.36 kPa
stagnation temperature	=	18.7 C
Flash Mach no., Ma^*	=	0.363
Flash Froude no., Fr^*	=	1.2
Flash Reynolds no., Re^*	=	158,000

The QCVs were triggered simultaneously along with the isolation valves (IVs). Since the QCVs close in about 35 milliseconds and the IVs close in about 2 seconds, the test section between the QCVs is isolated first, then the rest of the test section is isolated.

No "waterhammer" effect was observed; all dummy probes remained in place and no major leaks were detected.

The average void fraction between the QCVs was measured by observing the height of the liquid column and relating this to the known geometry of the test section. A value of $\alpha=0.867$ was determined.

The flow was then allowed to resume by opening all four valves, and the test was repeated. The same liquid column height was observed.

A minor leak of R-114 vapor was detected at one section of the seal between one QCV and the tube forming part of the test section. This leak has been repaired with epoxy and the facility is now ready for a systematic series of tests.

IV. PUBLICATIONS

1. "Geothermal Electric Power, The State of the World--1985" by R. DiPippo, 1985 Int'l Symp. on Geothermal Energy, Int'l Volume, Geoth. Resources Council, 1985, pp. 3-18.

V. MEETINGS

1. Dr. R. DiPippo participated in the Fifth Meeting of the Advisory Panel for the Miravalles Geothermal Project in San Jose, Costa Rica, from August 5-9, 1985. (No expense to contract.)
2. Dr. R. DiPippo presented a paper entitled, "Geothermal Electric Power, the State of the World--1985," at the 1985 International Symposium on Geothermal Energy, Kona, Hawaii, August 26-30, 1985. (No expense to contract.)
3. Professor Joseph Kestin completed preparation for an International Workshop on Two-Phase Flow Fundamentals. The Workshop will convene at the National Bureau of Standards in Gaithersburg and conduct its deliberations during the period September 22-27. The purpose of the Workshop is to make a scientific contribution by advancing the state of the art in calculation ("prediction") of the behavior of two-phase liquid flows.

It is expected that the Workshop will generate a volume of Proceedings which will be published and widely distributed.

It is also expected that the Workshop will lead to the formulation of a list of research topics that it expects the research community to tackle in the near and mid-distant future.

Fig. 1 Schematic of Test Section Showing the Location of the Quick-Closing Valves (QCVs)

PHOTO 1.

Internal structure of a quick closing valve (QCV).

PHOTO 2. Bench tests of QCVs.

PHOTO 3. Actual set-up of QCV's on the test section.

PHOTO 4.

QCVs mounted against the I-beam.

PHOTO 5.

Especially designed brass pipe following QCV to allow adjustments in height.

PHOTO 6. Hold-up is measured immediately in a 2-foot glass pipe between QCVs once they are triggered.