GEOTHERMAL FLUID MECHANICS LABORATORY
CERRO PRIETO, MEXICO

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ABSTRACT

The purpose of the Geothermal Fluid Mechanics Laboratory (GFML), is to supply a more effective and reliable basis for the optimum design of the surface equipment and geofluids conduction.

Basically the GFML is designed to give the investigator the flexibility and freedom required for experimentation by providing a permanent installation. The laboratory will consist of four major components: the well, the test platform, the monitor & control house, and the cooling pond. The well that the laboratory is going to employ for its exclusive operation yields 64 Ton/h of endogenous fluid, with and enthalpy of 888 kJ/kg, and from which it can be obtained: steam, separated water and steam-water mixtures at different conditions.

The main fields of study in which the GFML will be involved, can be grouped in four general areas: 1) surface equipment; 2) steam-water mixtures conduction; 3) equipment arrangement & control systems; 4) air conditioning, etc. From this the first two are for immediate study, and the second ones are for long term research programs.

INTRODUCTION

At the present time the geothermal processes & equipment designs, are based upon experiences obtained in the field, rather than being supported by a solid technological basis. This is mainly due to the lack of the adequate means to develop an exhaustive experimental program, driving the investigator to use for experimentation the resources of a production system, in which you are constrained both in time and in freedom to change the operation conditions. Although, that in the field of steam-water conduction has been a lot of research involved, there is still the need to work out a more reliable and complete theory to describe and/or predict the behavior of the two-phase mixture (pressure drops, flow patterns, etc.), that is present in most of the geothermal fields.

This report presents a description of a facility in which experimental work can be done in the field, without been isolated and counting on all the supporting services such as computer system, chemical laboratory, utility water, electrical service, etc.

The GFML will be located in the Mexican Electric Research Institute (IIE) facilities at the Mexicali Valley (fig. 1), within the Cerro Prieto Geothermal field, at which the Comisión Federal de Electricidad has already installed 180 MWe, and very soon there will be 440 MWe more. The laboratory is going to employ for it, exclusive operation one of the geothermal wells of Cerro Prieto to obtain the required working fluids.

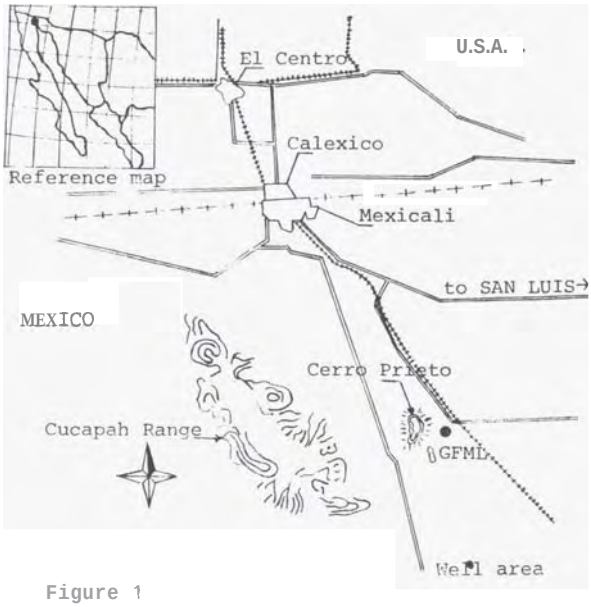

Figure 1

DESCRIPTION OF THE LABORATORY

The GFML is formed by four major components: the geothermal well, the monitor & control house, the test platform and the cooling pond, and from them the laboratory is going to get the working area, the working fluids, and the supporting, services.

The esquematic drawing of figure 2 shows the flow diagram of the GFML. The endogenous fluid from the well is lead to the steam separator located at the test platform 300m away from the well. Within the platform it can be obtained: steam, se-

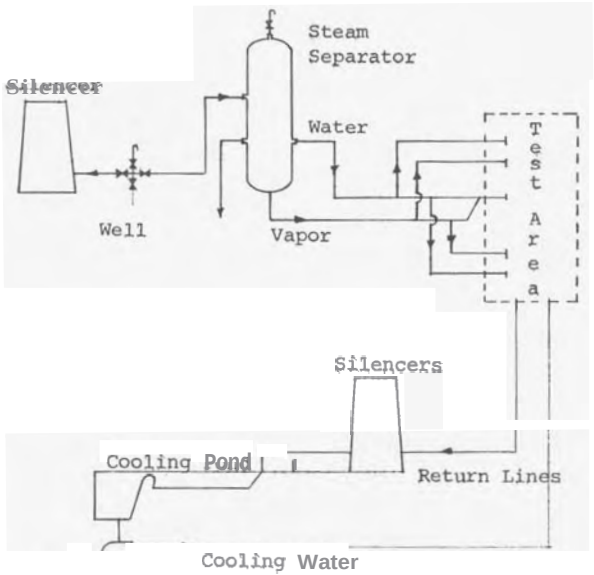

Figure 2

parated water, steam-water mixtures, and cooling water, all from the geothermal fluid. The excess of fluid and/or the "used" fluid in the test pad will be taken by the return lines to the silencers placed close to the cooling pond. The laboratory's four components physical distribution and situation with respect to the IIE buildings is shown in figure 3.

Geothermal Well

One of the main features of this facility is the exclusive use of a geothermal well as a source of working fluids. The well that the laboratory is going to employ is well No. Q-757 from Cerro Prieto, and it has the following characteristics.

General Data

Depth (m)	Max. Temperature at 450m(°C)	Production Casing Diameter (m)	Total disolved solids (mg/ℓ)
935.44	220	0.244 (9 5/8'')	18292

Production Table

Wellhead pressure	Enthalpy kJ/kg	Flowrate (Ton/h) Water	Steam	Total
12.4 Bar	1130	26.7	6.8	33.5
10.6 "	954	36.3	4.7	41.0
8.8 "	1092	36.4	8.2	44.6
6.9 "	925	51.4	5.8	57.2
5.5 "	929	52.9	6.1	59.0
4.8 "	888	58.5	5.5	64.0

The use of this well has many advantages due to the characteristics of the fluid, that are similar to the actual ones, and because of the relatively large flow rate, so that not only models but even full size equipment can be tested.

Monitor & Control House

The monitor house is situated next to the platform. It has a surface of 91 m^2 (7 x 13 m) in which there are distributed two private offices, a a working table, the process & data acquisition system, the control panel, and several desks in the general area for visitors. The house wall that is adjacent to the test platform is provided with a window section so that direct observation of the experiment can be done from inside the house. It will be possible too, to have a continuous record and monitoring of the test data from inside, either by looking the punctual digital indicators or by accessing the computerized data acquisition system.

Apart from the facilities mentioned above, the monitor house will be equipped with air conditioning, telephone, electricity, utility water, radio, and some other comfort services.

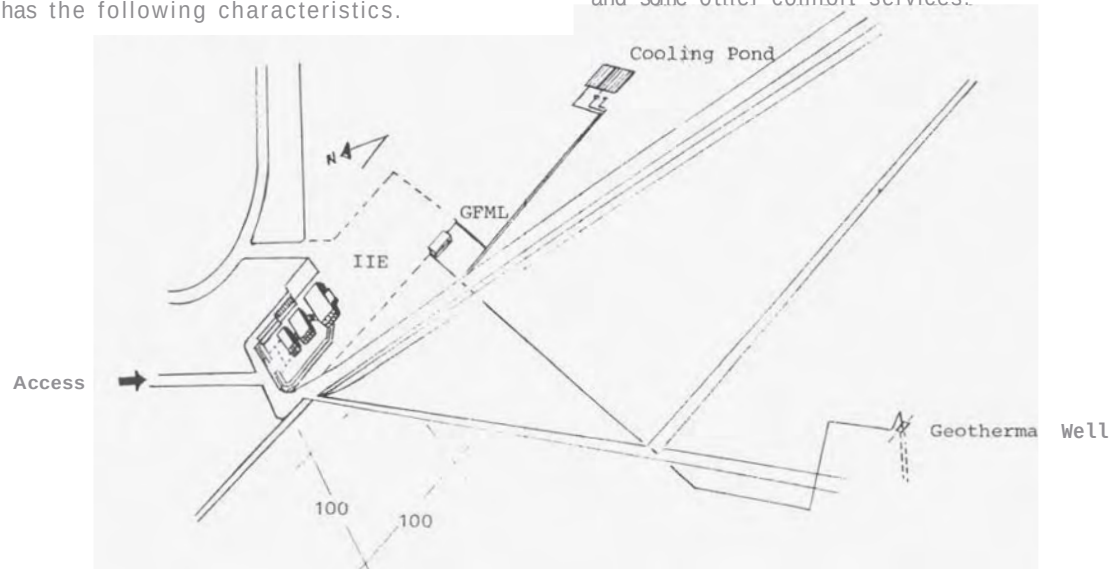

Figure 3

Attached to the monitor & control house is a warehouse that will be used to store hardware and supplies, and as a workshop where maintenance and installation work can be done. The shop will count on some basic tools such as metal lathes, drill press, welding equipment, a complete tool crib, etc.

Test Platform

The test platform consists of a concrete pad in which are located the steam separator and two sets of manifold arrangements, from which steam, water, cooling water, steam-water mixture, and return lines can be obtained. The test pad is designed to provide the area for the placement of test equipment, allowing free access to the manifold and other equipment.

The total area of the platform is of 1188 m^2. Within the test pad the two manifolds and equipment are disposed in one corner of the test pad, leaving a free usable space of about 750 m^2 (25 x 30 m). The manifold arrangement consist of 6 valves, one for each of the fluids mentioned above and it's respective return lines to the silencers. Over one side of the platform it will run a water and a steam line, that will eventually join together to get a steam-water mixture at the desired proportions. Figure 4 shows an isometric view of how will look the GFML test platform and monitor house.

cles and yet give the service.

The electrical power supply to the laboratory has a total capacityof 105 kVA, having the following services: 220 volts, AC-Three Phases; 220 volts, AC-One phase; 110 volts, AC-One phase. Compressed air will be available at 100 psig and with a total flowrate of 100 scfm. Utility water will also be available for cleaning the equipment and test area. All the instrumentation provided by the GFML will be of the electrical transmitters type (pressure, temperature, flowrate), that will send the signals to the acquisition system via service station connections.

SCOPE OF ACTIVITIES AT THE GFML

Once the construction of the laboratory has been carried out, it will be very useful to substantiate the theory and complement the analytical work by an exhaustive program of experimental research in geothermal systems.

An effective program of technology development will require a close coupling between the experiments at the GFML and a supporting program of analytical research. At the IIE there are already research programs concerning two-phase flow conduction, surface equipment desing and geothermal power conversion cycles, for which the laboratory facilities will be for immediate application.

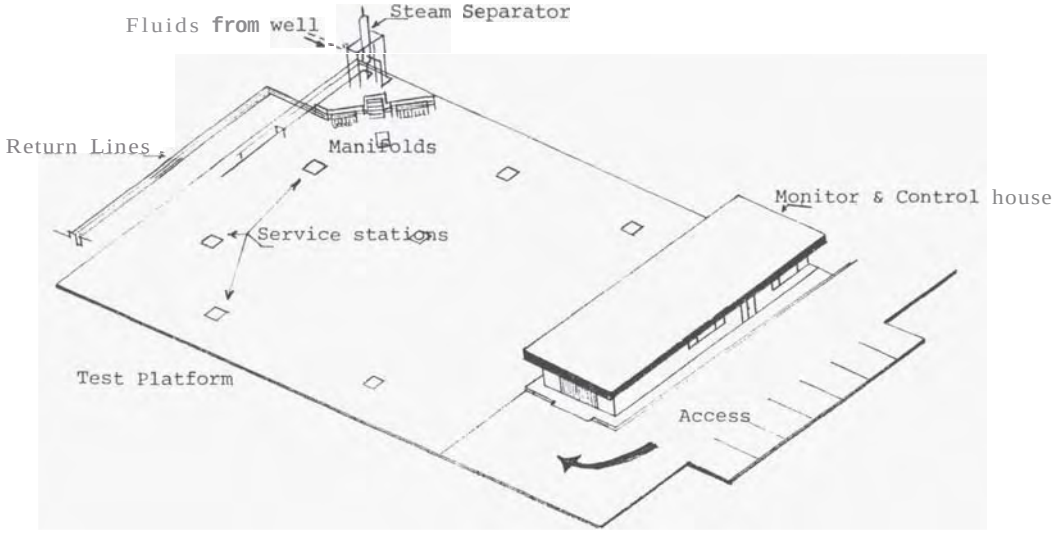

Figure 4

General Services

The GFML additionally will provide the experimenter with: perimeter lighting, electrical power, utility water, instrumentation, and compressed air. This services will be supplied by service stations, which are distributed in such way over the platform (figure 4), that the maximum distance from any point to a service station will be of seven meters. These service stations will be underground toleavethe working area free of obstacles and yet give the service.

Moreover the perfect location of the GFML, withing the Cerro Prieto geothermal field, will serve to improve the transfer mechanism between research programs & results and field problems, so that the technical problems could be tackled promptly and through the right direction.

In general the research programs at the GFML can be grouped in four general areas: 1) surface equipment; 2) steam-water conduction; 3) equipment arrangement and control system; 4) desalting plants,

air conditioning, etc. From this the first two are for immediate study and the second ones are for long term research programs. Within the first two areas the following research topics can be mentioned: a) two-phase flow pressure dropsin horizontal, vertical, inclined pipes and fittings; b) optimization of the steam separator's dimensions; c) Validation of the analytical computer two-phase flow pressure drops predictions with test results; d) performance test of valves in geothermal brine; e) total flow turbines; f) development of reliable control systems;g) heat exchangers, etc.

At the present time the GFML facilities design has already been completed an is expected to start its construction by the end of 1982 and finish it by mid 1983.

REFERENCES

DiPippo, R, 1980, Geothermal Energy as a Source of Electricity: U.S. Dept. of Energy: DOE/RA/28320-1: Washington, D.C. 20585.

Gutifrrez A., 1980 Anteproyecto: Laboratorio de Mecánica de Fluidos: Instituto de Investigaciones Eléctricas IIE/EI-F-128-3704/80: Reporte Interno: Cuernavaca, México

Takhashi, Y., Hayashida, T., Soezima, S., Aramaki, S., Soda, M., 1970, An Experiment on Pipeline Transportation of Steam-Water Mixtures at Otake Geothermal Field: U.N. Symposium on the Dev. and UT. of Geo. Resources, Pisa 1979. Vol. 2, Part I

Kestin, J., DiPippo, Khalifa, Ryley, 1980, Source-book on the production of Electricity from Geothermal Energy: U.S. D.O.E. : DOE/RA/28320-2: Washington, D.C. 20585.