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THE DEVELOPMENT OF THE GEOPRESSURED RESOURCE: A STATUS REPORT

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A B S T R A C T

As a response to the America's need for alternate energy sources, the United States Department of Energy has a Geothermal Program. Within this program is a category to study Geopressured Energy. Today many activities are taking place under the Geopressured Program. These activities for the most part fall under one of the following categories: Well Operations, Geoscience & Engineering Support and Energy Conversion. To date this program has had many successes. However, there is still more information needed concerning the Geopressured Resource. It is thought that continued research will give the developer a better understanding of the Geopressured resource and in turn increase the likelihood of its' development.

INTRODUCTION

Today, America is continuing the search for alternative energy sources. As part of this effort, the United States Department of Energy (USDOE) has numerous programs exploring various energy alternatives, one of which is Geothermal Energy. The Geothermal - Geopressured Program is one of the many activities in the Geothermal Program. This paper gives an overview of this program.

The geopressured energy resource is made up of large reservoirs containing high temperature and high pressure brines saturated with various amounts of hydrocarbons. These properties often result in large amounts of thermal, mechanical and chemical energy. The goal for the Geopressured Program is to improve the technology to the point where this energy can be converted to electricity in a cost range of 6 to 10 cents per kWh by 1995. Several questions must be answered before this goal can be obtained. These questions range from reservoir reliability to energy conversion technology.

The USDOE's Geopressured Program is actively pursuing answers to the questions that are limiting the development of the Geopressured resource. The program management is provided by the DOE-Headquarters' Geothermal Technology Division located in Washington D.C. The project management is provided by DOE's Idaho Operations Office with assistance from EG&G, Idaho.

The program is broken down into three tasks: Well Operations, Geoscience and Engineering Support, and Energy Conversion. Each of these tasks are made up of several projects that are carried out by various contractors and universities.

The Funding for the program in fiscal year 1989 was $9,850K. This has resulted in a large amount of activity in the Geopressured Program tasks and their associated projects follows.

WELL OPERATIONS

The Well Operation Task is a major part of the Geopressured Program. This task consists of producing DOE owned geopressured wells and then re-injecting the produced brine. DOE-ID currently has a contract with the Eaton Operating Company located in Houston, TX to operate and maintain the wells. The goals for the Well Operation task are: 1) to obtain production data that can be used by the program researchers to address the Geoscience and Engineering Support goals, and 2) to obtain experience to address the specific well operation goals. The specific goals for the well operation task are summarized below.

Prove long-term injectability of large volumes of spent brine by 1992,

Minimize fluid production expenses by 1989,

Develop technology for automated operation of geopressured production system by 1993,

Develop modified scale inhibitor treatment procedures by 1989, and

Reservoir Analysis

The testing ground for the well operations task currently consists of three geopressured wells located in the Gulf Coast Area. They are the Pleasant Bayou Well, the Gladys McCall Well and the Hulin Well.

Pleasant Bayou Well - The Pleasant Bayou Well is located in Brazoria County, TX. The well has a total depth of 16,500 feet. The temperature of the brine at the surface is 291 F. The brine has a total dissolved solids count of 131,320 ppm and a gas/water ratio of 29 scf/bbl. The site also has an injection well, where brine is being injected at a depth of 6,400 feet.

In May 1988 the well was brought on line. It is currently being flow tested at 20,000 barrels per day. The Eaton Operating Company has a subcontract with the Institute of Gas Technology to operate the surface handling equipment. Program plans call for well testing to continue through FY-1990. A 1 MWe Hybrid Power System (which will be discussed in the Energy Conversion section) will be installed at this site in the spring of 1989.

Gladys McCall Well - The Gladys McCall Well is located in Cameron Parish, LA. The well has a total depth of 15,831 feet. The temperature of the brine at the surface has been recorded at 288 F. The brine has a total dissolved solids value of 92,800 ppm and a gas/water ratio of 31.8 scf/bbl. This site also has an injection well where brine is injected at a depth of 3,514 feet.

Flow testing of the Gladys McCall Well was initiated December 1982. The well was tested off and on through October 1987 when it was shut in so that the reservoir pressure could recover. During the production period 27 million barrels of salt water brine were produced which resulted in 676 million scf of gas. The production period was considered very successful both because of the large amount of brine was produced and injected, and because an effective scale inhibitor was developed. The well head pressures before and after flow testing were 5,935 psia and 3,580 psia respectively. Currently, the well has been shut in for 17 months and the well head pressure is 4800 psia. Future plans for the well are being developed.

Hulin Well - The Hulin Well is located in Erath, LA. This well has a total depth of 20,700 feet. The temperature of the well at 20,700 feet is 366 F. The brine chemistry for the well is not yet available. An injection well has been drilled to a depth of 6,700 feet.

On October 31, 1988, rework of the Hulin Well began. The intent of the rework was to cleanout the well, replace old mud with new, and recomplete the well with new tubing. The cleanout and recompletion of the Hulin Well have been completed. The present small diameter production tubing will be used only for limited flow testing. Larger diameter tubing will be run in the future to permit higher rate brine production. Future plans for the well include installation of a surface handling system, long term flow testing, and possibly an energy conversion system.

GEOSCIENCE AND ENGINEERING SUPPORT

The Geoscience and Engineering Support Task is intended to accomplish two objectives: 1) evaluate well operation data and 2) examine factors which effect geopressured energy production. The task is broken into four projects: rock mechanics, reservoir engineering, liquid hydrocarbons, and environmental assessment.

Rock Mechanics - The effect of compaction and creep on geopressured - geothermal reservoir rocks is not well defined. The mechanics of these rocks is very important because it effects the wellbore stability. To better understand the rock mechanics, stress - strain relationships of reservoir rocks need to be defined so that basic rock properties at in-situ conditions can be determined.

Researchers at the University of Texas at Austin are conducting strength and mechanical property tests on Pleasant Bayou cores and completing work on compaction and creep testing of Gladys McCall sandstone. This work is resulting in improved methods for creep testing and improved knowledge of geopressured - geothermal reservoir rocks.

Additionally, the University of Texas researchers are making tensile measurements on core samples. The tensile behavior of geopressured-geothermal sandstone, the rock strength, well depth, fluid flow rate, temperature, and formation properties are all variables which effect wellbore stability during fluid production. This work is providing basic data for future well development programs.

Reservoir Engineering - The objective for the Reservoir Engineering project is to develop techniques to increase confidence in the ability to locate and evaluate geopressured resources by 1992. The project is taking two approaches to accomplish this objective: 1) data from the program's geopressured wells is being evaluated and modeled, and 2) improved logging techniques are being developed.

Researchers at the University of Texas at Austin (including subcontractor S-Cubed in California) and Louisiana State University are utilizing geopressured well data to develop two reservoir models. These models are intended to predict the reservoir size and behavior. Pressure drawdown and buildup data along with site specific geology is used to predict reservoir size. Brine chemistry, pressure, temperature and site specific geology are used to predict reservoir behavior.

The University of Texas at Austin is developing improved logging techniques intended to assist in evaluating the geopressured resource. The current efforts include evaluating logs from geopressured wells, conducting research on the effect of log resistivity resulting from rock wettablity and shale content, and determining the effect boron and other trace elements have on the neutron log.

Liquid Hydrocarbons - The objective of this project is to determine source and flow mechanisms for hydrocarbons being obtained from geopressured reservoirs by 1991.

Currently, the University of Southwest Louisiana is conducting research on cryocondensates in geopressured wells. Brine from the test wells is sampled and analyzed to determine the solubility of aromatics. The geochemistry of the

cryocondensates reflects the conditions in the geopressured reservoir. A spin-off of this work is the development of an in-line benzene monitor. This monitor has a sensitivity level which may make it suitable for use by the EPA in there effort to monitor the environment. Additionally, the University of Southwest Louisiana is developing an in-line pH monitor for use in the geopressured - geothermal well conditions.

Environmental Assessment - There are environmental concerns related to producing and injecting geopressured brines. These concerns primarily deal with land subsidence, growth fault activation and water quality. The objective for this project is to determine if geopressured fluids can be produced and disposed in an environmentally safe manner by 1995.

Researchers at Louisiana State University are currently conducting an environmental monitoring project. This monitoring effort is taking place at the DOE test wells. Subsidence and seismicity are monitored by instruments set up on site. Water quality is monitored by routine sampling of the ground water. The data obtained is then analyzed by researchers at Louisiana State University and Southern University. To date, no adverse environmental effects have been observed. However, further testing is needed before a conclusion can be made.

ENERGY CONVERSION

The ultimate goal for the geopressured program is to find a way to economically utilize the energy from a geopressured resource. To accomplish this, a utilization system is needed which takes advantage of the three forms of energy available (chemical, thermal and mechanical). The current project taking place in the Energy Conversion category is the development, construction and operation of the Pleasant Bayou Hybrid Power System.

Pleasant Bayou Hybrid Power System, (HPS) - The DOE and EPRI have a contractual agreement to collaboratively design, build and operate a small 1 Megawatt power plant to be located at the DOE's Pleasant Bayou Well. EPRI is responsible for the design and equipment refirbishment. The DOE is responsible for the equipment, construction and operation. The Eaton Operating Company is DOE's contractor for this project; they in turn have a subcontract with the Ben Holt Company to construct and operate the system. The HPS will utilize the geothermal brine as a heat source for a binary cycle and use the methane produced to power a gas engine. The exhaust from the gas engine will also be used as a heat source to the binary cycle.

Currently, the project is in the construction phase. It is planned to have construction completed by June 1, 1989. At that point a 12 month operation period will begin.

CONCLUSION

There is a lot of activity taking place in the Geopressured Program. All attempts are being made to insure that these activities result in success. However, without industry support, success will be more difficult. Currently, industry involvement in the program is limited. Efforts are being made to increase industry participation. These efforts will result in two things: 1) the knowledge base of the program will be increased, and 2) the transfer of technical information to industry will be increased. The transfer of technical information could be extremely valuable to industry since much of the work currently taking place in the program has the potential to be very useful outside the geopressured energy arena. Examples of this are the improved scale inhibitor and the in-line benzene monitor.

By continuing down the path which has been developed by program researchers, it is hoped that the program goal of producing electricity economically can be achieved. This would be a very positive step in our nations search for energy alternatives.

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