GEO
Drilling Fluids, Inc.

TECHNICAL SERVICES NEWSLETTER

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GEOTHERMAL ENERGY PRODUCTION AND DRILLING

By: MIKE NEEDHAM

HISTORICAL BACKGROUND OF GEOTHERMAL ENERGY IN THE USA

Evidence of first uses of Geothermal Energy in North America goes back as far as 10,000 years with the settlement of Paleo-Indians at hot springs. The hot springs served as a source of warmth and cleansing and the minerals as a source of healing.

In the early 1800's European settlers were the first to use geothermal energy commercially by developing spas at several geothermal vent sites.

In 1921 after several unsuccessful efforts the first geothermal energy plant went into operation in

Geothermal Energy
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Work spares us from three evils: boredom, vice, and need.
Voltaire
21 November 1694 – 30 May 1778, French Enlightenment writer and philosopher

WHAT DO *YOU* WANT IT TO BE?

1. If filtrate Ca is 60 ppm and pH is 11.2, adding Phosphoric Acid will cause the filtrate Ca to: a) go down, b) go up, c) stay the same, d) become cement.
2. When choosing between HEC and GEOZAN for use as a viscosifier in a clear water fluid, one of the factor is: a) cost, b) ULSRV, c) gel strength, d) biodegradability.

ANSWERS ON PAGE 4

BALLOONING

Ballooning is a phenomenon that looks like flow but is actually the return of mud lost to the formation. When the pump is shut off, the well is flowing if the amount of mud coming back is consistent over time or increases. If the flow decreases it indicates ballooning.

The problem is that ballooning can and usually does result in flow with pumps off and measured pressure. Then the critical issue becomes recognizing the difference between, ballooned pressures, vs. flow. This is where recognizing the totality of the well data becomes important – well "listening" is critical, and if the mud weight was arbitrarily too high to begin with, these conditions are masked and leaves one guessing as to what is really happening. When there is flow and pressure that is misinterpreted as flow instead of a ballooning event, and mud weight is then added the problem is made worse. Here is what happens:

Ballooning is misinterpreted as flow. Mud weight is increased. Possibility of fracturing and induced losses. Potential to induce well control issues as a result of the loss in hydrostatic pressure.

Geothermal Energy

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The Geysers (Northern California) at a resort, producing 250 kilowatts, enough electricity to light buildings and the street at the resort.

In 1927, Pioneer Development Company drilled the first exploratory geothermal wells in the Imperial Valley, California.

In 1960, the first large scale geothermal electricity-generating plant began operations by Pacific Gas and Electric in the Geysers. The first turbine produces 11 megawatts (MW) of net power and has been successfully operating for more than 40 years.

The Geysers, in California, boasts the largest group of geothermal power plants in the world with 21 (producing approximately 2000 MW of electricity) with more in development.

In 1993, ORMAT Industries Inc. completed the first 23 MW, binary technology power plant at Steamboat Springs, Nevada.

In 1995, the Department of Energy (DOE) made assessments in 10 western states identifying 9000 thermal wells and springs and 271 communities with a geothermal resource greater than 122° F.

Geothermal energy supplied less than 1% of the world's energy in 2008, however it is anticipated that this source of energy will meet as much as 20% of the worlds energy requirement by 2050.

WHAT IS GEOTHERMAL ENERGY?

Geothermal Energy is heat from deep inside the earth that intrudes through the Earth's crust by way of fractures and comes in contact with water near the surface. The portion of geothermal energy that

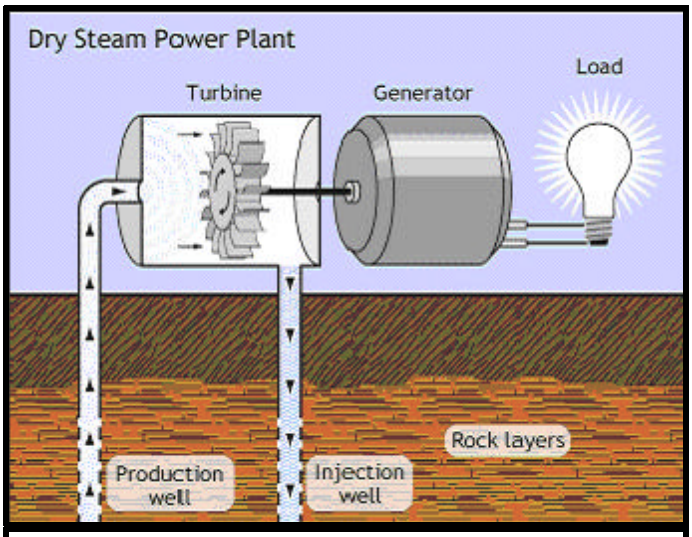

FIGURE 1—Dry Steam Power Plant

can be easily developed is trapped in permeable rock formations beneath the earth's surface. Geothermal plants produce steam or hot water from wells tapped into these formations to run an electrical generator, then return the fluids to the underground reservoirs to close a renewable loop that can last indefinitely.

COSTS

Real "levelized" costs for geothermal electricity generation are competitive with most fossil fuel facilities but with less pollution. The real "delivered" costs depend on ownership arrangements, financing, transmission, the quality of the resource and the size of the project. Most projects are relatively capital intensive with low variable costs and no fuel

Geothermal Energy

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Geothermal Energy
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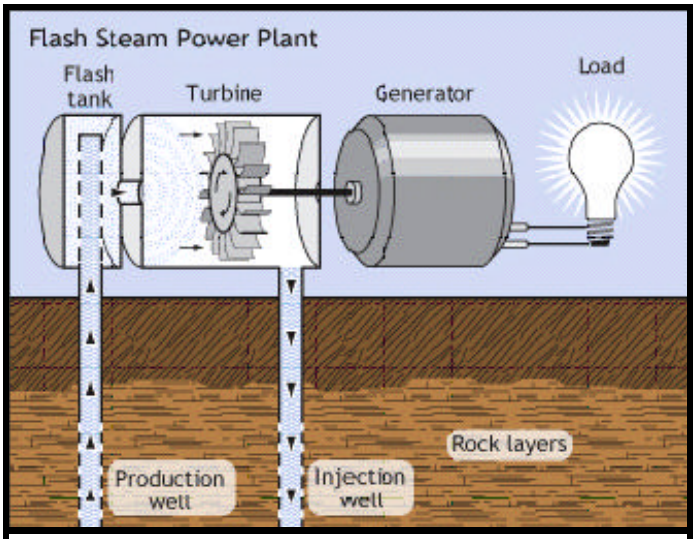

FIGURE 2—Flash Steam Power Plant

costs. This frees the power plants from the burden of cost fluctuations for hydrocarbon fuels.

TYPES OF GEOTHERMAL ELECTRICITY PRODUCTION

DRY STEAM - Dry Steam power plants use the steam as it comes from the wells to directly turn the turbine/generator units to produce electricity (see Figure 1). Allowing the raw fluid to come in direct contact with the turbine blades is very risky. Any bits of formation that are produced along with the steam can damage the finely tuned blades.

FLASH STEAM - Flash Steam power plants are the most common type of geothermal power generation plants in operation today. They use temperatures greater than 360°F. Fluid is sprayed into a tank with a pressure much lower than that of the fluid, causing some of the fluid to vaporize or "flash". The vapor then drives a turbine, which drives a generator. Any remaining liquid in the tank can be flashed again in a second tank with lower pressure to recover even more energy (see Figure 2).

BINARY-CYCLE - Binary-Cycle power plant technology can utilize a lower temperature (below 400°F). This is a more abundant resource and it is expected that most future geothermal power plants will use this technology. This process uses a secondary ("binary") fluid with a much lower boiling point. The hot water is passed through a heat exchanger (closed-loop system) where the secondary fluid (usually an IsoPentane with vaporizing temperature below 85°F) flashes to vapor which then drives the turbines (see Figure 3). Because it is a closed loop system, virtually nothing is emitted to the atmosphere.

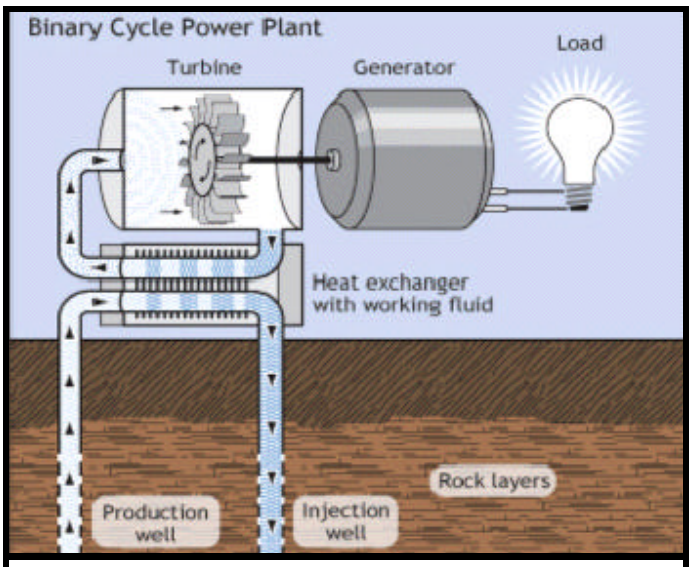

FIGURE 3—Binary Cycle Power Plant

All of the geothermal generating technologies return the geothermal fluid to the hydrothermal reservoirs for reuse.

PROS AND CONS OF GEOTHERMAL ENERGY

PROS - Once produced, geothermal energy is almost completely non-polluting. Geothermal power plants are relatively inexpensive to operate. The energy is technically renewable and can be used as a direct power source. These power plants are environmentally friendly and leave a small carbon footprint.

CONS - This technology only makes geothermal energy available to specific regions of the planet. Initial drilling costs are expensive and the process is complex. Although the earth's heat is ever present, heat sources can be depleted locally through mismanagement and/or being overproduced.

CHALLENGES IN THE GEOTHERMAL DRILLING PROCESS

Geothermal Energy
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Geothermal Energy

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Drilling technology used for oil, gas and other resources has been adapted to geothermal drilling. State-of-the-art geothermal drilling, utilizes oil and gas drilling methods, modified for geothermal environments. This is necessary to mitigate the effects of high temperatures and the corrosive effects of the hydrothermal environment on drilling equipment.

Some of the conditions that present challenges to the drilling process are; high temperatures, large well bores, sloughing shales, unconsolidated sand formations, volcanic ash formations, clays, high chloride produced fluids, lost circulation in fractures and permeable zones associated with producing formations, hard and abrasive rock formations, toxic and corrosive gasses, and controlling flow from pressurized production zones.

The drilling environment in geothermal fields

poses special problems that hinder the drilling process. Technologies are still being developed to overcome some of them. High temperature instrumentation and seals, specialized logging equipment, specialized chemicals and mud materials, anti corrosives, improved metals, improved drilling methods and other techniques are some of the things that have either been improved or are the subject of research to help overcome the challenges of geothermal drilling.

New equipment and materials used in geothermal drilling and energy production are continuously being developed to improve both the efficiency and cost effectiveness of geothermal resource development. Projectile drilling, spallation drilling, laser drilling and chemical drilling are being investigated for commercial geothermal applications.

New computer technologies are being developed for managing the processes both inside the plants and with reservoir management. These have the potential to greatly increase the efficiency and cost effectiveness of the geothermal production process.

FUTURE PROSPECTS FOR THE GEOTHERMAL ENERGY INDUSTRY

Sources have already been identified that could increase power production by thousands of megawatts from current levels. With improvements in technology, even more power will become available. Usable geothermal resources will not be limited to “shallow” hydrothermal reservoirs at the crustal plate boundaries. Much of the world is underlain (3 - 6 miles down) by *hot dry rock* - no water, but lots of heat. Scientists in the United States, Japan, England, France, Germany and Belgium have experimented with piping hot water into this deep, hot rock to create more hydrothermal resources for use in geothermal power plants. As drilling technology improves, allowing us to drill much deeper, geothermal energy from hot dry rock could be available anywhere. Then we will be able to tap the enormous heat resources of the earth’s crust.

ANSWERS TO WHAT DO *YOU* WANT IT TO BE?

1. B) Go up.
2. All of the above.

THE MUDMAN'S CORNER

SAFETY ALERT

In the last Newsletter the Safety Alert discussed taking action to prevent accidents. There were several comments that I think deserve publishing.

"When the Boss comes to you and says 'I don't care what it takes, GET R DONE!' He does not mean for you to do it at all cost, (foregoing safety). I think he means, "Get it done, even if it costs more. For example; hire a contract truck, call for a crane, or rent proper equipment to do the job Safely!"
David Hughes, Warehouse Manager, Bakersfield.

Another response read: "Apparently one out of four people would speak up if their concerns and identities were kept confidential." Jim Clifford said "This really misses the point. Waiting to present a concern until it can be done confidentially doesn't prevent accidents from happening right now. Every GEO employee is encouraged and required to speak up if they see a co-worker, supervisor, or a third party employee doing or about to do a job in an unsafe manner.

One of our new Mud Engineers, still in mud school, helped out by proof reading the entire Newsletter before it was printed. After 60 copies were printed he read the Safety Alert questions again and noted that the third question had no answer. I corrected it before sending it out as an attachment to e-mails but everyone who received a copy in the mail should have been a little stumped by the question. It read "About one in _____ employees fail to speak up when they see dangerous activity." This isn't the question I intended to ask but it does have an answer. The correct answer is one and one third.

HEAT ILLNESS PREVENTION

Summer is here (in the Imperial Valley), almost here (in the Central Valley), or will be along in a month (in the Rockies) and its time to think about heat illness prevention. Carry plenty of water. When you are working outside you must drink water to keep hydrated. Mud Engineers are not immune to this risk, just a few weeks ago one of our guys passed out from a lack of water. There is no excuse for getting dehydrated on a rig.

WELL CONTROL DISASTERS

Much has been written about the Deepwater Horizon Semi-Submersible disaster. Most of what I have seen or heard was written by people who had only a cursory understanding of the drilling industry. A week or two after the blow out Brad Bush forwarded a long description of what happened and why.

Of great interest to me was the description of three shut off mechanisms that were in place or should have been. They should have provided redundant protection in addition to the BOPE that failed to operate and continued to fail even with direct intervention at the sea floor. These protections included 1. Cement in the annulus outside a new string of casing just run from the sea floor to 18,000', 2. A packoff installed at the sea floor in the well head to hold the new string of casing, and 3. A packer that may or may not have been set inside the casing. In addition there was a column of 16 ppg or 17 ppg drilling mud in the riser providing about 4500 psi pressure on top of the packoff.

As time has passed and more information has seeped to the surface it is generally believed that the foam cement job failed after the riser was changed over to sea water reducing the hydrostatic at the well head by about 2500 psi. Pressure from 18,000' migrated to the surface and unseated the casing packoff. This would not have been much of a disaster except that the packoff apparently lodged in the BOPE at the shear rams, preventing them from closing. The blind rams couldn't close because there was drill pipe in the hole. As for the pipe rams and annular preventer, who knows. The casing may have also jumped up into the BOPE further complicating the issue.

A Kern County Well

My personal experience includes nearly being killed by a failed cement job that allowed gas to percolate to the surface below the packoff/slips at the top of the casing. This happened in about 1980 when I was a roughneck, on a rig that doesn't exist any more, for a contractor who is no longer in busi-

Disasters
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Disasters

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ness, on a lease operated by an oil company also no longer in existence.

We had just set casing at TD. We "dropped the slips" on the casing. This means that as the cement is hardening they stretch the casing with the elevators and then carefully lower the packoff device from the floor to the well head. This device holds the top of the casing and seals inside the well head after a set of Allen screws are tightened. The packoff consisted of two pieces of steel, each weighed about 15 pounds. After the packoff was in place we slacked off on the casing.

The next step was to lift the rotary table out so

we could take the BOPE stack off. This rig had very low sub-bases that required special equipment to rig up and rig down the BOPE.

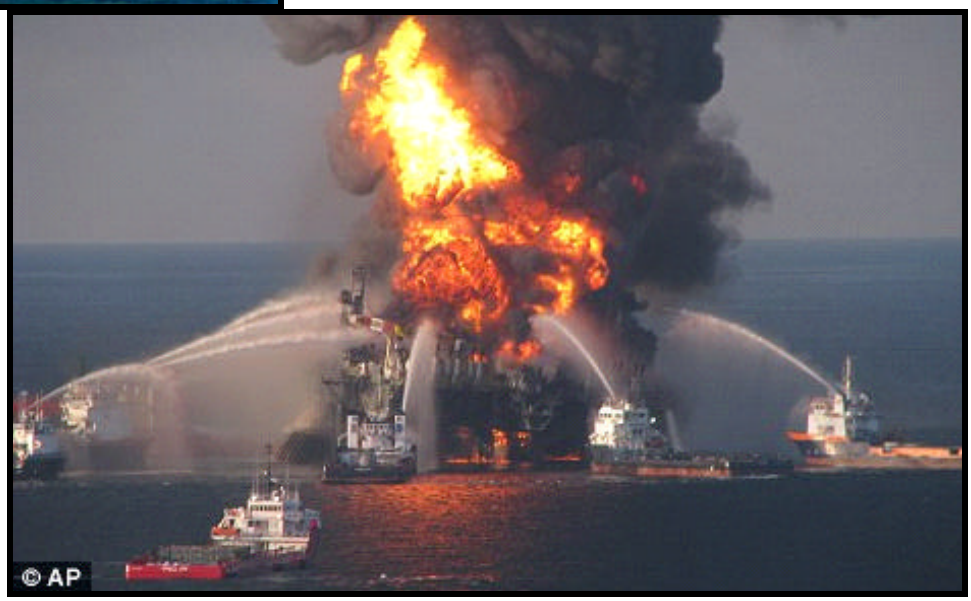
The first step was to unbolt the "mud-cross" (a spool with 2 kill line valves). This allowed the entire BOPE stack to be lifted a foot or two. The packoff was tighten and tested.

The next step was to set the stack back down, unbolt the rams from the mud cross and pick it up again. Two tracks were laid across the cellar and a little cart rolled under the preventers. They were set down on the cart and the "bag" was unbolted and picked up again. The gates were rolled out of the way and a second cart rolled in. The bag was set down and rolled out of the way.

We had just done all of that and were about to pull out the "mud cross". My job as Derrick Hand was to step into the cellar and hook the "four ways" onto the top flange of the mud cross so it could be lifted out with the elevators.

High pressure gas had infiltrated the cement as it was being pumped and compromised the integrity of the casing cement. A product called "Gas Check" was invented to cure this problem. As I stood by waiting for the Driller to lower the elevators the gas percolating through the cement built to the point where it blew the packoff out of the casing. The two pieces came with such force that they lifted the Mud Cross (maybe 500 pounds) into the air and it landed on the floor 10 feet above. One of the pieces of packoff went through the derrick, bent one of the 1" by 4" steel run-around fingers back, continued out of the derrick and landed across the location. We never found the other half of the packoff.

Fortunately, this was a high pressure low volume well that would need to be fraced before it would produce and there was no significant flow. We were able to get the BOPE back in place and shut in the well.



FREE MONEY $$

http://www.thegeothermalgolf.com/scholarships.htm

We recently were made aware of this scholarship opportunity for children of our employees. As one of the sponsors of the Geothermal Golf Tournament all of our employees, their spouses and children are eligible for one of these scholarships. The deadline is almost here, so try to take advantage of this opportunity immediately. Next year we will try to post this notice sooner.

Dear Sponsors,

First of all, the committee and I am extremely proud to announce we are again able this year to award a pool of $6000 in scholarship funds for participating students, due to the huge support of companies and people, such as yourself, to this yearly held fund-raising tournament!

Sincerely,
Ron McGranahan
President

THE GEOTHERMAL SCHOLARSHIP AWARD

"Only students affiliated with 2009 sponsors are eligible to submit applications."

The Geothermal, which represents the California Geothermal industry and service/supply contractors, is committed to our local communities. One of the major challenges facing each of these communities is the demand for an educated workforce. Not only are a large number of jobs requiring education and technical training beyond high school, but the costs associated with this continued education are escalating.

The Geothermal Scholarship Committee was formed to award scholarships to qualified graduating high school students or qualified college students. The funds for the scholarships are generated by supporting Companies in the field of energy participating in the Geothermal Golf Tournament.

The Committee will be awarding scholarships to students who meet the following requirements:

1. Must be a graduating senior in high school or student in college.
2. Must have a geothermal affiliation to a company involved in the Geothermal Golf Tournament, either by parent, close relative or associate of sponsoring company.
3. Be less than 25 years of age as of **April 15, 2010.**
4. Must have a G.P.A. of at least 2.5 if a senior in high school or a G.P.A. of 2.75 if in college.
5. Three (3) letters of recommendation from either teachers or counselors.
6. Certified copy of transcript in a sealed envelope to verify G.P.A.
7. Applicants will be required to submit a short essay (minimum one type-written page) which will be reviewed and judged in awarding the scholarships. Please submit the essay with the application but **DO NOT** write, type or in any way identify yourself by name in the essay. Simply include the essay with your application packet.
8. Please do not submit photos.

The subject Essay Question for this year is:
Our industry has seen over the past several years a movement towards renewable energy. With this in mind, in a two part question essay, please answer (1) what is "enhanced " geothermal and (2) where and why are our greatest opportunities in finding this type of renewable geothermal energy?

Please send your completed application with all supporting documents to:
The Geothermal Scholarship Committee
P.O. Box 53
Imperial, CA 92251

All submissions must be "received" or "postmarked" by **July 1, 2010.**

The Scholarship Committee will announce the scholarship awards no later than **July 30, 2010**. Scholarship funds will be awarded only after the recipient provides proof of admission from the college, university or institute where they plan to further their education. Any and all monies will be issued and sent directly to the college, university or institute under the winners' name. All decisions are final. The Scholarship Committee reserves its right to privacy.

The 2010 scholarship application is on the next page. **"Only students affiliated with 2009 sponsors are eligible to submit applications."**

The Geothermal

Application for Scholarship

Deadline for submission: July 1, 2010

Name: _____
(Last) (First) (Middle)

Home Address: _____

City: _____ State: _____ Zip: _____

Telephone: _____ Date of Birth _____

Name of parent or Guardian: _____

Address:_____City:_____State:_____Zip:_____

Name and relationship to you of the person that is affiliated with the Geothermal Golf Tournament _____

High school or college presently attending: _____

Address: _____City: _____State: ____Zip:_____

GPA: _____ SAT Score: _____ ACT Score:_____

Advisor Name:_____Telephone:_____

Outside Activities: office held in student organizations, church, scouts etc.:

_____

_____

List jobs you have held (part time or full time):

Employer: _____Address: _____

Business: _____Dates:_____ Position: _____

Employer: _____Address: _____

Business: _____Date: _____Position: _____

College/university or vocational institute you're planning to attend:

_____

Address and phone number of college/university or vocational institute:

_____

What career do you plan to pursue: _____

No. of brothers/sisters and ages_____

Father's Occupation: _____

Mother's Occupation: _____