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SURVEY FOR GEOTHERMAL COMPLETION FLUIDS*

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ABSTRACT

A survey of oil field fluids companies indicates that there are no geothermal completion fluids on the market. It is recommended that development of a completion fluid and appropriate support testing be funded.

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SURVEY FOR GEOTHERMAL COMPLETION FLUIDS

To date, research efforts have concentrated on techniques and materials needed to drill the geothermal well. With some of the initial drilling problems solved, attention is beginning to focus on developing the necessary completion practices, materials and tools. To obtain commercial quantities of power from geothermal sources will require large volumes of hot water or steam, which will necessitate high flow rates from individual wells (40,000 - 100,000 bpd/well). To be sure of obtaining these high flow rates the completion fluid becomes quite critical. This project was initiated to determine if there were any geothermal completion fluids on the market. Any products found were to be tested for suitability.

The principal requirement of a completion fluid is that it be non-formation damaging. Additional requirements for a completion fluid are:

(1) The fluid density can be varied as required to control formation pressure when the well is completed.

(2) The fluid viscosity must be low enough to allow downhole tools, such as the casing gun, to be run in and out of the hole easily.

There are two ways of making a non-damaging fluid. The first is to use a clear, filtered brine of sufficient density to control the well. The disadvantage of such a fluid is that it has no fluid loss control. Consequently if the producing formation is fractured or highly permeable, large volumes of the brine can be lost to the formation. Such losses are expensive and potentially damaging, through fines migration, clay hydration or reaction with formation fluids. The other approach is a fluid that forms a thin, highly impermeable filter cake that quickly and efficiently shuts off fluid loss to the formation. By restricting fluid loss the potential for formation damage is greatly reduced, particularly if the filter cake effectively stops loss to the producing formation instead of merely slowing the loss. Further, a highly impermeable filter cake will act as downhole filter to prevent the transport of scale, pipe dope and such into the formation. Also, if the filter

cake is thin enough (1/32" or less), then it will quickly and easily flush off of the wellbore surface when the well is turned around and put on production. Clay based fluids do not make good completion fluids because they contain large quantities of extremely fine particles (the clay) and form relatively thick filter cakes (1/16" or thicker) that do not easily flush off of the wellbore surface. The clay filter cake is relatively permeable and will allow fines to be carried into the formation.

The first step of the project was to survey the market. An example of the letter sent is in the Appendix. The major mud companies -- Dresser/Magcobar; Imco, a Haliburton subsidiary; Milchem, a Baker International subsidiary; NL Baroid -- and several independents -- Brinadd; Oilbase; Petroleum Associates of Lafayette; Texas Brine Corporation -- were contacted. Replies were received from Baroid, Brinadd, Magcobar, P.A.L. and Texas Brine. The only company that claimed to have a potential completion fluid was Baroid. Baroid recommended either a Carbonox/Aktaflo-S treated bentonite mud or an Invermul/Duratone HT system.

Oil phase invert emulsion fluids generally have an upper operating temperature limit of 450°F (235°C). Further, the fluid lost from an invert fluid while quite low is all oil. Since most geothermal wells will be producing brine or steam, there is a good potential the fluid lost from an invert could form an emulsion in the formation. Such emulsion blocks can severely limit production. Consequently, the decision was made not to test any invert systems at this time.

As mentioned before, clay based fluids generally make poor completion fluids. Since the Carbonox/Aktaflo-S system was the only potential, the fluid was studied. An initial static aging test failed when the aging cell leaked and the mud sample boiled dry. A second sample was prepared from the following recipe: 8 ppb Carbonox,¹ 4 ppb Aktaflo-S,¹ 25 ppb Zeobel, 8 ppb Q-Broxin,¹ 1.5 ppb NaOH and 250 ppb Barite in 9.1 ppg NaCl. The mud had a density of

¹Carbonox, Aktaflo-S and Q-Broxin are registered trademarks of NL Baroid.

14.0 ppg and the following rheological properties after dynamically aging at 180°F (82°C) for 16 hours: PV = 38 cp; YP = 7 lb/100 ft²; Gel (0/10) = 1/15 lb/100 ft². The sample was placed in a high temperature cell and a blanket of nitrogen was placed over the sample before the cell was sealed. The sample was statically aged at 500°F (260°C) for 48 hours, then the aging cell was removed from the oven and cooled to room temperature. When the cell was opened there was a very strong odor of hydrogen sulfide. Further, the mud was too thick to pour or test for rheological properties. Completion fluids are often left in the hole uncirculated for two to three days, consequently any fluid that develops the extremely high viscosities exhibited by the above sample over a two day period would be unsuitable as a completion fluid. The conclusion is that there are no geothermal completion fluid additives on the market.

Since commercial interest is concentrated on developing geothermal drilling fluids, future Sandia work should concentrate on the development of a completion fluid to meet the following criteria:

- (1) low fluid loss with rapid shut off
- (2) filter cake is easily removed with backflush
- (3) system is physically and chemically stable to 650°F (340°C).

Such requirements will likely be best met by a polymer base system, if polymers with the necessary temperature stability can be obtained. Testing of the developmental products should initially include static aging tests to determine general temperature stability. Later, rheological and fluid loss properties for candidate products should be obtained at expected bottom hole temperatures. The final stage of testing would be return permeability studies at bottom hole temperatures and pressures. The last round of tests would require the design and construction of the necessary test equipment.

MRC/vbm

APPENDIX

Brinadd Company

6003 MURPHY AVENUE

HOUSTON, TEXAS 77033

(713) 644-1895

September 6, 1978

Mr. Roy Wolk
Magcobar
P. O. Box 6504
Houston, Texas 77005

Dear Mr. Wolk:

Brinadd is surveying the market place for geothermal well completion fluids. We would like to know if your company has any additives that you could recommend for geothermal completion fluids. If you do have such additives we would like a sample so that we may make a preliminary evaluation of the fluid.

Brinadd is doing this work under contract for Sandia Laboratories, Albuquerque, New Mexico. Sandia Laboratories is a primary contractor for the United States Government. Our contract number is 13-0370 and Sandia contracting representative is C. R. Burbank.

I would appreciate your sending me a written reply at your earliest convenience.

Cordially,

BRINADD COMPANY

Michael R. Childers
Research & Development Director

MRC:sfw

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