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GEOPRESSURED-GEOTHERMAL TEST OF THE

EDNA DELCAMBRE NO. 1 WELL, VERMILION PARISH, LOUISIANA

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OHRW moved on location in the latter part of Janurary 1976. First, a disposal well was drilled to approximately 2500 feet and completed with a gravel pack. Injection tests were then run. The rig was then skidded over the test well, and a temperature survey was made. The bottom hole temperature at 14,300 feet was found to be 238°F. OHRW planned to flow test the Delcambre No. 1 well to obtain fluid samples and gas samples and run recombination tests. The test well at that time was completed in the #6 sand. OHRW found that the #6 sand was dead. OHRW went in with a wire-line, and found the fluid level down to about 4400 feet. Using salt water gradients, calculations indicated the reservoir to be essentially normally pressured. The question then arose, "Where did the pressure go?". We don't know. We know we were opened to the reservoir, and that it was not a case of the perfs being sanded up. OHRW pumped seventeen + pounds of mud in the tubing and lost that immediately into the formation. Since the #6 sand was dead whereas, when it had been shut in two years earlier, the tubing pressure was 4800 psi, there arises the question as to the true compressibility of geopressured reservoirs. OHRW intends to

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study this problem in more detail prior to issuring a Final Report.

After some problems, OHRW perforated the number three sand at the interval of 12,869-12,911 feet with four shots per foot. This is a perforation interval of approximately forty-two feet. The measured bottom hole pressure using a Hewlett Packard unit was found to be approximately 11,000 psi. OHRW then commenced flow tests and tested the number three sand for twenty-four days.

Upon completion of testing of the number three sand, OHRW moved up the hole after isolating the number three sand to test the number one sand. A thirty-two foot interval was perforated at four shots per foot from 12,573-12,605 feet and flow tests were commenced on the number one sand. The number one sand was tested for 25 days. Both the number three sand and the number one sand were flowed at rates near 10,000 barrels per day. Details as to flow rates, pressures, etc. will be covered in detail by Dr. Wieland.

OHRW found from the recombination test on the gas and reservoir fluid recovered at the surface that there was approximately twenty standard cubic feet of gas saturation per barrel of fluid. A plot of the gas water ratio versus pressure is not a linear function.

With a drop in bottom hole pressure of 5000 psi, approximately 2.0 scf of gas per barrel will be released out of solution. Further, at a pressure of 1000 psi there still remains in solution approximately 9 scf of gas per barrel. The significance of this is that very little gas will come out of solution due to the pressure drop caused by the flow; further, since approximately 50% of the gas is still in solution at a pressure of 1000 psi, it will be necessary to drop the pressure at the separator to nearby atmospheric pressure in order to recover the majority of the gas in solution.

Analysis of the gas recovered shows that it was approximately 90% methane and 10% other gases. Hence, there is a reduction in the BTU content which must be accounted for in determining the true value of geopressured reservoirs. It is also significant to note that due to the salinity of the reservoir fluid, the quantity of gas in solution is significantly reduced from the amount of pure methane that is in solution in distilled water. With a salinity of 80,000 ppm, there is a reduction of solubility of methane of greater than 50%.

Regarding the ratio of gas to fluid produced, after stabilized flow rates had been reached, the well produced 50-60 standard cubic feet of gas per barrel. Since the saturation level of the reservoir fluid is approximately 20 scf per barrel, this leaves an excess of about 30-40 standard cubic feet. The question arises, "What is the source of the excess gas?". It may have come from the gas cap up-dip in the reservoir; it could have come from one of the other sands by leaking by the casing from a bad cement bond; or there may be within these reservoirs not only fluid saturated with gas, but we may have a critical gas condition of two to three percent with additional free gas. If there is a high percentage of critical gas and free gas present in geopressured reservoirs, it will have a significant impact on the economics of these reservoirs for two reasons: (1) It will increase the quantity of gas that can be produced by a factor of two to four, or more. (2) It will also have a significant impact on the effective compressibility of the reservoir or in effect, how long the reservoirs will flow.

Regarding the sand production, a significant quantity of sand was produced from the number three sand; however, sand was not produced from the number one sand. Both of these reservoirs were flowed at approximately the same flow rates. From log analysis we were able to calculate the G/C_b ratio, this is a shear modulus to bulk compressibility of the sand. In calculating the G/C_b ratio for the number one sand, OHRW found the ratio to be approximately 1.5×10^{12}. We were unable to determine the G/C_b ratio on the number three sand. We, therefore, might make the hypothesis at this point that there may be some critical G/C_b ratio for water sands of somewhere between .9 to 1.5×10^{12}. It is generally accepted within the oil industry that if the G/C_b ratio for oil or gas sands exceeds 0.8×10^{12}, sand production will not occur. By determining the G/C_b ratio prior to completing a geopressured well may provide a very good indication of what sand problems might be encountered in producing the reservoir.

In recovering the in-situ fluid samples, the fluid samples under reservoir conditions, OHRW determined a very significant phenomenon. That is the chemical analysis of the in-situ samples were very near the same as the analysis of the fluid samples recovered at the surface. One other factor is that OHRW experienced a very, very low success ratio in capturing in-situ samples. The equipment used was not reliable. OHRW, therefore, would recommend that except in unusual cases, it is not prudent to attempt to obtain in-situ fluid samples.

From the draw down and build up pressure analysis, there is some reasonable, but preliminary, indication that there is not an influx of water from the shales. From chemical analysis, the chemical makeup of the fluids was found to be pretty much what had been predicted. From the pressure data analysis, it appears that both the number one sand and the number three sand has a permeability in excess of 150 millidarcies and it appears that the permeability increased away from the well bore. This could indicate formation damage due to fluid loss during drilling and emphasizes the need for a quality mud program during drilling of geopressured wells. Further, drilling with mud weights at as near balanced pore pressures as possible is also indicated to prevent fluid loss.

OHRW found a tremendous deterioration in the quality and experience of field personnel and in the condition of the equipment itself compared over the past few years. This is not a criticism of the suppliers or their people; however, this is a problem that should be addressed by the industry and DOE. OHRW greatly appreciates the excellent cooperation and service it received from all of its suppliers and sub-contractors.

For those of you who will be doing additional testing, we highly recommend that you have people on-site at all times that are fully experienced. Constant supervision is essential; many of the decision you make on geopressured wells are irreversible.

From the tests on the Delcambre well, we may conclude the following:

(1) Reservoirs in Southern Louisiana probably have sufficiently

high permeabilities and porosities to allow required flow rates.

(2) Geopressured reservoirs may produce more gas than predicted, based upon only the amount of gas in solution in the reservoir fluid.

(3) The reservoir fluid pressure will have to be reduced at the separator to near atmospheric pressure in order to recover the majority of the gas in solution.

(4) The quantity of gas in solution is significantly reduced from the amount that is soluable in pure water when the reservoir fluids have high salinities.

(5) The recovered gas is not pure methane, consequently, the BTU rating is reduced.

(6) Sand production may be a problem; however, prediction of sand production may be possible employing log analysis prior to completion.

(7) The true effective compressibilities of the reservoirs are unknown and will have a significant effect on the period the reservoirs will produce.

(8) Gas production will probably have a more positive effect on the economics of production from geopressured reservoirs than will the heat energy or the hydraulic energy.

(9) Equipment capable of handling high flow rates of high temperature fluid may present some problems.