Multistrata Exploration and Production Study

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ABSTRACT

OBJECTIVES

The objective of this project was to develop and verify a geotechnical/geostatistical approach to find natural gas resources and to verify the process by drilling, completing, testing and producing wells located by the process.

APPROACH

Research conducted in 1990 on the Eccles 7.5' quadrangle in Raleigh County, WV, USA, identified several target areas. Immediate landowners, gas companies, and mineral rights owners were contacted to determine their willingness to assist the College in conducting the research. Extensive talks were held and, as a result, agreements were drawn up between the College and the owners. Test Well 1 (TW1) was completed in May 1991 and Test Wells 2 and 3 (TW2, TW3) in November, 1991. The wells were shut in for one year thereafter while the parties involved negotiated agreements. The wells were placed on line at the close of fiscal year 1992.

PROJECT DESCRIPTION

The production phase of the Multistrata Project began in Fiscal Year 1993 when the three project wells were placed on line October 1, 1992. Natural gas from the Beckley coal zone, the Pocahontas #3 coal zone, the Ravencliff Sandstone and the Big Lime Limestone formations began flowing as designed by the agreements negotiated in 1991-1992. Tangible benefits were derived for all parties as a result of the unique gas production/transportation/sales/usage agreements created through the Multistrata Project.[1]

Gas production was enhanced and additional research was conducted with the automation of the TW1 and TW3 sites in 1993. Prior to automation, the progressive cavity pumps on these wells were operated with gasoline engines. Water and gas production from the coal seams were enhanced by running electricity to these sites and installing electrical control panels and 24-hour

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timers. This allowed for more effective variance and manipulation of the PC pumping rates and schedules.

Water disposal has been addressed on a continuing basis, and permission has been granted by the State of West Virginia to apply the produced water from the coal seams directly to the surface. The coal seam water has been analyzed and found to be potable. Water production from the Beckley coal on TW1 has averaged 14.0 bbls per day. Water from the Pocahontas #3 coal on TW3 has averaged 2.1 bbls per day.

Gas production was further enhanced and additional research conducted during 1994 with the installation of a small 16 horsepower compressor into the main CWV sales line. The primary purpose of this action was to observe the response of the Beckley and Pocahontas #3 coals to producing against low line pressures under ten pounds at the wellhead. Initially, coal gas production increased dramatically, tripling during the first year. Gradually however, gas production from the coals fell back near previous levels during 1995-1996. Coal gas production remains minimal but very steady with about 5 mcfd from the Beckley coal on TW1, 10 mcfd from the Pocahontas #3 coals on TW3. TW3 is a strictly coalbed methane well, and yet produces at a level equivalent to many of the conventional wells in southern West Virginia.

A variety of pump types, schedules, rates and methods have been utilized from 1993 - 1997. As expected, gas production in southern West Virginia is directly tied to effective, consistent dewatering activity. Somewhat unexpected was the poor performance of the progressive cavity pumps. The College's experience indicates that the minimal water flows in our coals combined with high levels of coal fines and other debris causes excessive wear and damage to the PC pumps. They are much more likely to pump dry and become damaged. Standard pump jacks have proven much more efficient and durable.

In an effort to learn more about the coals closer to abandoned mine works in the area, a fourth project well (TW4) was initiated in 1995. Permitting was completed 5/16/95, site work finished 5/22/95, and the well spudded 6/5/95.

A 17-1/2" hole was drilled to a depth of 36 feet, and 13-3/8" conductor pipe was set. A 7-7/8" diameter pilot hole was drilled from 36 feet to a depth of 684 feet, requiring approximately 60 hours of rotating time. The pilot hole as then reamed to a diameter of 12-1/4" to a depth of 684 feet. Surface pipe consisting of 15 joints of 8-5/8" casing was run and cemented back to ground level using 305 sacks of Class A cement containing 3% calcium chloride and 1/4 lb per sack of flocele. Cement was allowed to set for six hours before making up the blow-out preventers and diverter.

Drilling of a 7-7/8" diameter hole was resumed and drilled from 684 feet to a total depth of 1556 feet, requiring a total of 24 hours rotating time. At TD a logging suite consisting of a gamma ray, spectral density and temperature logs were run in the well by Halliburton. Production casing consisting of 37 joints of 4-1/2" 10.5 #/ft. pipe was run to a depth of 1545 feet with a latch down baffle located at 1535 feet. The casing was cemented using 150 sacks of 50:50 Pozmix with 10% salt.

The well logs were analyzed and three coals were identified for stimulation: (1) an unnamed coal at 1351 feet, (2) the Pocahontas #3 coal at 1255 feet, and (3) the Beckley at 994.5 feet. Based on these findings, a three-stage foam/sand fracturing program was designed. Cement bond and correlation logs were run inside the production casing. Stage #1 was perforated from 1351 to 1352.5 feet with nine holes. Breakdown of the zone was accomplished with 300 gallons of 15% HCL and nitrogen at a pressure of 3491 psig. The zone was fractured with 1500 lbs of 20/40 sand in 110 bbls of foamed water, average pump rate was 11 bpm at an average treating pressure of 3305 psig.

Stage #2 was perforated at 1255.5 to 1257.5 feet (15 holes), 1265 to 1265.5 feet (3 holes), and 1284.5 to 1285.5 feet (6 holes). A frac baffle was set at 1290 feet by wireline. The zones were broken down with 500 gallons of acid at 3300 psig, and foam fractured with 5000 lbs. of 80/100 sand and 25,500 lbs. of 20/40 sand in 213 bbls. of foamed water. The average rate was 19.2 bpm and the averaged treating pressure was 2082 psig.

Stage #3 was perforated from 993.5 to 999 feet with 33 holes. When the perforating gun was fired, the gun and collar locator were lost downhole, causing suspension of activities until retrieval was accomplished the following day. Sand fillup was measured at 1000 feet, and the well was opened to the pit and flowed for two hours to remove the sand. The zone then broke down at 3243 psig with 500 gallons of acid, and was foam fraced with 8900 lbs. of 80/100 sand and 3100 lbs. of 20/40 sand. The average rate was 20 bpm; the average pressure was 2824 psig.

The Stage #1 coal is thin and did not respond well to stimulation. Indications were that this zone would not be productive. The Stage #2 coal (Pocahontas #3) responded well to stimulation and had indications of possible successful production. Stage #3 was more than five foot thick but was difficult to frac due to high treatment pressures. The well was swabbed through the 4-1/2" with 10 bbls. recovered in three hours. 2-3/8" tubing was then run to bottom at 1248.28 feet and a seating nipple at 1313.98 feet. On 8/15/95, a rod type bottom-hole pump and sucker rods were run on this well, TW4, just as on TW1 and TW3.

TW4 initially had indications and promising shows of gas production that would likely exceed that of TW3. However, water production rose very quickly over the first three months of the well's life, and gas production dropped almost immediately to zero. A variety of pumping rates, methods, and schedules were used in an effort to tweak the well and recover its gas production. The amount of fluid reached very high levels (for our area) of 60 bbls. per day. The College expected that the Beckley coal zone was serving as a channel for water from the nearby abandoned mine works. Therefore a workover plan was developed to verify the theory and correct it if possible.

In September of 1996, TW4 workover was initiated to solve the excessive water influx problem. Crews found 600 feet of water standing in hole, and swabbing conducted over a two day period found that water was in fact coming into the hole very quickly. A video log was run in conjunction with swabbing, making four pulls every 15 minutes and bringing fluid at a rate of 24 bbls. per hour (7" each pull). Video log with gyro showed strong fluid strings shooting across the wellbore from the Beckley perforations near 950 feet.

Decision was made to isolate the Beckley coal zone and attempt to produce gas only from the Pocahontas #3 coal zone (as on TW3). On 9/13/96, a perforated nipple, seating collar, and seven joints of tubing were run in hole, totalling 227 feet below the tension packer. The packer was set and then 1127.25 feet of tubing was run on top, bringing total for all to 1354 feet. This put the bottom of the tubing at perforated nipple two foot below the perforations and 26 feet from the bottom of the hole.

As anticipated, closing off the Beckley zone eliminated the high water production from TW4. However, it has taken about three months to begin to see a successful recovery process in the gas production from TW4. Gas production from the Poca coal has averaged 4 mcfd in 1997, with water production at 5 bbls. per day.

The latest workover activity on the Multistrata Project involved the installation of a Logic Plunger Lift System on Test Well 2 (TW2) in January, 1997. This plunger lift "rabbit" system included an autocycle controller, 2" Norriseal motor valve, drip pot/regulator assembly, 2-3/8" lubricator w/ nipple, inductive sensor switch, 2-3/8" logic fiberseal plunger and bottom hole spring. The rabbit system has been continually adjusted since its installation and optimum operational settings have been identified. A second motor valve has been installed to increase production time, and a differential controller has been added to the system to smooth production and decrease spiking and vibration.

Current settings on the plunger lift system have it bringing gas for about 4 minutes every 1.5 hours. This results in TW2 actually producing gas less then 90 minutes per day. The gas production, however, has tripled from 7 to 21 mcfd. The installation of the plunger lift system on TW2 has proven to be quite effective in removing fluid and increasing gas production.

In summary, the Multistrata Gas Well Project boasts several notable accomplishments. First, it provided for the creation of the area's first in-depth natural gas study and database assessing all factors pertaining to gas location, identification and production. Second, the Project created the first document of its kind in West Virginia to successfully partner surface, coal and gas owners for a coalbed methane project.

Third, the Project led to the drilling of the first multistrata well producing from conventional gas formations and coal seams in the same wellbore. Fourth, it provided for the drilling of the first strictly coalbed methane gas well ever permitted in the State of West Virginia. As a result, the Project has verified that gas production from coal seams in southern WV is a function of dewatering just as it is in other regions of the country. Fifth, the negotiation of unique gas transportation and sales agreements through this Project has allowed the College of West Virginia to save more than 80% on the cost of heating its facilities.

Finally, the Project has helped raised the level of awareness about natural gas production in general and coalbed methane in particular. Many other coalbed wells have since been drilled in WV and several companies have coalbed methane projects underway at this time. The success of the College's Project has helped encourage some private companies to focus on coalbed methane, and has proven to be an important catalyst in the economic development of the state of West Virginia.

REFERENCES

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