LIGHT WEIGHT CEMENTING WITH TUNED LIGHT SLURRY

Robert Reyes, John Brown and Lito Perin, Halliburton
Gerry Torres, Bryan Measles and Jaime Lopez, Pioneer Natural Resources

ABSTRACT

As the gap between supply and demand continues to increase for oil and gas, operators are challenged to develop wells in various economic environments. Because of the cyclical nature of the commodity market and the constant change in commodity prices, operators must reduce the overall cost while pursuing much more challenging wells. One such environment is the Wolfcamp/Spraberry, or the “Wolfberry” play in West Texas. Because of the early rapid production decline in these wells, the wells must be drilled and completed as efficient and cost effective as possible. This includes drilling to total depth quickly, running affordable casing and successfully achieving zonal isolation in a severely under-pressured environment. Single stage production cementing is a must to maintain the economic viability of these wells. In order to maintain long term stability of the well-bore, cement must be brought above the top of the Spraberry formation (7000’ to 7500’) from TD (9500’-10,500’) without fracturing the well. The Spraberry formation typically has a fracture gradient on the order of 0.43 – 0.53 psi/ft. If cement top is too low, remedial cement job(s) must be performed to isolate the productive zones from a potential up-hole corrosive water zone while still having adequate strength to allow us to fracture stimulate the Spraberry zone. Remedial cementing has a severe adverse effect on the economics of a well and compromises the well-bore because of the squeeze perforations.

Engineered solutions and application of new technologies have addressed several of these issues and allowed drilling in areas of the basin that were previously thought to have marginal economics. We will look at several wells in this operator’s area of interest where cementing technology was utilized to achieve success in a challenging area. Light weight cements and Tuned Light will be introduced. The operator in this paper used Tuned Light low density cement to achieve zonal isolation and still having enough strength to allow high pressure stimulation work to follow.

BACKGROUND

General

Zonal Isolation is desired from cement slurries with densities ranging from 14.8 to 15.6 lb/gal when the recommended water/cement ratio is used. The challenge here is to cement the well and lift cement from total depth to surface or above the Spraberry without overcoming the fracture gradient of the formation. The 14.8 lb/gal cement slurry has a 0.76 psi/ft equivalent gradient which exceeds the formations fracture gradient of; thus, it is probable that the objective would not be met and top of cement would be too low. With the top of cement not adequate, a remedial squeeze job would be required to get an adequate cement top. The squeeze job would require shooting squeeze holes and attempting to lift cement Production can be hindered due to cement invasion into the producing formation caused be remedial cement jobs.

Challenges

As one can see, a solution is needed. The cement density must be reduced in order to not frature the well. Increasing the water/cement ratio will lower the densisty of the cement; however, this will increase the free water. Water extenders offer the ability to occupy free water. There is a limit as to how much water you can be added before slurry stability problems and operational issues develop. To effectively isolate the Wolfcamp and Spraberry zones, cement slurries must: 1) apply coverage from total depth to above Spraberry formation, 2) reduce recommended cement densities, 2) not invade formation, 3) tie up free water if water is used to reduce slurry, 4) cement in one string for economic reasons, 5) have minimum wait on cement time.

LIGHTWEIGHT CEMENTING

The industry has needs in which density variability is a must. Some wellbore exist in which the gas flow potential is moderate high enough that the density of the slurry must be increased in order to prevent inflowing fluids/gas from entering the annulus. Raising the density with heavy weight additives is a practice much in use for these reasons. In high and severe gas flow potential, other methods must by utilyzed such as foamed cement and CBL that prevent gas channels from forming when cement transitions from a liquid to a gel. Some believe a right angle cement set time will disallow gas to migrate. The ability to adjust density is needed, whether you desire to increase or decrease it. The cementing technology used to mix and measure the cement slurry monitors density and the water/cement ratio is vulnerable to lower densities where adding water to reduce the density can be disaterous to a cement slurry. One must take care in lowing density in which to much water caused the density to appear correct, but the water/cement ratio was out of tune and cement slurry ruined for operational mishap.

Solutions to the five challenges to our problems from earlier involve the use of technology and lightweight cementing to lower the density. With the properly engineered solution, the slurry density will be reduced, the slurry will be a cement in which it is safe to perforate in, not fracture the low fractrue gradient, some of the methods will not require water extenders, allow operator to cement in one stage, have no remedial work. The industry technology allows density reduction through three different mechanisms: 1) Addition of extra water, 2) foaming the liquified cement slurry, and 3) bulk blending microspheres into the dry cement powder. [1]

WATER EXTENDED SLURRY

Additional water to a cement slurry above the standard 5.2 to 6.3 gal/sack is a way of lowering the density of the resulting slurry. This is true only if the original slurry density is greater than that of the 8.32 lb/gal for water. In utilyzing this practice, water extending additives must be used in order to tie up any free water that is formed. Water extenders include bentonite, diamataceous earth, fumed silica, potassium silicates and pozzolan. Point out that these additive are not light weight additives, they are indeed water extenders. The water in the recipe is actually the light weight additive. Using water as a lightweight additive will cause instability issues with the slurry once the density is lowered to 11 lb/gal. The reason for the popularity of this light weight slurry is the cost. Because the additive cost is low and there is an increase in yield, the slurry works well with low budget economics. Note that as it is one of the cheapest slurries, it is also the lowest in performance compared to all cementing slurries.

Although these slurries can be the answer for some applications, they generally will not develop the slurry properties to handle more difficult cementing challenges. There is also a limitation as to how much density reduction before slurry stability issues arise. At lower densities, even if special cement properties are not required, compressive strength development may become unacceptably slow. As the slurry may be attractive because of pricing, an unattactive freature is the slurries slow compressive strength development and low ultimate compressive strength. Slow compressive strength devolopement leads to excessive waiting on cement (WOC) times and low ultimate compressive strength may inhibit the capabilty to provide required levels of long term zonal isolation. Once zonal isolation is lost, stimulation jobs can fracture into undesired zones or even worse, back to surface. [2]

FOAMED

Another option for lowering the cement slurry density is to inject nitrogen into a cement slurry. The injection of a gas into the cement slurry involves a foam generator and pumping the gas phase and letting this “tee” into the cement. Some data acquisition system can monitor and determine the quality of the foamed cement real time and compute an equivalent circulating density real time. This allows operators to tell real time what density of slurry is in the wellbore. There are other gas media besides nitrogen, but nitrogen is the most popular. The benefits include: increased elastisity of the “cured” cement,[3] increased compressability of the liquid slurry, and provision of operator ability to easily change design densty as well job conditions change. Increasing the elasticity of the annular cement is beneficial in an oil well because it hepls the cement maintain it’s seal in the presence of outside stresses. [4]

For wells in which a gas potential exists, foamed cement is a solution. The slurry becomes compressible with gas injected into it and as a result maintains hydrostatic weight on gas flows during the transition period for a longer period of time than a mere neat, zero quality slurry. The drawback is that for a sevice company to provide foamed cement, there are more costs involved. These cost come from computer modeling needed, ussually a foam cement engineer, more personell and equipement and access to nitrogen is a requirement. [1]

TUNED LIGHT

A third option for achieving lightweight cementing for oil and gas wells is by adding a low specific gravity additive, or a beads. These beads are microsheres which are batch mixed with the bulk loaded as the dry cement is loaded. They are available and exist as: solid, plastic beads of approximately 1 specific gravity; hollow, pozzlanic spheres of approximate 0.7 specific gravity; and hollow glass bubbles at 0.32 to 61 specific gravity. These specific gravities are equal at surface and downhole. The advantages that solid beads have are the bead is resistant to crushing under pressure and increases the elasticity of the set cement. Also, it is the only lightweigh additive needed to cement from total depth to surface. The pozzlanic bead is the most popular because of price. These beads have a thin wall and trauma to the slurry will crush a percentage of them. Before pumping downhole, concideration to design a lower density is needed to accommodate the bead crushing. [1]

All microsphere slurries have high strenght to weight ratio and low permeability compared to other cement slurries. There is also a high compressive strength development which in turn reduced the wait on cement time (WOC). A shorter WOC time with help combat gas flow migration and get the well to the next operation quicker. This will in turn get the well on line in a shorter timeline.

WELL HISTORY

General

The wells for the operator are located in Martin, Midland and Glasscock counties at depths ranging from 9500 to 10500 ft. The bulk of the Tuned Light jobs were performed on wells in Martin County. The target formation is the Wolfcamp/Spraberry play. This play led to a record revenue plataeu's for the service company for each of the last two years in production enhancement and zonal isolation during an era of oil and gas economic flourishment in 2007 and 2008. For the time period of the paper and its well history, there were 45 wells drilled and cemented with the Tuned Light slurry.

Operational

The Tuned Light job cost was an additional $20,000 more compared to a conventional cement job.. The Tuned Light slurry gave each well the best chances of 1) not breaking down the formation, 2) getting top of cement to the desired depth and 3) having adequate bonding with no mud channels. Economics were satisfied when there was success in all aspects of the construction of the well. The operators success ratio went from approximately 62% success ratio to an 80% success ratio utilizing Tuned Light cement slurry. There were 9 wells from our viewpoint in this study in which for some reason, the top of cement did not reach desired depths, even with Tuned Light as the design. In these cases, squeeze work was utilized at a cost of $55,000 per well after Tuned Light costs. This additional cost put a strain on the economics and the importance of a successful well zonal isolation process.

REFERENCES

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3. McCulloch, J.: "Life Cycle Modeling of Wellbore Cement Systems Used for Enhanced Geothermal System Development," October 12, 2003.
4. Tahmourpour, F.: "Use of Finite Element Analysis to Engineer the Cement Sheath for Production Operations," 8 June 2004.

PNR Tune Light Jobs

Well Name	API	TOC	U. Sprby	not achieve objective	well count
		feet	feet	TOC low	
Rig: UTI 466					
Dickenson OA #5	42.317.34803	7474	7422	*	1
Howard #7	42.317.34831	5992		*	2
Strain 10-1	42.317.34746	6078	7300		3
Littleton #3	42.317.34819	7496	7330	*	4
Howard #8	42.317.34830	7350	7434		5
Louder #4		6606	7364		6
Glasscock CC #2	42.317.34902				7
Rig: UTI 73					
Louder 33-1	42.317.34883	8322	7708	*	8
Lindsey T #2	42.317.34899				9
Louder 33-2	42.317.34901	6380	7732		10
Louder 33-4	42.317.34939	5206	7708		11
Woody I #1	42.317.34859	8238	7694	*	12
Woody IC-5			7696		13
Louder 33-3	42.317.34938	8340	7696	*	14
Woody IC-6	42.317.34944	5964	7614		15
Woody IB#3					16
Woody H4-1	42.317.35008				17
Woody H4-2	42.317.35009		7616		18
Woody H4-3	42.317.35010	6720	7638		19
Woody H4-4					20
Rig: UTI 196					
Erwin C #3	42.329.35493	7310	7032	*	21
Kaderli 25-1	42.317.34971	4670	7000		22
Kaderli 25-2	42.317.34972	6900	7004		23
Kaderli 25-4					24
Rig: UTI 461					
Dove E-4	42.317.34822	6200	7940		25
Scharbauer Ranch A #4	42.317.34813				26
Scharbauer Ranch #64	42.317.34813	6500	8128		27

PNR Tune Light Jobs, continued

Well Name	API	TOC	U. Sprby	not achieve objective	well count
		feet	feet	TOC low	
Glass #2	42.317.34676	7660	7734		28
Glass W-3	42.317.34678	7564	7828		29
Scharbauer Racnh 74	42.317.35029	6910	8150		30
Dove U-4	42.317.35028	7530	8028		31
Scharbauer A-9	42.317.35030	7930	8090		32
Late Additions to the list					
McAdams 10 #3	42.317.35128	6210	6788		33
Wiley Est #2	42.317.35137	6218	6168	*	34
Dove N #2	42.317.35160	6810	8006		35
Shoemaker A #1	42.317.35206	6404	7390		36
Foreman 32 #1	42.317.35125	6582	7492		37
Scharbauer Ranch #44	42.317.35143	8184	8234		38
Hall Trust #1	42.317.35208	6578	6574	*	39
Bessie Smith #3	42.317.35202	6750	7414		40
Scharbauer Ranch A -6	42.317.35145	7622	8114		41
Strain 10-2	42.317.35191	6940	7294		42
Rogers 42-1	42.317.35181	6874	7520		43
Rogers 42-2	42.317.35182	7330	7462		44
Crespi Q #5	42.329.35882	6170	7536		45

Total wells TOC not hight enough	**9**
Successful jobs	**36**