**White Paper - Oil Well Cement Problems**

Oil and gas wells today are constantly under scrutiny due to many factors. Wells today are deeper, hotter and some are in the middle of our cities and on our property. Increased costs to drill and operate create incentives to get “the most” from every well. New technologies have us “fracking” wells and drilling in areas that historically would not have been considered viable.

Many environmental concerns are being raised about the safety of our water and food in areas where active oil and gas production is part of our yard, golf course and farmland. The key to managing these environmental and production concerns can be taken back to the basics. Like any good construction project, building a good foundation is key. Constructing a well bore is no different. The well bore being the entire structure that connects the surface valves to the reservoir where the oil and gas sits.

Several operations that are outside the discussion of this paper, are put in place to ensure the rig and the wellbore are stable and safe throughout the drilling process. Once the rig is set up and drilling, it drills through all the potential fresh water zones and aquifers to a depth where the rock formation is stable. This is determined by the government responsible for managing natural resources such as the Energy Resources Conservation Board (ERCB) in Canada or the Texas Railroad Commission in Texas. The surface casing depth is normally less than 1000 feet. Next, the drilling stops and pipe or casing is placed in the well bore and cemented in. This is designed to protect the well and the surrounding formations from contamination. This is called a surface cement job.

The rig then lowers a new drill bit inside the surface casing down to the rock face and continues to drill the well. Depending on the well plan (construction drawings) the well may deviate, go horizontal or continue vertical. This is determined by what formation is being drilled, what the total depth is and what is going to be produced from the well. Like the surface casing, one or more strings of pipe will be set in the well and cemented in. For example, if two more are necessary for well bore stability, the second is an intermediate string and the final, deepest string is the long string or production string. Just like there are many different styles of houses, bungalows, two story and split levels, there are also many variations and configurations of casing.

The multiple casing strings and corresponding cement jobs create the well foundation. The quality, design and proper placement of the cement are key to the safe and environmentally sound operation for the life of the well. Like a house. If the foundation is poor, it is difficult to keep the walls from cracking, the roof from leaking and the floors from squeaking no matter how much time, energy and effort you put in.

Historically, the oilfield has placed minimal emphasis on the quality of the cement job. The old ways of “Mix it grey and pump it away!” are no longer acceptable. As technology, cost of drilling and managing wells increase, we place greater and greater stresses on the well bore – casing and cement. Historically minimal work was required to keep the wells producing so little or no stress was put on the casing and cement.

Production of shales, both oil and gas, has generated the potential of the USA becoming energy self-sufficient. The development of this technology requires significant operational procedures including multiple frac treatments. Frac’s cause cooling on the wellbore because we pump water that is the same temperature as our lakes and rivers. When we stop pumping, the well bore warms up to its natural down hole temperature which can be several hundred degrees Celsius. This is far above the boiling point of water (a thermal cycle is the cooling and heating of a system). The thermal cycling of the well bore caused by every frac creates stress on the cement job and casing due to the significant temperature change.

Why is fracking getting such a bad rap? When a well is frac’ed, 1000’s of gallons of fluid (usually water) are pumped at a high rate down the well bore (a back-yard pool is about 10,000 gal and a small frac is 20,000 gal, a large frac can exceed a million gallons). This fluid is pumped so fast, the formation (rock) cannot absorb the water so the water breaks the rock or fractures the rock. Hence the term frac. The proper terminology is “hydraulic fracturing.”

The definition of hydraulic is: **hy·drau·lic**

[hahy-draw-lik, -drol-ik] adjective

1. operated by, moved by, or employing water or other liquids in motion.
2. operated by the pressure created by forcing water, oil, or another liquid through a comparatively narrow pipe or orifice.
3. of or pertaining to water or other liquids in motion.

Therefore, hydraulic fracturing is the process of moving water to fracture the rock. The fracture or channel make it easier for the oil and or gas to flow versus flowing through the natural rock.

Frac treatments are done on the “producing formation” of the reservoir and are usually 1000’s of feet below the ground water which is protected by the surface casing and cement job. So why do frac’s contaminate our water? When the cement is not properly bonded to the pipe or the rock formation, a micro channel is formed and the oil and or gas can migrate up behind the casing and the hydrocarbon (oil or gas) contaminates the water system.

The other is when the frac is complete, the well is flowed back as quickly as possible. One of several reasons is to help draw the oil and gas to the wellbore. The water that was used to frac the well, is now brought back to surface. This water is now contaminated with reservoir fluids, frac chemicals and must be properly disposed of. Most frac chemicals are now bio-degradable or environmentally friendly, however proper management of the well returns is necessary to ensure they do not get in the fresh water.

Now that we understand some of the critical reasons behind building a solid foundation of well bore, cement and casing, we can review solutions that create a stable, long term well bore.

Cement is an excellent, permanent material that is easy to mix, pump and place between the formation and the casing.

Cement facts:

* Well bore cement is different than surface concrete. Concrete frequently has aggregate or rock in the mix. It is not feasible to have aggregate in well cement because the pumps cannot pump rocks.
* Cement settles into a gradient, cement is a liquid with solids often referred to as a slurry. Therefore, the heavier particles sink, and the lighter ones rise. Water ends up at the top. So, the top has less strength than the bottom.
* Due to chemical charges and reactions that occur as the cement cures, water migrates to the sides (to the pipe and the rock wall) which affects the bond to the rock and the pipe, creating micro channels that hydrocarbons can flow through.

Current technologies accomplish the goal of placing the cement in the well bore by modifying the slurry properties. Unfortunately, these modifications are detrimental to the finished product because they lead to water channeling, poor bonding and limited wellbore integrity.

Utilization of ThixoPro® chemistry, because of its unique properties such as high wetting, extremely low surface tension, no ion charge to the cement and does not preferentially adsorb on to solid surfaces, altogether these properties enable any cement slurry with ThixoPro® to overcome the above concerns. The chemistry also helps prevent the water from moving to the edges – as does occur typically with ALL other entrainer chemistries - so with ThixoPro® the cement bond with the pipe as well as with the rock are significantly improved.

 At Miracon® Technologies®, we have developed not only a different, but a superior chemistry in order to enhance cementing technologies - both on the surface, for everyday concrete applications such as driveways and houses, as well as wellbore solutions that keep your water safe, and get the oil and gas out of the ground so we can make roads, gasoline, makeup, plastics and other products that impact our lives on a daily basis.

Miracon® can be used with compressed air as well as conventional nitrogen depending on the application. Utilizing air makes the overall safety, cost and delivery greener, and at a significantly reduced cost as compared to using nitrogen-based entrainment. This impact intensifies as we drill in more populated areas.

Miracon® ThixoPro® reduces the friction pressure which reduces the horsepower and the fuel necessary to pump the cement job. By using consistent bubbles that act like ball bearings, the cement flows easily which eliminates the need for extra water which is commonly found in today’s slurry’s. If there is extra/excess water it will cause channeling and separation of the fluid in the wellbore. Water is also chemically attracted to the pipe wall and this can cause micro channels for oil and gas to flow and contaminate our fresh water. ThixoPro® cannot compensate for poor quality cementing mix designs, but it can and does cost effectively perform to allow easier and faster placement of the cement slurry so that there should be no tendency or need to have excess water in the slurry.

**Positive Environmental Impact**

Miracon® ThixoPro® helps protect potential fresh water contamination from Frac fluids or hydrocarbons. Well bore bonding is significantly increased due to reduce movement of water and cement particles. Frac fluids cannot move behind the casing because the area is sealed and bonded tightly to the casing and the rock.

Miracon® ThixoPro® replaces up to 40% of the cement volume. And this is performed on the site with a very small operating footprint (as compared to CO2). Reduced cement volumes reduce greenhouse gas emissions. Up to 4.5% of the world’s CO2 emissions are caused by the production of cement. 40% less cement also reduces transportation and delivery of 40% less product.

Miracon® ThixoPro® Summary Benefit Points :

Safer, lower cost, meets strength requirements, better bonding, less shrinkage due to lower cement and/or water requirement, optimized environmental impact/improvement, enhanced longevity performance for the well.

Miracon® ThixoPro® products have been developed with the goal and standard in mind that we must look after our children’s future home -The Earth.