NOVEL, SOLID SCALE INHIBITOR PROVIDES LONG-TERM PROTECTION IN BLINEBRY / PADDOCK DUAL ZONE COMPLETIONS IN SOUTHEAST NEW MEXICO

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ABSTRACT

Oil Operators in Southeast New Mexico have been very successful in producing wells dual completed in both the Blinebry and Paddock formations. One area of contention, however, has been the mineral saturation in the commingled brine and the incompatibility of the various minerals in the two produced brines. Liquid scale inhibitors, applied conventionally during the fracture stimulation of each zone have not been successful in preventing formation of calcium carbonate and calcium sulfate scales after the wells have been placed on production. This paper details several successful applications of a novel, solid scale inhibitor that is applied with the proppant during the fracturing process. The application of this inhibitor has provided the Operator with maximum production and minimal remedial workover expense through long-term inhibition of calcium scales.

DISCUSSION

The Blinebry and Paddock intervals are parts of the Yeso formation located in the Central Basin platform of Eastern New Mexico and West Texas. The Yeso is composed of alternating bands of dolomite limestone, gypsum and sandstone. The presence of calcium carbonate ($CaCO_3$) in the limestone and calcium sulfate dihydrate ($CaSO_4$-$2H_2O$) in the gypsum contribute to mineral scale issues seen in wells producing from the Blinebry, or the more common, dual zone, Blinebry / Paddock completions. When laboratory analyses of the produced brines from the Blinebry or Blinebry / Paddock wells are scrutinized with mineral scale modeling programs such as Downhole SAT™ produced by Frenchcreek Software or Scalesoft-Pitzer™ from Rice University, the brines are often indicated to be over-saturated for calcium carbonate or gypsum (or sometimes both minerals). Figure 1 details the gypsum scale potential of a Blinebry / Paddock producer with the modeling varied for pH and temperature. The various bars indicate the maximum gypsum deposition that could potentially occur at the given pH and temperature. Potential depositional amounts are listed as pounds per thousand barrels of water. To maximize production and profitability from Blinebry and Blinebry / paddock producers, it is critical that scale deposition be prevented from the onset of production.

Historically, liquid scale inhibitors have been utilized during hydraulic fracture stimulations to try and prevent scale deposition in new producers. These products have generally been applied in one of two ways, either throughout the whole liquid portion of the frac or as products included only in the pre-pad or pad portions of the frac. Most often, usage was dictated by compatibility of the scale inhibitor with the frac system being used. While liquid inhibitors have been applied to frac systems throughout oilfield operations with generally good success, there are some issues associated with this type of application. Scale inhibitors do not adhere well in the proppant area post-frac. This is usually due to the limited amount of contact time available as most wells are brought back on immediately after the frac and scale inhibitors usually require 12-24 hours to form the electro-chemical bond that provides for long-term feedback in the produced brine. Often, liquid scale inhibitors tend to bleed of early with fluid lost to leak-off. For these reasons, the longevity of scale inhibitor feedback in the produced fluids from wells treated with liquid inhibitors during the frac is often less than originally anticipated. This does occasionally lead to mineral scale deposition in wells thought to be protected. Because of premature scale failures seen in some Blinebry and Blinebry / Paddock producers, a new method of providing long-term inhibition starting with initial production was needed.

In 2005, BJ Chemical Services introduced a novel, solid scale inhibitor, designed for application with the proppant during hydraulic fracture stimulations, to the exploration and production market. This product is a 100% active aminophosphonate that is coated onto an inert substrate. Most conventional, liquid scale inhibitors used in oilfield applications are 20-35% active products and have minimum effective concentrations (MEC) of 3-5 parts per million (ppm). Below this MEC, the product cannot inhibit mineral scale and treatments must be increased or re-applied, in

the case of reservoir displacements. MEC for the solid, 100% active scale inhibitor described in this paper has been established at slightly less than 1 ppm.

Determining the amount of scale inhibitor to apply in the frac is generally dependent on anticipated water production, but can be limited by the maximum amount of scale inhibitor that can be added to the fracture fluids without causing compatibility issues. The solid scale inhibitor had previously been tested for compatibility up to a loading rate of 2% of the proppant in most commonly used fracture fluids used in Blinebry / Paddock stimulations. Based on anticipated water production in these wells, a loading rate of 1% was selected. In other words, if 50,000 pounds of proppant were to be used on a given interval, it would contain 500 pounds of the solid scale inhibitor. Addition of the product is simple and straight-forward as most fracturing crews have available "dry add" hoppers and augers, so that the rate of addition of a dry product can be monitored and adjusted to match the recommended rate in the proppant "on the fly". Another key factor in the use of this product is the ability to monitor returns in the produced brine. The analyst has the choice of either conventional wet digestion chemical methods used for converting phosphonate to phosphate and then reporting results as ppm chemical or, if plasma spectroscopy is available, the analyst can determine total phosphorous in the brine and report as ppm scale inhibitor (after subtracting any naturally occurring or ortho-phosphate).

To date, 80 newly drilled Blinebry or Blinebry / Paddock wells have been treated with the solid scale inhibitor during the fracture stimulation of the producing interval(s). The original wells have produced adequate scale inhibitor returns and have had no indications of scale deposition for ten months. Examples of flowback returns of the inhibitor are shown in Figures 2-4. Figure 2 depicts the inhibitor residual measured in a well producing only from the Blinebry interval with an average brine production rate of 88 barrels of water per day (BWPD). Figure 3 illustrates the measured inhibitor returns from a well producing from both the Blinebry and Paddock and with an average brine production of 145 BWPD. A higher rate brine producer is profiled in Figure 4. This well is also a dual Blinebry / Paddock producer. In all three presented examples, the inhibitor returns are consistently staying above the MEC of 1 ppm.

Measuring and cumulating the inhibitor returns over time can give us some indication of expected return life. Well C, discussed above, has been producing an average 10,000 barrels of water over the last 10 months. Doing a mass balance calculation on the amount of measured scale inhibitor return over time versus the amount of water produced reveals that approximately 45% of the applied product has returned. As we fully expect all of the material to eventually feed back, we can estimate that the expected scale inhibitor return in this well will continue for at least another 10 months. This information is presented graphically in Figure 5. As Well C is a fairly high rate brine producer, there is an expectation for longer feedback profiles in Blinebry / Paddock producers making lower amounts of brine.

CONCLUSIONS

- Produced brine from the Blinebry and Paddock intervals of the Yeso formation are known to have the potential to deposit both calcite and gypsum mineral scales.

- To maximize production and minimize depositional issues in these wells, it is critical that they be inhibited against mineral scale deposition from initial production on. To accomplish this, placement of a scale inhibitor during fracture stimulation is desired.

- Liquid scale inhibitors have proven to be of limited effect for the desired long-term protection of these wells.

- A novel, solid scale inhibitor applied with the proppant during the frac has shown to provide protection against mineral scale deposition over a lengthy period.

- Based on current returns, inhibitor feed back is expected in these wells for at least 18 months and in many cases longer.

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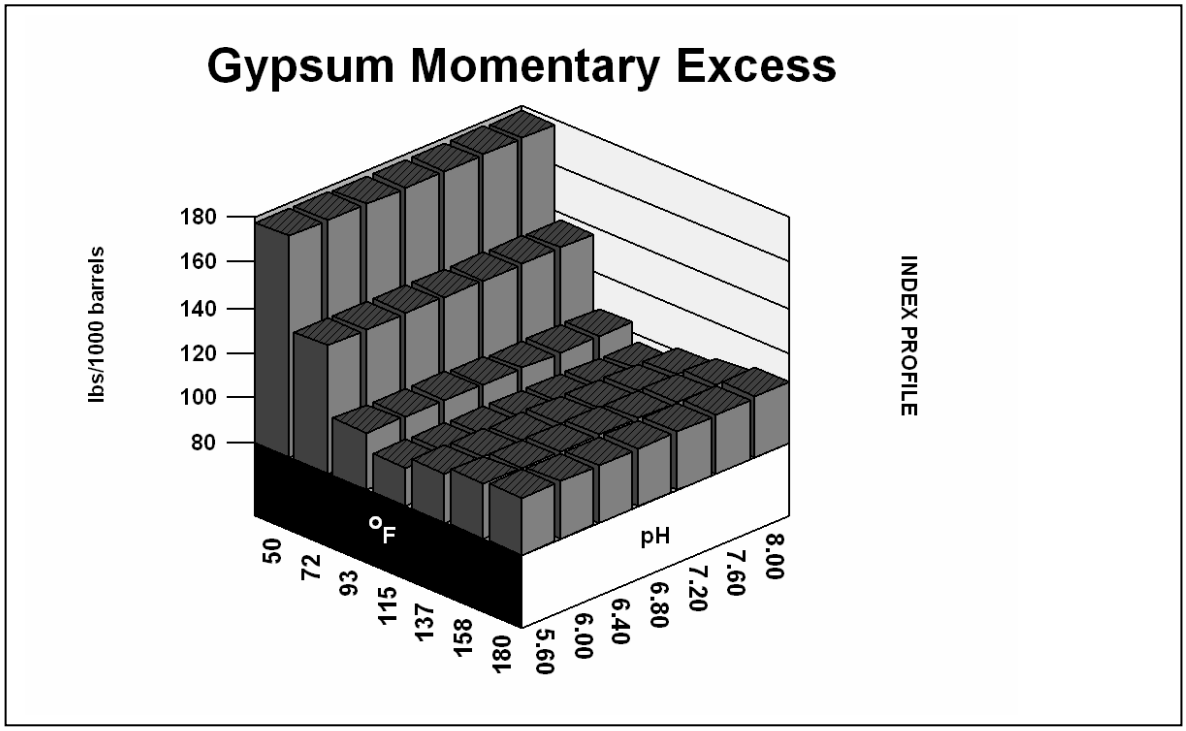

Figure 1- Scale Modeling of a Blinebry / Paddock Brine

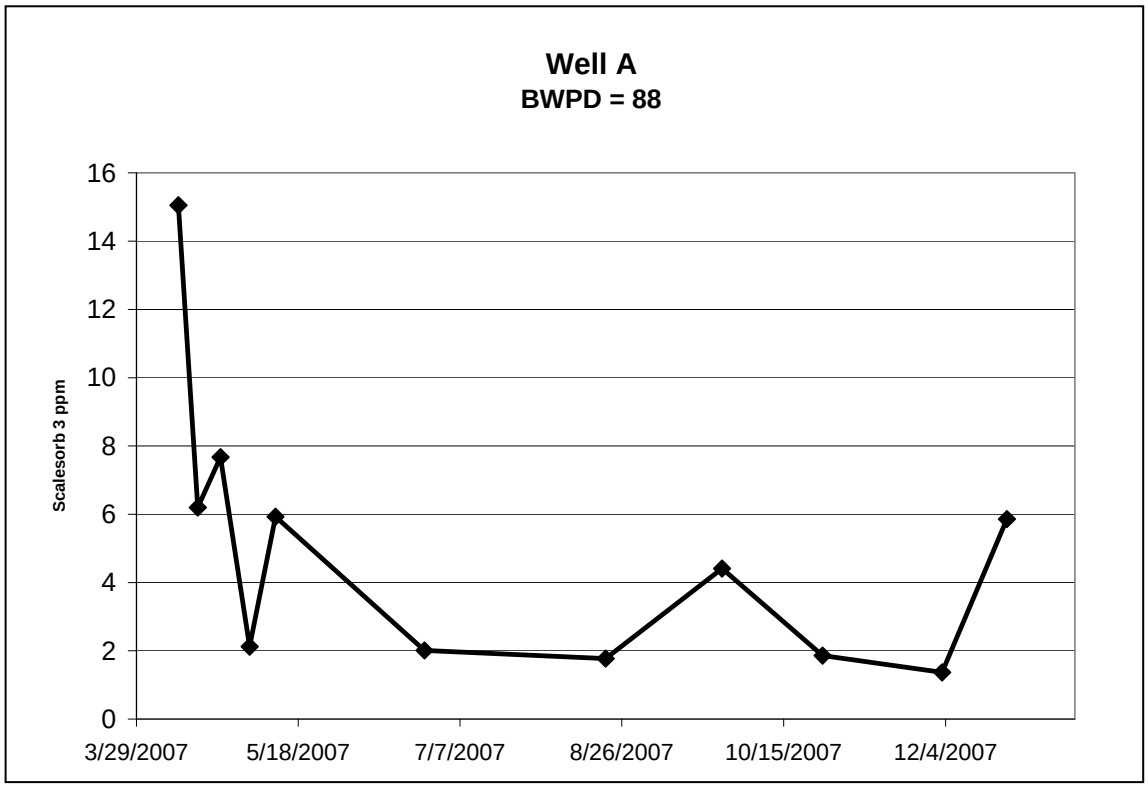

Figure 2 – Inhibitor Returns - Low Brine Rate Blinebry Producer

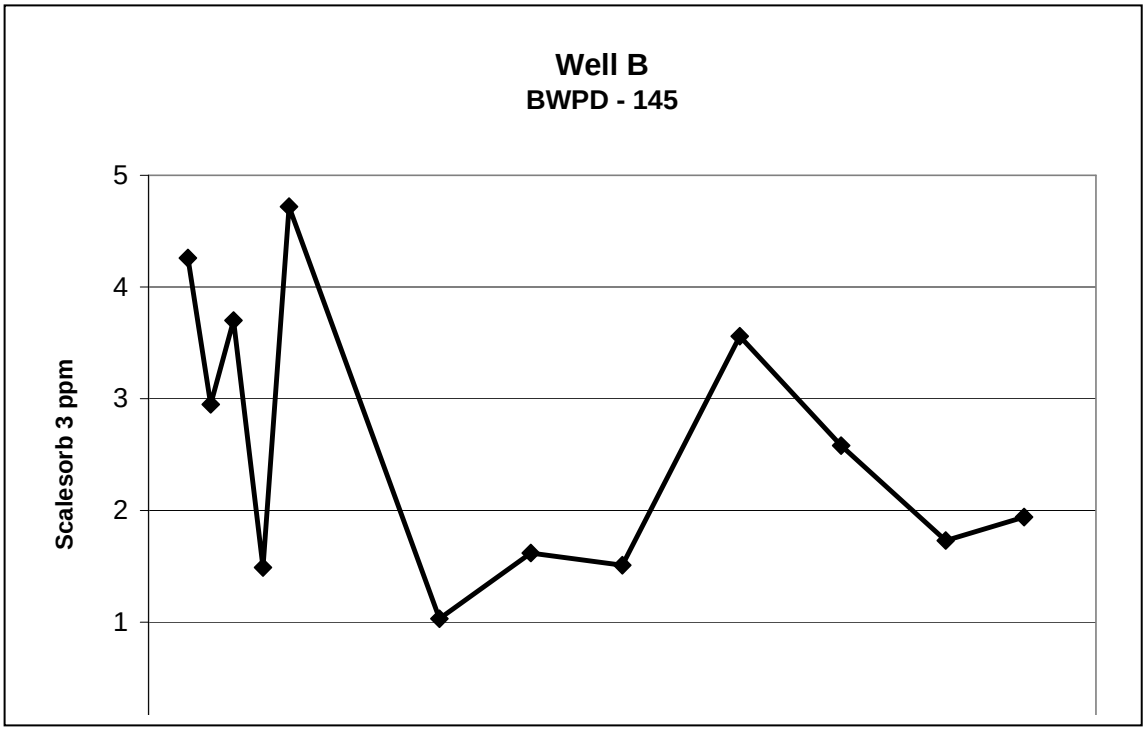

Figure 3 – Inhibitor Returns – Mid-rate Blinebry / Paddock Producer

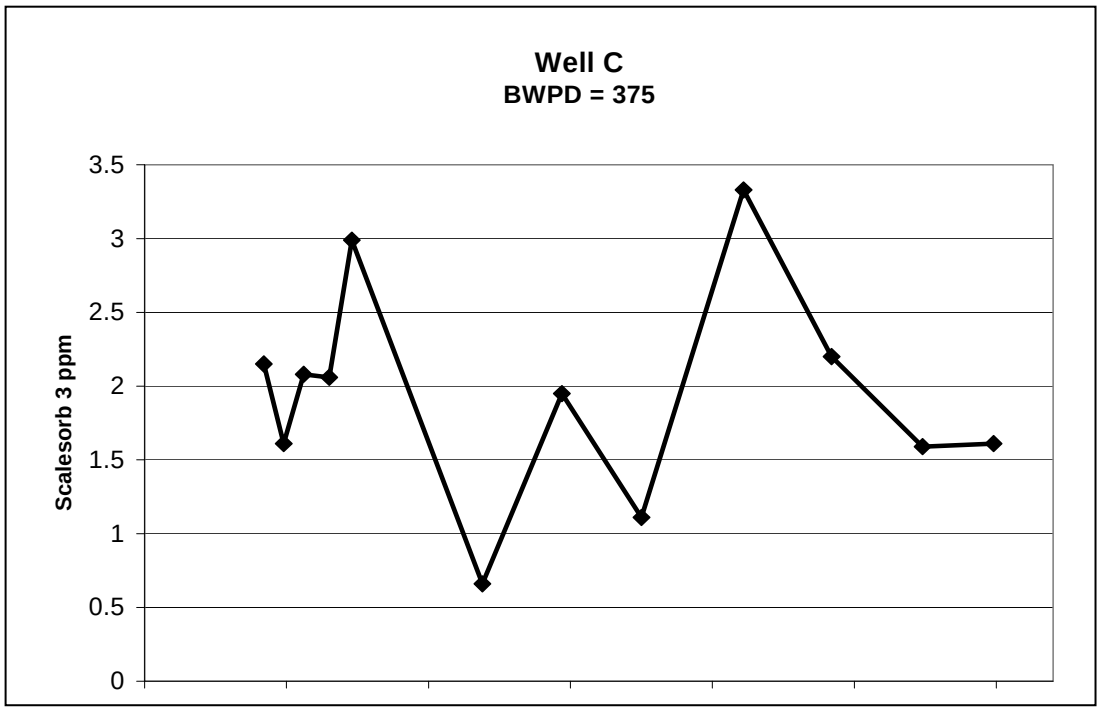

Figure 4 – Inhibitor Returns - Higher Brine Rate Blinebry / Paddock Producer

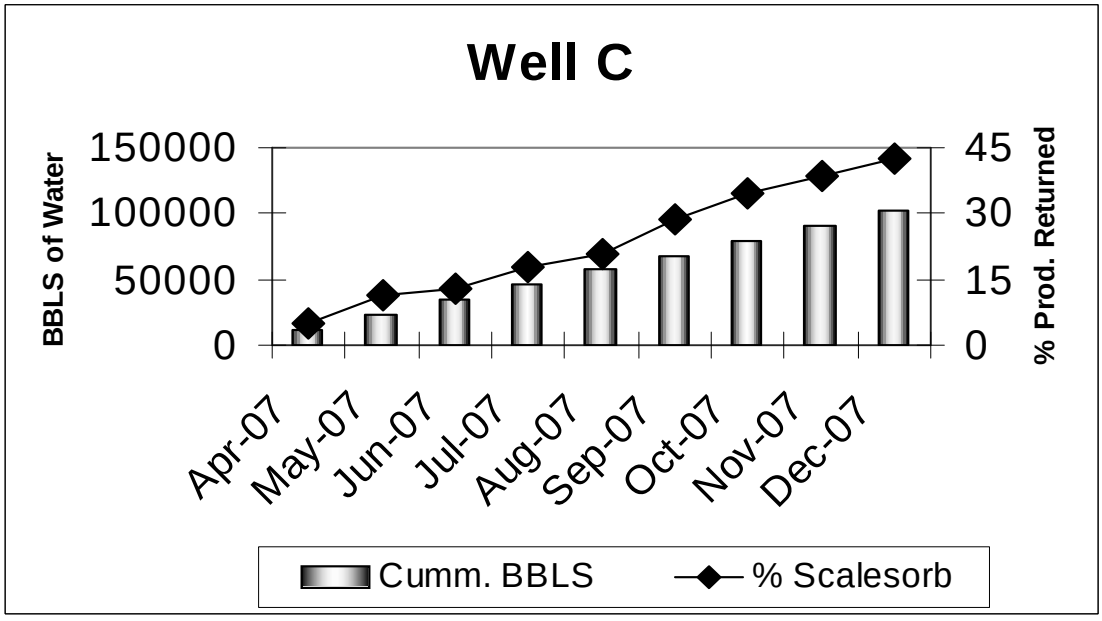

Figure 5 – Cumulative Return in a High Brine Rate Producer