APPLICATION OF CHEMICAL CONCENTRATES TO WELL ANNULUS VIA HIGH QUALITY, LOW LIQUID VOLUME FOAM

J. Mike Brown and J. Greg Darby
BJ Chemical Services

INTRODUCTION

A novel method of treating wellbore spaces with high concentrations of chemical actives has been developed using self-supporting foam. High quality foam is used to minimize the amount of liquid introduced to the well. This application method has been successful in applying scale inhibitor and acid into low pressure coal bed methane wells. Complete filling of the wellbore spaces including annular spaces is possible on wells that will not support a column of fluid. The foam can be made to persist long enough to fill the wellbore. After a few minutes the foam will break leaving behind a liquid residue containing a high concentration of chemical. Foamed acid has also been applied to remediate scale prior to applying scale inhibitor.

BACKGROUND

Southwest Virginia has seen the production of coal bed methane (CBM) for many years. The geological formations in the area are also rich in limestone. The production of CBM and the associated water from the limestone formations have led to problematic deposition of mineral scales, primarily calcium carbonate. Calcium carbonate scale is an acid soluble, mineral scale which essentially cements the well tubular, the production casing and tubing, together making well repairs and intervention time consuming, difficult, and costly. It has been stated that in some areas, work over costs to repair and remediate the mineral scale deposition exceeds $120,000 per well.

The majority of the wells in this area are low pressure gas wells produced from the casing annulus. Water associated with gas production is removed via down hole rod pump up the tubing. Down hole video camera runs have shown that scaling is the result of water running down the inside of the casing and tubing and mixing with produced water from other coal seams. This mixing of waters from high alkalinity zones with high calcium zones produces calcium carbonate scale in the annular area between casing and tubing. Scaling can be severe enough to cause significant production decreases and make removal of the pump and tubing difficult or impossible.

Many customers recognize the mineral scale problem is preventable. Several cost effective and proven technologies have been applied to combat the problem. Each of these applications has been used in the Southwest Virginia area:

- Squeeze applications- Forced precipitation squeeze with polymeric inhibitor
- Fracture applications – Solid inhibitor adsorbed onto proppant particle
- Continuous applications – Conventional liquid organic phosphonate inhibitor
- Batch/Foam applications for prevention- FSI 1
- Batch/Foam applications for removal - FSD 1

Squeeze applications have enjoyed limited success due to the difficulty in obtaining sufficient overflush over the long perforated intervals to achieve the radial penetration necessary to have adequate inhibitor placement. Extremely large volumes of liquid are necessary to attain a minimal radial distance of 3-5 feet from the wellbore across the entire producing interval. Large volumes of water applied to the formation are potentially damaging to production, require long times to recover and can present disposal problems.

Continuous applications of scale inhibitor has been successful but has resulted in logistical problems due to the difficult terrain and geographical separation of many of the wells. Maintenance of chemical pumps and delivery of chemical is difficult for many of these isolated wells.

The Batch/Foam applications in the form of FSI 1 (Foamed Scale Inhibitor 1) and FSD 1 (Foamed Scale Dissolver 1) have received very positive feedback from several producers in the Southwest Virginia area. To date over 200 wells have been treated with FSI 1 and over 50 wells with FSD 1.

FOAMED TREATMENTS AND RESULTS

FSI 1 and FSD 1 are foamed chemical applications developed to treat the annular space of CBM wells to prevent or dissolve mineral scales. The technology used was derived from foamed acidizing systems which use nitrogen gas to generate a stable, self-supporting foam from a liquid acid and foamer additive. Equipment developed for these applications include a purpose-built skid containing a liquid scale treatment/foamer mix, a nitrogen source, and pump to apply a foamed chemical application to a well annulus. For the FSI 1 application, the foamed application consists of scale inhibitor foam which, when the foam breaks to a liquid, leaves behind a film of scale inhibitor on the tubulars. For the FSD 1, the foamed application is an acid that covers a larger area for a longer time versus pumping liquid acid. A liquid tends to follow a narrow path and gravity pulls the liquid to the bottom of the well.

The primary benefits of a foamed chemical application are the near universal coverage of the annular gas space and the viscosity of the application that keeps the application higher in the annulus versus treating with a liquid. Other benefits to using the foamed chemical applications are listed below.

- No permanent equipment required at well site
- Low volumes of chemical added with small pumping equipment
- Can be monitored
- Easy and fast to apply, several wells can be treated daily
- Inexpensive and cost effective
- Option of re-treatment could delay intervention for years
- Wells appear to increase in production after treating

Table 1 represents a sample of monitoring results of the first 5 wells treated with FSI 1.

The foamed chemical formulas and applications have lead to an increase in gas production from many of the wells treated as shown in Figure 1. An addition benefit has been the elimination of remedial acid treatments on disposals wells. This is presumably from carry-over of scale inhibitor into the disposal wells.

CONCLUSIONS

The foamed scale inhibitor and acid treatments have been very successful in preventing production problems resulting from scale formation in CBM wells. The foamed treatment is easily generated onsite using a purpose built truck mounted skid. The entire annulus of the well is completely contacted by stable, self supporting foam that allows the placement of a high concentration of scale inhibitor containing a minimal amount of liquid volume. After a short period of time the foam completely breaks leaving behind a concentrated adsorbed film of scale inhibitor which continues to provide residual protection for periods exceeding 3 months after treatment. By utilizing a low volume of treatment, the well production is not adversely affected and some operators have reported enhanced production following treatment.

The advantages of foamed scale remover include longer contact time on the affected area. Because the wells will not hold a fluid level over the perforations, conventional acid treatments have required large volumes to be moderately effective. Foamed acid treatments using a much lower total liquid volume have proven more effective than conventional liquid acid.

TABLE 1
Scale Inhibitor Residuals after Foamed Treatment

Well	Casing Pressure	Tubing Pressure	Injection Pressure	Time to Pump hrs	Liquid Volume Pumped gals	SI Conc.	Foamer 1	Residual ppm
1	18	6	18	1:15	36	12%	2%	NA
2	29	40	29	1:20	29	12%	2%	31.82 ppm
3	14	0	14	2:20	42	12%	2%	145.29 ppm
4	5	0	20	2:15	38	12%	2%	116.7 ppm
5	20	0	25	4:00	43	12%	2%	26.25 ppm

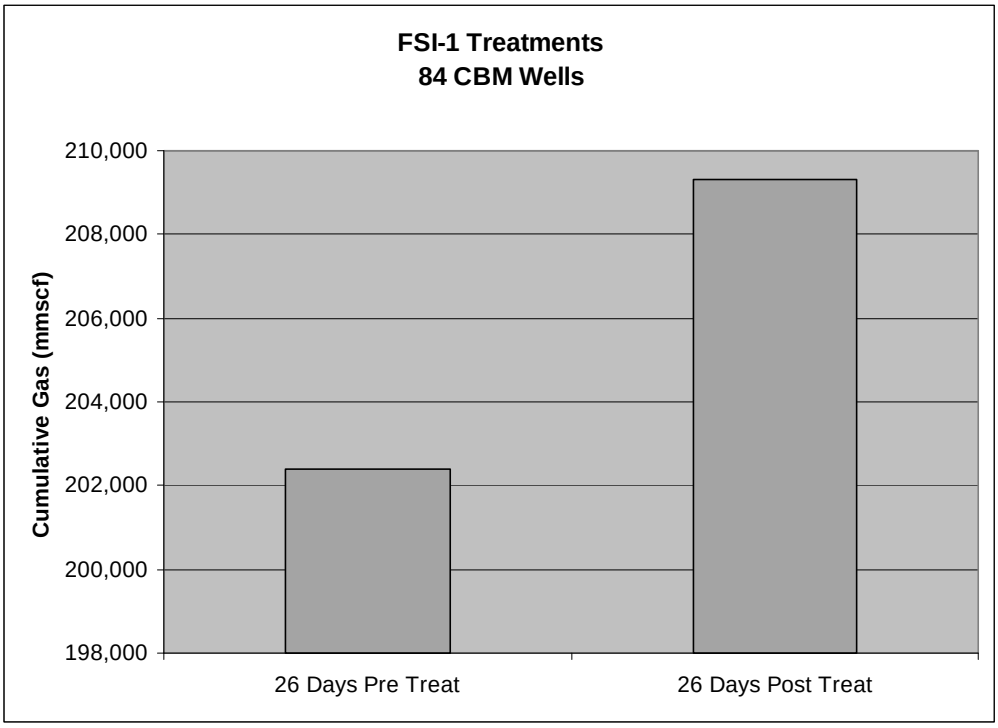

Figure 1- Average Production Increases After Foamed Treatments