INJECTION WELL CLEANOUTS IN THE IATAN EAST HOWARD FIELD

TERRY PAFFORD
ARCO OIL AND GAS COMPANY

INTRODUCTION

The Iatan East Howard Field is located in eastern Howard County, Texas. Production is commingled from the San Andres, San Angelo and Clearfork zones. Pressure support in the field is provided by waterflood. Injectivity into these zones was poor due to the buildup of iron sulfide and biomass. Several methods were used to cleanup this buildup. The first method used was to cleanout the wellbores with 15% acid and 14% sodium hypochlorite (bleach), utilizing a coiled tubing unit. The second method was to pump bleach and acid into the injection system, which would in turn be pumped down the wells. The third method was to cleanout both the surface and downhole lines with 3000 parts per million (ppm) chlorine dioxide (CLO2) and 15% NEFE acid. The relative benefits and costs of these three methods is discussed.

This work was performed when ARCO Oil and Gas (ARCO) operated the properties. In the fourth quarter of 1992, Anadarko purchased ARCO's interest in the properties.

It is not the objective of this paper to discuss the chemistries and chemical reactions involved with these methods. Those can be found in numerous places in the literature. The objective is to communicate the procedures involved, the costs, and the benefits.

DISCUSSION: WELL INFORMATION

At the time of publication, ARCO operated 137 producing and 111 injection wells in the field. The majority of producers have openhole completions. Producers are on 10 acre spacing, and with injectors the spacing is five acres. All the injection wells utilize a cased hole. The depths range from 2400 to 2800 feet. The San Angelo zone takes the majority of the water. The surface injection pressure averages approximately 800 psi.

For the purposes of this paper, the discussion will be limited to the G.M. Dodge lease, which comprises the majority of the ARCO operated portion of the field.

DISCUSSION: WATER SOURCES AND RATES

There were two sources of injection water for the leases. The majority of the injection came from produced water. This water contains anaerobic (sulfate reducing) bacteria, iron sulfide, and oil carryover.

The make-up source is from the Colorado River Municipal Water District (CRMWD) Moss Creek system. This water contains aerobic (slime producing), anaerobic (sulfate reducing) bacteria, and iron sulfide. The water contains high concentrations of nutrients which make the water an ideal environment for the growth of the bacteria. Solids are removed from this water using a strainer system, after which it is treated with sulfur dioxide (an oxygen scavenger).

At the time of publication, the produced water volume was approximately 12,000 BWPD and the CRMWD volume was approximately 8,000 BWPD. The optimum injection rate per well is 200 to 250 BWIPD. Generally, the produced and CRMWD waters were kept separate. A few wells take a combination of the two waters.

DISCUSSION: PROCEDURE DETAILS

COILED TUBING UNIT CLEANOUTS

The coiled tubing unit cleanouts utilized 2000 gallons of 15% NEFE hydrochloric acid and 1100 gallons of 14% bleach. Below is a generalized procedure.

1. Jet out the injection tubing on the way in the hole with the coiled tubing (CT), taking returns.
2. Cleanout to total depth (TD) and continue circulation on bottom until two tubing volumes of clean fluid have been returned. (CRMWD water, with a biocide, was used for circulation. All the pumping was done down the CT. Returns were taken from the injection tubing/CT annulus. Circulation rates were between one and two barrels per minute.)
3. Shut-in the injection tubing.
4. Pump the entire bleach volume, while moving the CT nozzle up and down across the perforations at least twice.
5. Pump at least a five barrel water spacer.
6. Pump the entire acid volume, while moving the CT nozzle up and down across the perforations at least twice.
7. Displace CT volume with treated water.
8. Come out of the hole with the CT and return the well to injection.

Note: For wells that took produced water, a mutual solvent package was included in the acid.

Caution should be taken to NOT mix the acid and bleach under atmospheric conditions. The result is a potentially violent and dangerous reaction. Also, it is advised that the well NOT be flowed back because of the probability of having high concentrations of chlorine gas in the return fluid.

ACID/BLEACH TREATMENT ON THE CRMWD SYSTEM

The CRMWD injection system was treated with 3000 gallons of 14% bleach and 12,000 gallons of 15% HCL NEFE acid. The bleach was pumped into the injection system using our injection pumps. After the bleach had been pumped, the acid was pumped into the system at four separate end points. These points were chosen to evenly distribute the acid in the system. The acid injection rate was slighty higher than the average daily injection rate. After the acid was pumped, the system was returned to injection.

CHLORINE DIOXIDE PROCEDURE

This method involved 1500 gallons of 15% NEFE acid and 500 barrels of 3000 ppm CLO2, per injection system. The CLO2 was provided by Exxon Chemical.

The CLO2 was generated on site by pumping fresh water through their generation system. The product was then pumped off the Exxon Chemical trailer by the acid company. Each injection system volume, from the injection pumps to the perforations, was approximately 1000 barrels. Exxon Chemical had recommended that we use a CLO2 volume equal to 1/4 of the injection system volume. We decided to use twice that amount.

The treatment was pumped into the injection system just downstream of the injection pump connection. In this way the entire system, from the pumps to the perforations would be contacted.

Following is a generalized procedure.

1. Hold pre-job safety meeting with Exxon Chemical representative in charge.
2. Pinch back on injection wells that already receive their recommended injection rate.
3. Shutdown waterflood injection pumps and rig-up acid pump truck just downstream of the injection pump connection.
4. Pressure test lines to 900 psi.
5. Treatment schedule:
   a. 750 gallons acid
   b. 10 barrel water spacer
   c. 250 barrels CLO2
   d. 10 barrel water spacer
   e. 750 gallons acid

f. 10 barrel water spacer
g. 250 barrels CLO2
h. 20 barrel water flush

Actual treatment rate was approximately 5 BPM at 900 psi.

6. Rig down acid pump truck and immediately return system to injection.

The procedure was used on both the CRMWD and the produced water systems separately. For the produced water system, the acid contained a mutual solvent package.

DISCUSSION: COSTS AND BENEFITS

COSTS

Attached are the cost estimates for the three treatment methods. Basically, the CT treatments cost approximately $7,100 per well. The acid/bleach surface treatment cost approximately, $14,000 or $240 per well. The CLO2 treatments cost approximately $220/well.

The unit cost for the CLO2 treatment is based on a total cost of $21,800 for two treatments. One was performed on the CRMWD system and one on the produced water system. The CRMWD system has 58 total injectors and the produced water system has 41.

BENEFITS: ACID AND BLEACH COILED TUBING CLEANOUTS

The coiled tubing treatments increased the average injection rate from 40 to 180 BWIPD. However, after six months the rate started to drop off, and was down to 100 BWIPD after a total of 14 months. The system injection pressure remained relatively constant over this period. Attached is a graph of the results. Between January 1989 and March 1990, 25 CT cleanouts were performed on the G.M. Dodge lease. Of this total, 19 were considered successful.

BENEFITS: ACID AND BLEACH SURFACE TREATMENT

The acid/bleach surface treatment increased system injectivity by 14%. However, the treatment success lasted less than one month.

BENEFITS: CLO2

To determine the effect of the CLO2 treatments, the CRMWD and the produced water injection systems were analyzed separately.

The CLO2 treatment increased the average injection rate on 22 out of the 58 CRMWD wells from 70 to 150 BWIPD. Of the 58 wells, 19 did not need treatment, since they were already at there desired rate. These wells were choked back after the treatment. Thus, 22 out of the 39 wells that needed the treatment responded favorably. Attached is a

graph of the average rate on the 22 wells that were affected. After a total of eight months, the average rate on these 22 wells had increased to 200 BWIPD. This is with a relatively constant injection pressure.

For the produced water injection system, the injectivity was increased on 20 of 41 wells treated. However, after two months, some mechanical and water distribution changes were made in the field which lowered the produced water system pressure by approximately 40 psi. Even with this pressure drop, the injectivity on the 20 wells remained higher than the pre-treatment level. Thus the treatment was considered successful on these wells also.

COST COMPARISON

The total cost of the coiled tubing cleanouts for 25 wells was $177,500. The cost per successful treatment was $9,342. For the CLO2 treatments, the total cost was $21,800. The cost per successfully treated well was $520. Thus the coiled tubing cleanouts cost approximately 18 times more per successfully treated well than the CLO2 cleanout.

ANALYSIS OF METHODS

The first two methods were used before CLO2 had been approved for use by ARCO. The combination of bleach and acid was used in these two treatments because each separately had shown some success in improving injectivity. This combination was successful, but it was found to not be as cost effective as CLO2. One factor which limited the success of these two treatments was the volume used, especially on the surface treatment.

Having seen that bleach and acid offered only limited success, approval was sought to try a CLO2 treatment. After review by ARCO's safety and environmental groups, local ARCO management approved the use of the Exxon method of on-site generation.

The success of the CLO2 treatment is primarily attributed to the fact that it is such a strong oxidizer. Another factor which made the treatment successful was the volume. The acid was used to enhance the effect of the CLO2. The CLO2's ability to treat iron sulfide and biomass buildup is greatly improved in a low pH environment.

Another reason for the greater success of the CLO2 treatment over the CT cleanouts, was that it treated the surface and downhole systems at the same time. The CT cleanouts treated only the wellbores, which would be recontaminated by the untreated buildup in the surface lines.

CONCLUSIONS AND CREDITS

All three methods discussed improved injectivity. The CLO2 treatment is considered the most cost effective, followed by the CT cleanouts, and finally the surface treatment with bleach and acid. I wish to thank ARCO for the permission to publish this paper. I also wish to thank Laura Smith with ARCO for her invaluable assistance in the assimilation of data and the preparing of graphics.

Table 1
Iatan East Howard Field Injection Well
Cleanouts Costs Estimates

COILED TUBING CLEANOUTS PER WELL

1-1/4", Coiled Tubing Unit	$2,400
Acid and Pump Truck	1,200
Water Haulers	300
Tanks	400
Bleach and Inhibitors	2,800
TOTAL	$7,100

ACID AND BLEACH SURFACE TREATMENT

Bleach	$6,000
Acid and Pump Trucks	8,000
TOTAL	$14,000

CHLORINE DIOXIDE TREATMENT PER SYSTEM

CLO2, 500 barrels	$9,000
Acid and Pump Truck	1,500
Water Trucks	400
TOTAL	$10,900

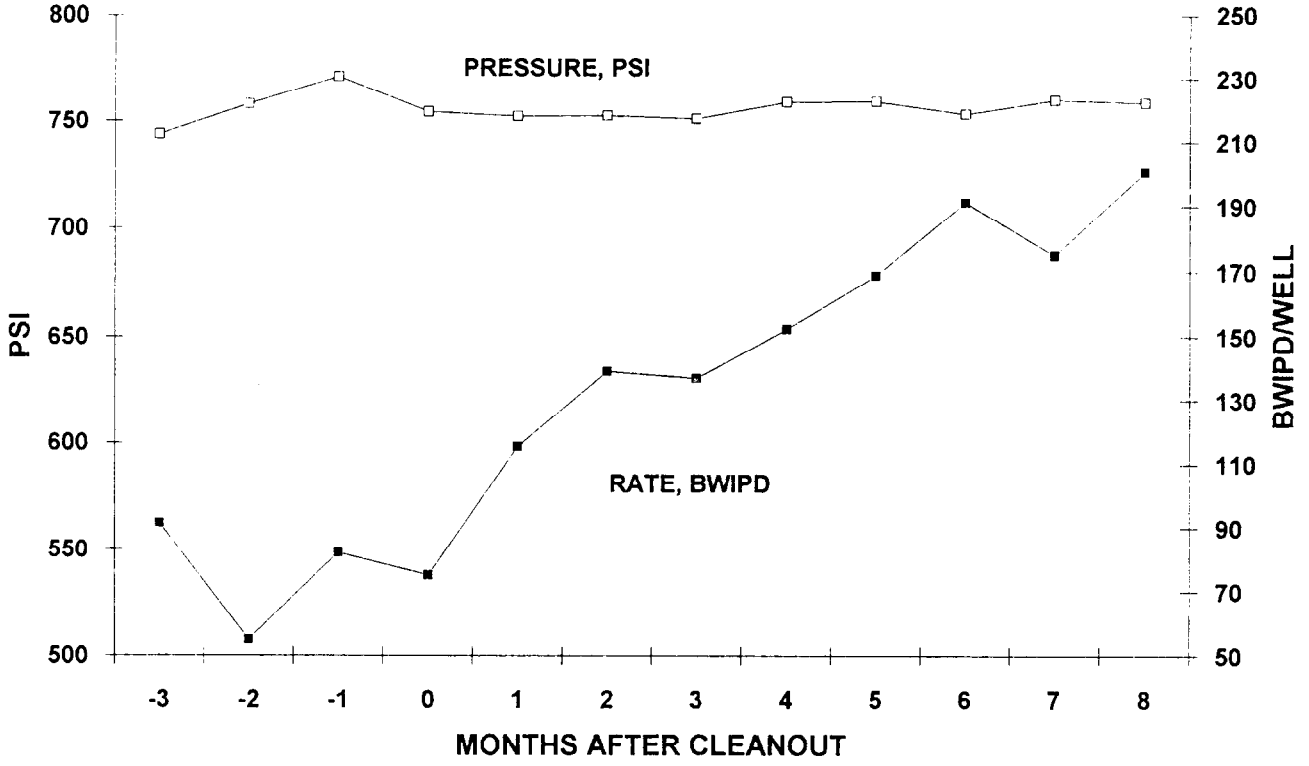

Figure 1 - Iatan E. Howard CLO2 CRMWD system cleanout, 22 well average

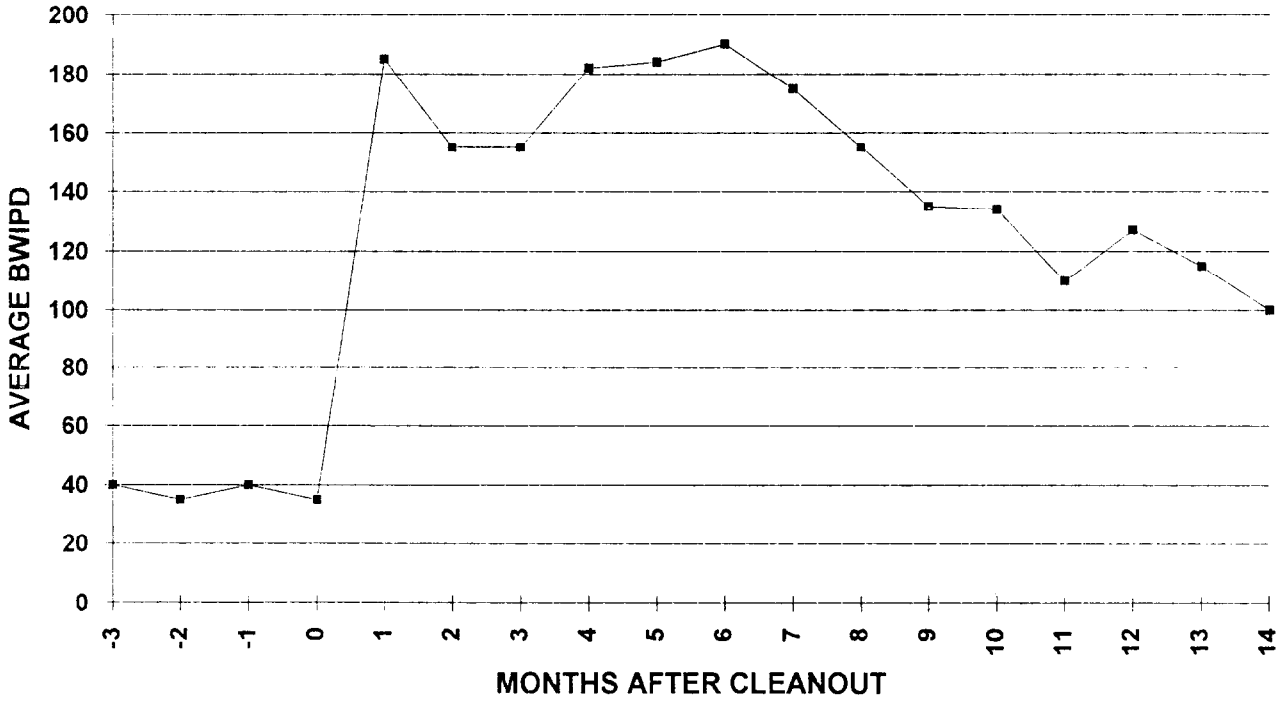

Figure 2 - Iatan East Howard Field coiled tubing injection well cleanouts