FRACTURE STIMULATION QUALITY CONTROL PROGRAM

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ABSTRACT

Approximately 20% of all fracture stimulation treatments in Conoco Inc.'s Odessa, Texas production area experienced problems which resulted in less than optimum frac jobs. Close examination of these treatments indicated that poor quality control was the primary reason for the problems experienced. To improve the quality control, guidelines were generated by engineering, field and service company personnel that 1) evaluates the service and safety performance of the treating company, 2) evaluates the design itself, and 3) discusses areas for improvement in subsequent jobs.

Since inception in June, 1984, use of the program has spread from one production area to five areas and 48 jobs have been monitored. Misinterpretation of the job procedure has decreased since engineers are submitting more specific and workable procedures. Also, the service has significantly improved since the project quality control program was implemented. Overall, monitoring all phases of the project in an organized manner has resulted in higher quality performance.

INTRODUCTION

Fracturing is one of the most important stimulation tools used in the oil industry today. It is however, one of the most expensive operations in the oil field. Thus, it is important to maximize profits by both increasing productivity gains, and reducing expenses caused by repeated errors.

Conoco Inc. was experiencing a significant number of problems with frac jobs in its Odessa Texas Area in late 1983 and early 1984. Most of the factors contributing to poor frac jobs could be traced to poor quality control and poor communication between the involved parties. The equipment failure rate was estimated to be 20%.

Some of the problems encountered were caused by incomplete treating procedures. Other problems included the absence of many of the specified fluid additives on location, and inadequate gel and water quality. Frac tanks were not always clean and the frac gel did not always break. Foreign materials, such as rope strands, were found in the tanks. Finally, equipment or communication failures impeded job success.

It was believed that these problems were adversely affecting frac job results. Therefore, an effort was made to devise a system that would do the following:

1) increase productivity gains of frac jobs,
2) increase the success ratio of frac jobs,
3) improve the quality of service provided by service companies,
4) allow Conoco to evaluate the service presently supplied by these companies, and
5) identify more accurately the factors contributing to unsuccessful frac jobs.

DISCUSSION

The attached fracture stimulation quality control program was developed by engineering, field, and service company personnel for Conoco's Odessa, Texas production area. Central to the subject program are guidelines on project quality control for the fracture stimulation treatments, and evaluation critiques for acidizing, perforating, and logging companies. The guidelines specifically outline the division of responsibilities of the respective parties prior to, during, and after the job. Following is a discussion of each section included in the attached guide and results since implementation.

Checklist

a. Heading

The heading contains information regarding the well name, field, date of job, and list of service companies utilized. The main function is to provide a system for filing the frac jobs for future reference. This allows us to study and categorize the frac jobs.

b. Before the Job

This section is divided into the Engineer's and Field Personnel's responsibilities.

The engineer's primary responsibility prior to the job is to correctly design the stimulation and include complete data on the type of system recommended, pumping rate, treating pressures, and the size of recommended equipment. This information is needed by the field personnel before the job can be set-up. Once the engineer has been notified of a specific date for the job, a meeting is held with engineering, field and service company personnel to discuss the job and any special safety precautions. This initial meeting between all involved parties drastically reduces the possibility of job failure due to lack of communication.

One of the field personnel's initial responsibilities is to insure that the location area is adequate for the planned stimulation. This requires a knowledge of both the equipment necessary and how such equipment will have to be positioned. Field personnel will also insure that the frac tanks are clean, and biocide is added in the first load of water in each tank. This prevents gel contamination caused by bacteria. After the tanks are

loaded, the water is tested by a water specialist to confirm that the water quality (pH and iron content) is acceptable. Once the service company arrives on location, the foreman checks that all fluid additives are on location, coordinates with the service company, collects pre-job samples and insures that all equipment is working properly. Finally, a pre-job safety inspection and meeting are conducted to explain any special safety precautions and to present a contingency plan for emergencies.

c. During the Job

This section is also divided into the Engineer's and Field Personnel's responsibilities.

The engineer's primary responsibility is to monitor the pressure, rate, volume and sand concentrations. The engineer will also have a contingency plan for potential problems.

The field foreman/technician monitors the blender and other equipment, collects samples of the fluid being pumped and insures that all safety precautions are being followed. During the job, the engineer and the foreman maintain communication via an independent communication system (usually walkie-talkies). This independent communication system allows the field foreman and the engineer to be constantly informed of the job progress and any changing conditions. On occasion, it has also served as a backup communication system when service company communication systems have unexpectedly failed.

d. After the Job

After the job, each party will check the location to make sure that all fluid additives were used, and that the location is left clean. Afterwards, the engineer will meet with the field personnel to critique the job.

Pre-Frac Work Critique

This section contains a brief critique of each service company utilized prior to the frac job. A mistake in any of the operations can directly influence the success of the frac job.

a. Perforators

The perforating section is included to insure that the guns actually did fire, the hole shape and size is consistent, and that the guns did not swell excessively or hang up.

b. Loggers

The logging section evaluates log quality and service. It is also included to emphasize the importance of using logging tools to monitor zone coverage, and in pointing out other problems such as channeling or the existence of multiple fractures.

c. Acid Company

The acid company utilized is evaluated on the pH of the acid and any failures of equipment. A successful acid job is important to break down the perforations.

Frac Critique

The most important aspect of the frac guide is the Frac Critique section.

a. Design

Three topics concerning frac design which are addressed in this section are listed below.

1) Was the job designed correctly?
2) Was it redesigned if necessary?
3) What, if anything, could be done to improve the design?

The engineers use this section to analyze this stimulation and to aid in future designs.

b. Service Company

The four objectives are to evaluate: 1) service company equipment performance, 2) service company safety practices, 3) service company thoroughness, 4) service company overall performance.

c. Our Quality Control

This section is for comments on any aspect of Conoco's quality control. Comments range from recommending obtaining more fluid samples to recommending that a densiometer always be present on location. Densiometers are now part of our required equipment. Another recommendation was made in mid-1984 to have Conoco radios on location.

d. Areas To Be Improved On

This section is for comments or recommendations on miscellaneous subjects. Areas generally covered in this section are communication, monitoring and coordination.

RESULTS

The results of the 48 jobs performed to date are listed below.

1. Of the 48 perforating jobs evaluated, only 5 had misfires and/or blown ports. Overall, service company performance was high.

2. All 48 acid stimulations evaluated were completed satisfactorily.

3. Thirty-four of 48 jobs had the frac design critique section completed. Of the 34 jobs , 30 required no re-design during treatment while four did. Three of the four jobs were redesigned on location. The final job could not have been redesigned on location as it required more gel and sand than were available. One example of inadequate job design occurred in three instances having insufficient pad volumes. The practice of logging "dummy stages" prior to initiating the frac job has helped tremendously in job design and insuring zone coverage.

4. Since implementation of the quality control guide, the safety evaluation ratings indicated 25 cases of excellent safety, 16 instances of good safety, and 7 that were not evaluated.

5. The overall performance ratings indicated 35 jobs rated good or excellent and 9 jobs rated fair or poor.

6. Equipment problems/failures occurred in almost half of the treatments. Fortunately, only 2 problems were severe enough to significantly impair the job. This indicates a reduction of the equipment failure rate from approximately 20% to 4% (2 of 48). In one case the blender screws failed during the job. The second major equipment failure occurred when the discharge pump was partially blocked by foreign matter from the blender approximately 2/3 of the way through the job. In 8 cases the problems were detected early enough and were rectified. The remaining 10 cases consisted of very minor equipment problems such as difficulty in opening the hatch on the sand truck or meter malfunctions.

7. In 2 separate cases, Conoco's back-up communications were instrumental to job success when during the job, the service company's communication system failed.

CONCLUSIONS

1. The safety performance on the 48 stimulations is above average. Twenty-five jobs had an excellent safety rating, 16 had a good safety rating and 7 jobs were not evaluated.

2. Overall service company performance varied. Fourteen jobs received an excellent rating, 21 received a good rating, 5 received a fair rating and 4 jobs received a poor rating.

3. Treatment logs run after the dummy stage aided in redesign of the fracture job on location. Two different jobs attribute the log as the factor which determined the success of the frac job.

4. In most cases, the fracture stimulation was designed correctly. Of the 34 jobs evaluated, 30 were designed correctly, 3 jobs were redesigned on location, and 1 needing redesigning was not.

5. The pre-job inspection has aided in reducing the job impairment rate by identifying equipment problems before the job begins.

6. The perforating quality has been acceptable, with only 5 of the 48 jobs having either misfires or blown ports. The logging and acid job quality has also been excellent.

7. Communication continues to play a large role in the success of the frac job. While communication problems have been reduced, the pre-job meetings are still important in providing direct communication between all involved parties.

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PROJECT QUALITY CONTROL

Well Name _____

Field _____

Date _____

Service Company

Perforators _____

Loggers _____

Acid Company _____

Frac Company _____

Other _____

BEFORE THE JOB

I. Engineers

A. Specify System

1. Sand type (Example 20-40 Ottawa)
2. Gel system (Example 40# HPG System or 30# HPG Titanate Crosslink System
3. Fluid additives; amount/1000 gallons, type

a. Breaker; specify where it is to be added, breaker time
b. Fluid loss
c. Surfactant
d. Biocide; specify where and when it is to be added
e. Miscellaneous

B. Rate

C. Maximum treating pressure, expected treating pressure (Make sure wellhead is adequately rated)

D. Tubing size (Example 2 7/8" workstring)

E. Quality control equipment (If available and necessary)

1. Calibrated recording densiomenter in same van w/pressure recorder.
2. Fann VG meter

F. Special safety precautions

G. Meet with foreman, technician and service company representative to discuss job

II. Field Personnel

A. Make sure the location is clean and adequate size (have a picture of how everything will be set up before all equipment arrives).

B. Have pit dug.

C. Order clean frac tanks. Check frac tanks, blender, transports, etc., for cleanliness.

D. Watch biocide go in first load of tank.

E. Test water quality before gelling up (Ph, iron content).

F. Make sure all chemicals are on location before gelling up.

G. Coordinate with service company personnel as needed.

H. Collect sand samples. Perfrom sieve analysis.

I. Make sure all equipment is in working order.

J. Prejob safety inspection by foreman.

DURING THE JOB

I. Engineers

A. Monitor pressure, rate and recording densiometer in frac van.

B. Keep foreman informed.

C. Know when you are going to flush! (If problems arise - equipment parameters, frac gradient of reservoir, etc.)

D. Monitor barrel counter - (know when each stage begins and ends).

II. Field Personnel

A. Watch blender operations. Check screw rotation. Insure all additives are being used in correct proportions.

B. Collect samples of gel and sand laden fluid.

C. Insure that safety precautions are followed.

D. Keep engineer informed.

E. Monitor all equipment to insure that it is working.

AFTER THE JOB

1. Check to make sure all chemicals were used.

2. Weigh sand trucks to insure the correct amount of sand was pumped.

3. Check location to make sure sand or other additives have not been dumped on the ground.

4. Meeting of engineer with field personnel concerning job quality. Critique job.

PRE-FRAC WORK CRITIQUE

Perforators

General remarks (for example: Did the gun fire? Hole shape and consistency? Gun swelling, etc.)

_____

_____

Overall service (circle one) Excellent Good Fair Poor

Loggers

General remarks (log quality, are they on depth? Tool failure? etc.)

_____

_____

Overall service (circle one) Excellent Good Fair Poor

Acid Company

General remarks (Ph? equipment failure?)

_____

_____

Overall service (circle one) Excellent Good Fair Poor

Frac Critique

1) Design

Was the job designed correctly? Explain.

_____

_____

Was it redesigned if necessary?

_____

_____

What could be done to improve the design?

_____

_____

2) Service Company

Were there any failures of the service company equipment?

_____

_____

Safety attitude (circle one) Excellent Good Fair Poor

Were all additives on location?

_____

_____

Overall performance of service company (circle one)

Excellent Good Fair Poor

3) Our Quality Control

Comments _____

_____

_____

_____

4) Areas to be improved on _____

_____

_____

Signatures

Foreman _____ Date _____

Engineer _____ Date _____

Technician _____ Date _____

Technician _____ Date _____