DECLARATION OF REBEKAH STACHA OF THE SOCIETY OF PETROLUEM ENGINEERS

1. My name is Rebekah Stacha. I am over the age of twenty-one years, of sound mind, and capable of making the statements set forth in this Declaration. I am competent to testify about the matters set forth herein. All the facts and statements contained herein are within my personal knowledge and/or within my field of expertise, and they are true and correct to the best of my knowledge.

2. I have been employed by the Society of Petroleum Engineers ("SPE") since 2001. SPE is the largest individual-member organization serving managers, engineers, scientists and other professionals worldwide in the upstream segment of the oil and gas industry. SPE focuses on disseminating information regarding practices and technology in the oilfield industry. In addition to sponsoring conferences, SPE publishes several peer-reviewed journals, including *SPE Drilling and Completion*, *SPE Economics and Management*, *SPE Journal*, *SPE Production and Operations*, and *SPE Reservoir Evaluation and Engineering*. SPE also publishes several magazines in the oilfield industry.

3. SPE collects and makes publicly available papers presented at the various conferences it sponsors. For conference papers, SPE distributes hardcopy, compact disc or digital versions of the proceedings including all papers at the conference to all fully registered attendees of a conference. Since at least 1998, SPE has made

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4. SPE Paper SPE-51177-PA, a true and correct copy of which is attached as Exhibit A to this Declaration, is an SPE Paper entitled, *Design and Installation of a Cost-Effective Completion System for Horizontal Chalk Wells Where Multiple Zones Require Acid Stimulation*, that was received for publication on March 23, 1998 and was peer approved for publication on June 15, 1998. The article was subsequently published in the September 1998 issue of *SPE Drilling & Completion* at pages 151-156. *SPE Drilling & Completion* has had both individual and institutional subscribers including numerous libraries since 1993. The September 1998 issue would have been

distributed to subscribers at least by October 1998. Since its publication in September 1998, SPE-51177-PA was also publicly available to anyone interested in purchasing a copy of the paper through the online sources provided by SPE discussed above.

5. SPE Paper SPE-37482-MS, a true and correct copy of which is attached as Exhibit B to this Declaration, is an SPE paper entitled, *Design and Installation of a Cost Effective Completion System for Horizontal Chalk Wells Where Multiple Zones Require Acid Stimulation*, presented at the SPE Production Operations Symposium on March 9-11, 1997 in Oklahoma City, Oklahoma. SPE is a sponsor of the SPE Production Operations Symposium. Since that conference on March 9-11, 1997, SPE Paper SPE-37482-MS has been publicly available to anyone interested in purchasing a copy of the paper through the online sources provided by SPE discussed above.

6. SPE Paper SPE-19090-MS, a true and correct copy of which is attached as Exhibit C to this Declaration, is an SPE paper entitled, *Production and Stimulation Analysis of Multiple Hydraulic Fracturing of a 2,000-ft Horizontal Well*, presented at the SPE Gas Technology Symposium on June 7-9, 1989 in Dallas, Texas. SPE is a sponsor of the SPE Gas Technology Symposium. Since that conference on June 7-9, 1989, SPE Paper SPE-19090-MS has been publicly available to anyone interested in purchasing a copy of the paper through SPE directly and later through the online sources provided by SPE discussed above.

I declare under penalty of perjury of the laws of the United States that the forgoing information is true and correct of my own personal knowledge.

Executed on July 11, 2016, in Richardson (city), Texas (state)

By: Rebekah Stacha

Print: Rebekah Stacha

Title: Senior Manager Technical Publications

Design and Installation of a Cost-Effective Completion System for Horizontal Chalk Wells Where Multiple Zones Require Acid Stimulation

D.W. Thomson, SPE, Halliburton Manufacturing and Services Ltd., and **M.F. Nazroo,** Phillips Petroleum Co. Norway

Summary

An innovative completion design that allows multiple acid fractures to be performed in horizontal subsea chalk formation wells with a single trip into the wellbore has recently been codeveloped by a major North Sea operator and an oilfield engineering/manufacturing/service company. The project was begun to develop a system that would allow multiple acid stimulations to be efficiently performed in the shortest possible time in the North Sea Joanne field. The system ultimately developed allows acid stimulation of up to 10 different zones in a single trip with no through-tubing intervention. The first well in which this new technique was used had seven zones, and three additional wells with 10 zones each were later completed. This paper presents the development of this system and case histories of the first four subsea wells requiring stimulation.

The key element of the system is a multistage acid fracture (MSAF) tool that is similar to a sliding sleeve circulating device and is run in the closed position. Up to nine MSAF tools can be run in the completion with isolation of each zone being achieved by hydraulic-set retrievable packers that are positioned on each side of an MSAF tool. Each sleeve contains a threaded ball seat with the smallest ball seat in the lowest sleeve and the largest ball seat in the highest sleeve. With this system, stimulation of 10 separate zones is accomplished in 12 to 18 hours. A unique procedure that lubricates various sized, low specific gravity (SG) balls into the tubing and, then, pumps them to a mating seat in the appropriate MSAF tool to seal off the stimulated zone is used. This allows stimulation of the next zone, which is made accessible by opening the sleeve.

This technique provided a substantial reduction in the operation time normally required to stimulate multiple zones and allowed the stimulations to be precisely targeted within the reservoir. The case history data provides comparisons in operation times between traditional stimulations and this new method, as well as the significant enhancements to cost efficiency that resulted from its use. Additionally, this completion method allowed the stimulations to be designed and matched to the requirements of each reservoir zone, which provided the most cost-efficient treatments possible.

Introduction

The Judy/Joanne fields are located in the central North Sea on Block 30/7a (commonly known as the J-Block of the U.K. North Sea), 280 km southeast of Aberdeen. The water depth is approximately 80 m.

The complete field development consists of a 24-slot platform for Judy and a 12-slot subsea template for Joanne. Production from the Joanne subsea manifold is transported through two 12-in. pipelines, 5 km in length, to the Judy platform.

To date, five Joanne subsea wells have been drilled and completed, four of which were in chalk formations, and thus, comprehensive acid stimulation programs were required for their completions. **Fig. 1** is a map showing the location of the J-Block Judy/Joanne fields.

This paper (SPE 51177) was revised for publication from paper SPE 39150, first presented at the 1997 Offshore Technology Conference held in Houston, 5–8 May. Original manuscript received for review 50 May 1997. Revised manuscript received

Well Design

Phillips' original plan had been to drill 60° wells in these fields; however, because drilling horizontal wells would reduce the number of well slots, which would subsequently reduce overall drilling costs, the decision was made to complete horizontally. Additionally, it was believed that stimulation programs would be required to achieve the necessary production potentials. The new wells were designed to intersect the most productive reservoir layers twice to further maximize production. Ideally, each reservoir layer was to be stimulated by means of a design developed for its specific needs. Thus, it would be necessary to perform multiple stimulations targeted at the reservoir layers. **Fig. 2** shows how the well path would intersect the individual reservoir layers.

A review of similar completions carried out by Phillips and other operators indicated that each zone would require between 3 and 4 days to stimulate. This would have meant a minimum of 30 days per well to complete the stimulation procedures. It was clear from the initial review that the project could not support such greatly increased costs, so an alternative method was needed. The resulting completion design was based on earlier completions performed by Phillips on the Hewett field in the southern part of the North Sea (see Fig. 1). During these completions, the initial development phase of the MSAF tool had taken place. This tool was instrumental in the success of the design and is described in more detail in the following section.

The primary difference in the completion designs concerned the number of zones stimulated. The Hewett field completions typically used only two MSAF tools that resulted in three stimulated zones, whereas the first Joanne completion (Well M1) used six MSAF tools, and the completions for Wells M3, M4, and M5 used nine MSAF tools. **Fig 3** is a schematic of a typical Joanne completion.

Typical Joanne Completion Design

1. Tubing Hanger, 5⅛-in. Horizontal (lateral) subsea trees were used to allow the completions to be run through them. The final operation before leaving the wells was the installation of wireline-set, metal-to-metal-sealing wellhead plugs in the tubing hangers.
2. Tubing-Retrievable Safety Valve (TRSV), 5½-in. A non-equalizing TRSV with metal-to-metal seals was used to ensure reliability.
3. Side Pocket Mandrel, 4½-in. × 1½-in. These were run with blanked off annulus ports to enable electronic memory gauges with the same envelope dimensions as a standard 1½-in. gas lift valve to be installed in the completions during the stimulation without compromising full bore access. These gauges were run and retrieved with conventional gas lift kick-over tools and gave valuable bottomhole information during the stimulations, cleanup procedures, and well tests.
4. Sliding Sleeve Circulating Devices, 4½-in. The devices were run to enable the upper completion/casing annulus to be circulated

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