A CASE HISTORY - REVIEW AND PROGRESS REPORT ON THE PRESSURE FLUCTUATING TOOL FOR PERFORATION CLEAN UP IN PRODUCTION AND INJECTION WELLS

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ABSTRACT

The Pressure Fluctuating Tool (PFT) utilizes a bi-stable, fluidic oscillator to create pulsating pressure for breaking down and/or cleaning up perforations in oil, gas and injection wells with or without stimulation fluids. The pressures generated by the PFT are from 1,500 psi above hydrostatic to 1,500 psi below hydrostatic at 140 to 150 cycles per second. This focused energy has been very successful in perforation tunnel clean up as will be indicated in the detailed case history review contained in this paper.

INTRODUCTION

The purpose of any perforation cleaning technique is to remove debris and impermeable layer of formation or skin damage. The PFT cleans perforations by exposing the formation face to rapid pressure fluctuations which induce cyclic tensile and compressive stresses in the formation skin. Since the formation is quite weak in tension this can cause rapid breakdown of material on the formation face. The pulverized material can then be completely removed with HCl or other appropriate fluids. The perforation is then open to accept the proper formation treatments. By using appropriate fluids or solvents the same type treatment can be performed on scale or paraffin deposits.

PFT cleaning treatments are accomplished by moving the tool through the target zone while pumping through the tool. This exposes each perforation to fluctuating pressure while it is adjacent to the PFT, providing uniform treatment of perforations through the entire interval. This is an advantage in treating long or short intervals, regardless of shot density, since the tool can be moved fairly rapidly while providing sufficient exposure to each one foot interval of perforations.

The PFT can be utilized in the CIRCULATION MODE, or the INJECTION MODE, or both. In the circulation mode the perforations are cleaned while circulating fluid through the tool, up the annulus to the pit. This treatment is

important in sensitive formations because the perforation tunnels can be cleaned without pumping into the formation. The injection mode is used to combine the pressure fluctuations generated by the tool with an acid or solvent treatment. By closing the casing head valve the treatment is pumped into the formation in a matrix condition while moving through the target interval.

The Pressure Fluctuating Tool has established favorable results in new completion and remedial treatments. The treatments represented in Table I were chosen to give a wide diversification in wellbore characteristics, formation, location and treatments.

Figure I represents data obtained in one field of West Texas in an ongoing program of new completions. In this field, the PFT is being used to initially break down and clean perforations prior to a major acid treatment. The data is compiled from treatments in the West Levelland Field in Cochran County, Texas. The PFT is utilized to clean a 30 ft. gross interval in the San Andres formation at approximately 4,900 ft.

Prior to the introduction of the PFT, breakdown pressures averaged 1,800 psi Surface Treating Pressure (STP) or approximately 3,900 psi Bottom Hole Treating Pressure (BHTP). Due to underlying water, the maximum STP is set at 2,200 psi. As depicted by the figure, of the wells treated with the PFT, 75% have broken down with a lower STP than the average for the field.

CASE HISTORY # 1

This East Texas well had 5 1/2" casing with 30 perforations spaced out in a 173 ft. interval at approximately 9,500 ft. Production was from the Cotton Valley Lime formation. The well was about one year old and was producing 21 BOPD through a downhole pump. Analysis of data indicated paraffin and carbonate scale were plugging the perforations. The PFT was run in with 2 3/8" tubing and positioned 20 ft. above the top perforation and the tool was tested. With the test complete, the tool was lowered through the interval while pumping 2% KCl. Perforation cleaning was indicated on the surface monitoring equipment. When the tool reached the bottom perforation, an acid-solvent mixture was pumped to within two barrels of the PFT. The annulus was closed and the acid-solvent mixture was pumped into the perforations as the tool was raised through the interval. Production 30 days after treatment was stabilized at 40 BOPD and 30 BWPD.

CASE HISTORY # 2

This Oklahoma well was producing from the Skinner and Redfork formations in the South Maramec Field, Payne County. A gross interval of 106 ft. was perforated with 64 holes at approximately 3,000 ft. Combined production had fallen off to 0.68 BOPD and 60 BWPD due to scale buildup. After testing the tool above the perforations, the target interval was treated once with lease water. The perforations were then treated with 7.5% HCl from bottom to top while in the circulation mode. Two days after the treatment, the well was producing 9 BOPD and 68.7 BWPD. Five weeks after treatment the well had stabilized at 4 BOPD and 61 BWPD.

CASE HISTORY # 3

This case involved a well in the Parochial Bade Field, Sterling County, Texas. The Clearfork formation was perforated with 1 JSPF in a 30 ft. gross interval at approximately 2,200 ft. Two trips were made through the interval while oscillating at 2 BPM. The pump time was less than one hour. Production before treatment was 0 BOPD and 250 BWPD. Three days later the well tested at 14 BOPD and 116 BWPD.

CASE HISTORY # 4

This particular well is in the St. Louis Field, Pottawatomie County, Oklahoma. The Earlsboro formation is being produced from a 50 ft. gross interval at approximately 3,600 ft. with 54 perforations. Production had fallen off to 17 BOPD and 30 BWPD. Analysis of scale taken from the pump revealed 83% $BaSO_4$ (Barium Sulphate). A bit and scraper was run to TD and the PFT was used with 200 barrels of lease water and 500 gallons of acid-solvent mixture. The treatment was started at the top perforations operating for approximately one minute over each setting in the circulation mode. After treating the lower perforation the acid-solvent mixture was pumped in the injection mode. The original pump was reinstalled and put on production. After two weeks the well had stabilized at 33 BOPD and 60 BWPD.

CASE HISTORY # 5

This well was in the Cherry Canyon formation in West Texas. It has 24 feet of perforations shot at one shot per foot in 5 1/2" casing at approximately 6,000 feet. The PFT was run on 2 3/8" tubing until the Primary Oscillation Zone was below the bottom perforation. KCl water was circulated at 2.1 BPM producing an oscillation frequency of

163 Hertz. The tool was then raised through the perforated interval while continuing to circulate at 2 BPM. Performance was monitored by surface instrumentation while raising the tool. Oscillation frequency and amplitude reductions occurred in less than one minute while the PFT was stationary.

Surface instrumentation indicated that all perforations were successfully broken down. The well was fractured two days later and a post-frac temperature survey showed an excellent distribution of fluid production throughout the interval.

CASE HISTORY # 6

Well number 6 is a San Andres well in Ector County, Texas. Production in this well had fallen off to 0 water and 0 oil. There are 23 perforations over a 275 ft. gross interval. Two trips were made through the perforations with 2% KCl in the circulation mode to remove any heavy debris. The injection mode was used to pump the acid treatment with only one trip through the perforations. Production after one week was 11 BOPD and 80 BWPD.

CASE HISTORY # 7

Case number 7 is the Devonian formation in Crane County, Texas. The formation was perforated with 60 shots in a 608 ft. interval in 5 1/2", 14# casing at approximately 9,100 ft. Treatment consisted of two trips through the perforations in the injection mode with 15% HCl. Total pump time on this treatment was approximately 2.5 hours. After a month, oil production was up 40% and total fluid was up 25%.

CASE HISTORY # 8

Well number 8 was treated for paraffin in the Buda formation at approximately 8,700 ft., located in Brazos County, Texas. The well was perforated in a 70 ft. gross interval with 70 shots in 5 1/2", 17# casing. After a trip through the interval with 2% KCl in the circulation mode, the formation was treated with a mixture of paraffin dispersing solvents and acid in the injection mode. Complete pump time was 90 minutes and the tool was tripped out. Production after four weeks was 30 BOPD and 25 BWPD. This production was up from 15 BOPD and 3 BWPD prior to treatment.

CASE HISTORY # 9

This case was a well in Winkler County, Texas. Production had fallen to 38 BOPD and 42 BWPD from the Fusselman formation. Paraffin and calcium carbonate scale had been determined to be the cause for production decline. The 5 1/2", 17# casing was perforated in two intervals in 150 ft. gross with 8 SPF at approximately 8400 ft. The tool was operated through the perforations with xylene and 20% HCl in the injection mode. Production after two weeks was 59 BOPD and 91 BWPD.

CASE HISTORY # 10

This well was located in the Bolton Field, Hinds County, Mississippi. The Rodessa formation being produced from a gross interval of 347 ft. with 156 shots. The PFT was used in 5 1/2", 20# casing with lease water in the circulation mode. The tool was utilized to open the 4 JSPF density over the combined 43 ft. of perforations prior to acid treatment. The PFT ran through the perforations three times in 68 minutes. After two weeks, production was up to 22 BOPD and 110 BWPD from 12 BOPD and 60 BWPD.

REFERENCES

1. Payne, R.A., Williams, K.A., Pelty, L.L. and Baily, H.L.: "Pressure Fluctuating Tool", paper SPE 13803 presented at Production Operations Symposium, March 1985.

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Table I

LOCATION COUNTY/STATE	FORMATION	DEPTH	TREATMENT	MODE	PRODUCTION (BOPD/BWPD) BEFORE	AFTER	WEEKS AFTER TREATMENT
1. Navarro/TX	Cotton Valley	9500	2% KCl, One Shot	C/I	21/0	40/30	4
2. Payne/OK	Redfork & Skinner	3000	2% KCl, 7.5% HCl	C	.68/60	4/61	5
3. Sterling/TX	Clearfork	2200	2% KCl, 7.5% HCl	C/I	0/250	14/116	1
4. Pottawatomie/OK	Earlsboro	3600	2% KCl, 7.5% HCl	C/I	17/30	33/60	2
5. Loving/TX	Cherry Canyon	6300	2% KCl	C	NW	48/408	1
6. Ector/TX	San Andres	3700	2% KCl, 15% HCl	C/I	0/0	11/80	1
7. Crane/TX	Devonian	9100	Brine, 15% HCl	I	40/200	57/255	4
8. Brazos/TX	Buda	8700	Paravan 75/25	C/I	15/3	30/25	4
9. Winker/TX	Fusselman	8400	Xylene, 20% HCl	I	38/42	59/91	2
10. Hinds/MISS	Rodessa	11000	Lease Water	C	12/60	22/110	2

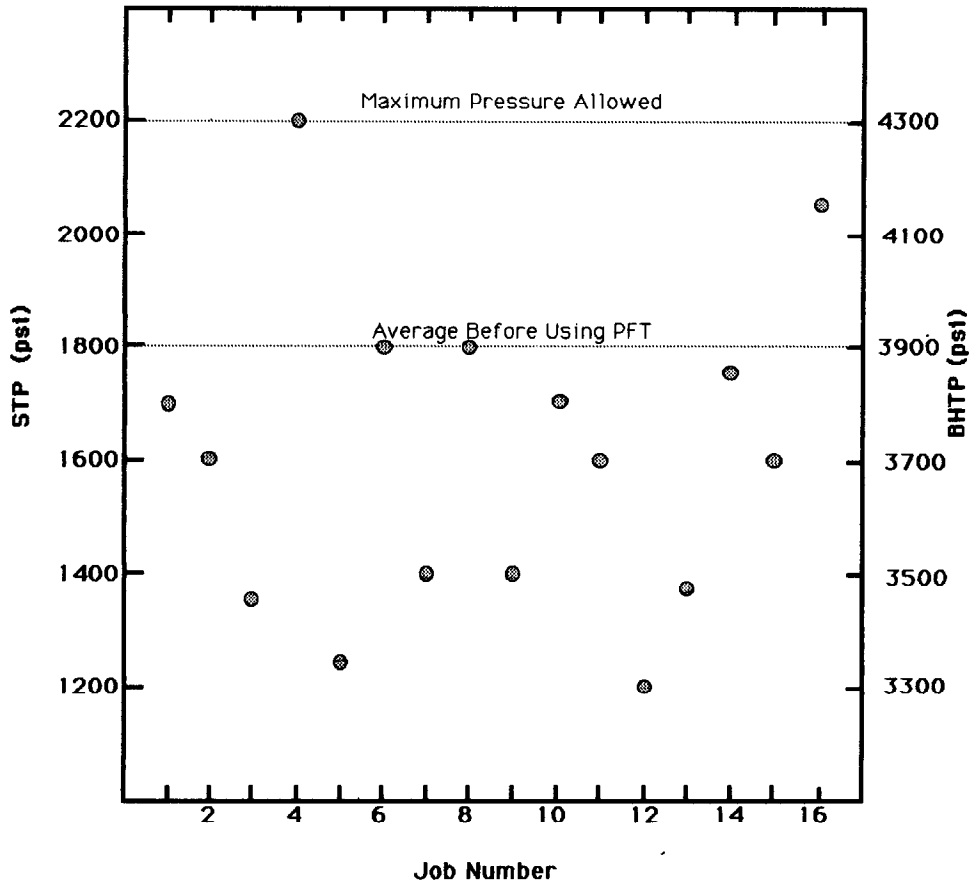

Figure I—Breakdown pressures in one field