OPTIS™ HD ELECTRIC LINE
SHEDDING LIGHT ON FRACTURE EFFICIENCY

EV's electric line side view camera sheds light on perforation performance and fracture efficiency

UNDERSTANDING THE PAST TO OPTIMISE FOR THE FUTURE

The rapid expansion of tight oil & gas field development in the lower 48 US states has been facilitated, in part, by the advances in horizontal drilling and hydraulic fracturing technology. Future energy needs between 2010 and 2035 are expected to double production from tight gas reservoirs, and operators will be looking for technology to increase the effectiveness and efficiency of the entire operation from exploration to production in order to meet this demand.

An analysis of completion efficiency involves examining a range of data from geological and reservoir sources to perforation and hydraulic fracturing design. By understanding more about the fracture efficiency, future completion designs can be optimised saving the operator time and cost as well as minimising risks such as screen out.

UNCONVENTIONAL PLAYS – UNCONVENTIONAL SOLUTIONS

The geometry of perforation entrance hole size and area is determined under laboratory conditions that closely simulate those in the downhole environment. Actual wellbore conditions however, add variations that cannot all be tested in the lab. The best way to assess perforation entrance hole performance in a wellbore is to go down and look at the hole which is accomplished through deployment of downhole cameras. In this case study, the operator desired to accurately measure the perforation dimensions downhole both before and after a hydraulic fracturing job to improve their understanding of perforation performance and gain and insight into which clusters and individual perforations fractures initiated from.

EV's full colour, 360° motorised, side view camera was deployed on e-coil to acquire images of each individual perforation pre and post fracturing. Each image was post processed to provide an accurate measurement of perforation geometry to the customer.

Area=0.15 in^2

Area=0.307 in^2

Figure 1: Example of perforation area pre (left) and post (right) hydraulic fracturing

THE CHALLENGE

A US land operator sought to assess their fracture efficiency in a horizontal completion by evaluating the geometry of perforations pre and post hydraulic fracturing.

THE SOLUTION

EV deployed a full colour, side view camera on e-coil. Detailed video and images of each individual perforation were acquired before and after the hydraulic fracturing operation. The geometry of each perforation was measured and analysed to establish correlations and links to fracture efficiency and production performance.

THE RESULTS

Analysis of the perforation geometry showed (1) a high percentage of low-side perforations were plugged, and (2) revealed which clusters of perforations had been eroded by proppant thereby inferring if the stimulation had likely connected the wellbore to the natural fracture network of the reservoir. This information was then utilised as a valuable input into optimising the

QUALITATIVE TO QUANTITATIVE AND BEYOND

Conventionally camera images are used as visual aids to qualitatively describe an environment. In this case, EV advanced to the next level and, using proprietary techniques, offered a detailed analysis of the perforation circularity and area along the length of the wellbore. The orientation of each perforation with reference to the high side was also possible using the relative bearing measurement on the camera (Figure 2). This allows an analysis of the pre-fracturing perforations to be made and to assess entrance hole size variation circumferentially around the wellbore as well as with trajectory (Figure 3). It was noted that a number of perforations on the low side had become plugged and could not be measured. The pre-fracturing measurements established a baseline to which post-fracturing perforation dimensions could be compared.

In cases where pre fracturing surveys are not acquired, the condition of the perforation provides insight into whether frac fluid has entered it or not. A small hole with jagged edges indicates that the perforation has remained unchanged whereas a larger hole with smooth edges indicates that a significant amount of frac fluid has entered the perforation.

USING SIGHT TO DEVELOP VISION

The use of EV's Optis™ HD Eline camera, careful measurements and in-depth analysis provided the customer with a better understanding of the fracture efficiency. This information was utilised as a valuable input into future perforation, fracture and completion design.

EV's technology and innovation have offered a unique solution to enable the customer to optimise costs and production performance in future field operations.

Area	Perimeter	Circularity	Height	Width	Degrees from High Side	Notes
0.1165	1.3174	0.8433	0.4245	0.3585	135	Partially Plugged
0.1141	1.2923	0.8587	0.4135	0.3510	45	Partially Plugged
0.1439	1.4904	0.8140	0.4904	0.3942	90	
0.1090	1.2512	0.8751	0.3750	0.3654	0	
0.0531	0.9042	0.8167	0.2212	0.3077	135	
0.0714	1.0247	0.8539	0.2981	0.2981	135	
Completely Plugged - Could not measure					180	Plugged
0.1151	1.3021	0.8533	0.3654	0.3990	180	Plugged
0.1129	1.3131	0.8229	0.4231	0.3750	0	
0.1039	1.2879	0.7875	0.3942	0.3462	0	
0.0909	1.2147	0.7741	0.3558	0.3558	0	
0.0802	1.1251	0.7960	0.3462	0.3269	0	
0.1157	1.3390	0.8112	0.3846	0.3750	90	Plugged
0.0942	1.1621	0.8769	0.3737	0.3053	180	
0.0765	1.0679	0.8426	0.3365	0.2981	45	
0.0953	1.2039	0.8263	0.3365	0.3558	0	
0.1252	1.4140	0.7866	0.3878	0.4082	90	
0.1152	1.3589	0.7843	0.3894	0.3942	90	Plugged
0.1208	1.3525	0.8295	0.4000	0.4000	0	

Figure 2: Example of pre-fracturing perforation dimensions

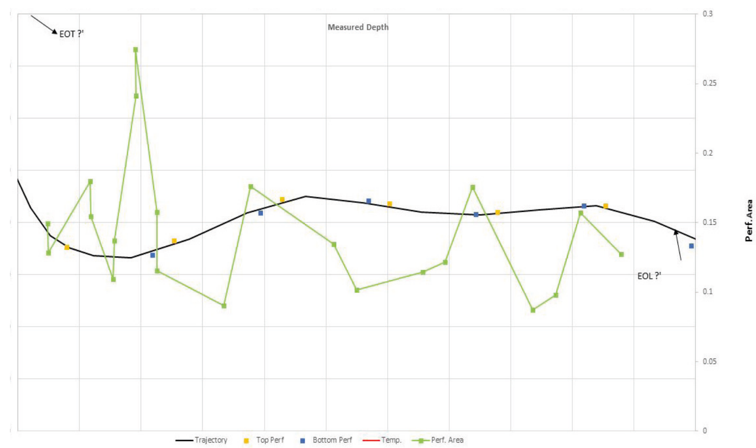

Figure 3: Pre-fracturing perforation area plotted along wellbore trajectory