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Hydrajet (Abrasive) Perforating Can Improve Success of Fracturing Stimulations

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Abstract

At least as early as the 1960s, many well operators knew that hydrajetting perforations, or slots through cemented casing, could often "bail-out" a problem well that otherwise seemed completely resistant to hydraulic-fracturing attempts. However, for more than 50 years of fracturing applications, there was insufficient demand for this process to make it a commodity service, especially before the advent of coiled tubing (CT) services in the 1980s. With very sporadic use, this type of well service was costly because abrasive mixing and high-pressure pumping were both needed, and efficiencies of repetitive use were not developed. Conventional explosive shape-charge perforating was usually lower-cost and seemed sufficient for most wells.

As oil and gas prices have drastically increased interest in multi-stage fracturing operations and wells are more often being completed in hard, low-permeability reservoirs, hydrajet perforating (HP) has seen a global resurgence. For many applications, HP can improve fracture-stimulation efficiency and well economics. In a few cases HP has proven to be the only way that effective fracture stimulation could be achieved. There is a growing acceptance among both operators and service companies that hydrajet (abrasive jetting) perforating can result in superior well stimulation. Some newer methodologies have combined HP and hydraulic fracturing into a single, continuous, multistage stimulation method. The use of a larger number of discrete stimulation stages has often provided significant production gains and greater recoverable reserves. Reductions in nonproductive time (NPT) also can allow for reduced well costs, even when more actual fracture stages are pumped.

Additional to using HP as a component for multistage fracturing, in many moderately hard and very hard formations operators have proven the value of converting from shape-charge perforating to hydrajetting as a stand-alone operation to avoid severe near-wellbore problems during hydraulic-fracturing stimulation treatments. This often has drastically enhanced stimulation success for many wells. This paper reviews the expanding services and global applications of HP in recent years.

Background

Jetting of carbonate formations in openhole completion has been reported at least as early as 1939. It was not until 1958 that there were oilfield reports of incorporating solid abrasives in the jetted fluid and reporting widespread use for perforating the casing and formation. What preceded the successful move from hydrojetting (w/o abrasives) to hydrajetting (w/abrasives) was the transition to more abrasion-resistant carbide jets (Brown et al. and Pittman et al.). Ousterhout indicated that by early 1961 over 2,500 successful HP jobs had been performed. This was a time when bullet perforating was common, and explosive/shape-charge perforating technique was still in its infancy.

There was not always a distinction between perforating and slotting in the very early papers, with the slotting mostly a result of pipe rotation. Today, this would be carefully implemented to avoid severing, or even over-weakening, of the casing. For fracturing through such slots in vertical wells, there would be some concern that a fracture might initiate horizontally, although if a second vertically oriented fracture that intersected the wellbore was to form quickly, this may not be a problem. For horizontal-well applications, rotational slotting could be beneficial when transverse fractures are preferred but would need to be carefully controlled because a parted liner could mean future problems with re-entry to the wellbore below that point. Additionally, excessive rotational slotting could weaken the liner to the point it might collapse with long-term production.