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Agitating Explosives in Extended Reach Wells: A Good Idea?

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Abstract

The total length of horizontal wells increasingly exceeds the normal running limits of coiled tubing (CT), therefore the industry has invented and adopted the use of water hammers to emplace the coiled tubing and its related equipment into the farthest reaches of the lateral (toe). This equipment can include hydraulic jets, mills and motors for cleaning debris out of the well, and tubing conveyed perforating (TCP) systems (guns with firing heads) for establishing the first initial flow path into the well for fracturing and production. From a safety perspective, the use of perforating systems, which contain several types of discreet explosive components designed to fire based on impact (some more sensitive than others), may conflict with the use of water hammers, which axially impact the lowest components of the bottom hole assembly.

Sometimes the industry requires this combination in extended reach wells, especially before formation breakdown where no flow path exists for pumping down wireline perforating guns, and when primary completion equipment (sliding sleeves) fails. Modeling tools may allow users to configure tool strings with coiled tubing, water hammers, and perforating guns however this does not take into account the compatibility aspects regarding whether this is safe to do so. To truly determine the compatibility beyond simple conjecture, testing is required and has been completed.

Laboratory testing of an industry-leading water hammer run above a typical coiled tubing and TCP assembly (toe gun) was carried out to determine the effect of accelerations (G's) and long-term related vibrations (~100,000 cycles) on safety-critical TCP system equipment and simulated explosives. A field trial using live explosives was successfully completed, confirming the test results.

A novel approach, part of which is patented (Henke, 2010) is also described in which TCP equipment is configured with a fluid bypass to allow deployment on coiled tubing above a water hammer, hydraulic jets or mills and motors. This approach improves operator efficiency by allowing the clean-out and TCP system equipment to be run in a single trip. Laboratory testing measuring accelerations (G's) and long-term related vibrations (~100,000 cycles) again proved that there is no detrimental effect on safety-critical TCP equipment to include the shear pin in the firing head and liners in the perforating charges. Field testing of this system is pending.

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