Postprint: ALE Simulation of Perforating Charge Penetration into Ultra-High Strength Sandstone in Ultra-Deep Wells

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Abstract

As the drilled well depth continues to increase, the compaction, strength, and formation pressure of reservoir rocks also increase, necessitating the use of super-perforating charges to penetrate the damaged zone. The combination of super-charge, super-target, and high confining pressure increases the difficulty of penetration analysis. Using LS-DYNA software combined with the ALE algorithm, a three-dimensional model of HS45-5 super-perforating charge-gun-fluid-casing-sandstone under both no confining pressure and 50 MPa confining pressure was established, taking downhole perforation in an oilfield as an example. By establishing non-reflecting boundary conditions, the interference of detonation waves on jet formation and effectiveness was eliminated; by adjusting mesh density in critical regions and optimizing mesh coordination between different contact surfaces, numerical distortion and mesh count were reduced, thereby improving analysis accuracy and reducing computational time. The study shows that: at 13 s, the jet energy reaches a peak of 60 kJ, accounting for 23% of the total energy, after which it decays sharply to zero at 850 s; at 16 s, the jet velocity peaks at 6,300 m/s; the penetration depth under 50 MPa confining pressure is 560 mm, which is 20% lower than that under no confining pressure. This study can provide a reference for simulation analysis of downhole super-perforating charge penetration into high-confining-pressure super-targets.

Full Text

Preamble

Note: Figure translations are in progress. See original paper for figures.