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Shaped Charge Particle Jet Penetration in Limestone DAVID DAMM, ANDREW SEAGRAVES, MOISES SMART, Schlumberger — Oil well perforators typically consist of shaped charges that use powdered metal liners to form high-velocity particle jets. Although the physics of jet penetration is well established for solid materials, the particle jet poses computational challenges. We report on the development of a particle-scale model of a jet penetrating a limestone (CaCO3) target. The particles vary in size (1–500 microns) and consist of one or more materials (e.g., tungsten or copper). Interparticle spacing is adjusted to match the apparent jet density (experimentally determined from flash X-ray images of powdered metal jets). The limestone target is 100% calcite, with log-normal size distribution of circular voids randomly distributed throughout the matrix. Voids can be empty or filled with fluid, such as brine or hydrocarbons. At low-impact velocities, the strength of the particles and calcite matrix strongly influences penetration depth, tunnel diameter, and other tunnel features. At higher velocities, strength is less important; density and compressibility become the dominant parameters. Results of particle-scale simulations are compared with continuum calculations of multimaterial porous jets with bulk-averaged properties. The continuum models perform reasonably well under certain conditions, although some discrepancies between model results exist. Particle-scale simulations are being investigated as a means to parameterize the continuum models for full-scale simulations of oil well perforators.

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