Impact Fracture Characteristics and Failure Modes of Well Cement in Coalbed Methane Wells: Postprint

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Abstract

The fracture behavior and failure modes of well cement under perforation impact constitute a critical issue urgently requiring resolution for the overall integrity protection of cement sheaths in coalbed methane (CBM) wellbores. Using polyvinyl alcohol (PVA) fiber-reinforced well cement as the research subject, this study utilized a Split Hopkinson Pressure Bar (SHPB) apparatus to perform high strain rate loading on cement specimens, acquiring information regarding crack propagation and failure patterns at four distinct strain rate levels. The research demonstrates that: under impact loading, the fracture failure process of fiber-reinforced cement encompasses four stages—compressive deformation, crack initiation, crack propagation, and crack coalescence. The fracture velocity of fiber-reinforced cement ranges from 137.93 to 513.37 $m \cdot s^{-1}$, exhibiting a clear trend wherein fracture velocity increases with strain rate. The impact failure modes of fiber-reinforced cement comprise three categories: tensile splitting, shear failure, and mixed failure. With increasing strain rate, the failure mode transitions from shear-dominated to mixed and subsequently to splitting failure, accompanied by finer material particle size, intensified damage severity, and a shift in failure mechanism from plastic to semi-brittle failure.

Full Text

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