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PROCEEDINGS

Influence of Syringe Needle Configuration on Micro Particle Generation During Penetration

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ABSTRACT

Penetration of syringe needles into the rubber plug of vials occurs daily in usual medical operation, but in nature, it is a complex mechanical process concerning the deformation, friction and failure of materials. Micro particles could be generated during the fracture process of plug and needle friction during penetration. Actually, the structural configuration of needle pin plays an important role besides of plug itself. In this work, mechanical behaviors of butyl rubber and needle material are obtained firstly, after performing various strain rate experiments based on Instron 5848 machine and Hopkinson bar technique. And their constitutive relation and parameters are then determined, and used for numerical simulation work. Series of penetrations of traditional syringe needle are designed and experimented through butyl rubber plugs of vials. Some are designed and listed below. One needle is repeatedly penetrating into various new plugs for sufficient times, to investigate its friction and deformation characteristics. Another experiment is for one plug which is repeatedly penetrated by various new needles, and weighted for its mass loss, to investigate the micro particles' generation. Additionally, different velocity of penetrations are conducted experimentally for ensuring a preferred velocity range for medical operations. As a results, the dependence of micro particle generation is quantitatively determined on the penetration times, velocity, and angle etc., together with potential mechanism proposed. Micro observances are performed on the needle pins' surface and fracture surface of plugs, to confirm the potential generation mechanism of micro particles. Finally, the finite element model is built based on Abaqus code and series of numerical simulations are performed for penetration process, and the mechanical behavior and fracture characteristics are verified. Meanwhile, the optimization of needle configuration is conducted for less particle generation.

KEYWORDS

Constitutive relation; penetration; butyl rubber plug; syringe needle; micro particle

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