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COMPUTATIONAL MODELING OF FOREST FIRE BARRIERS GENERATED BY HYDROGEN EXPLOSION SHOCK WAVES

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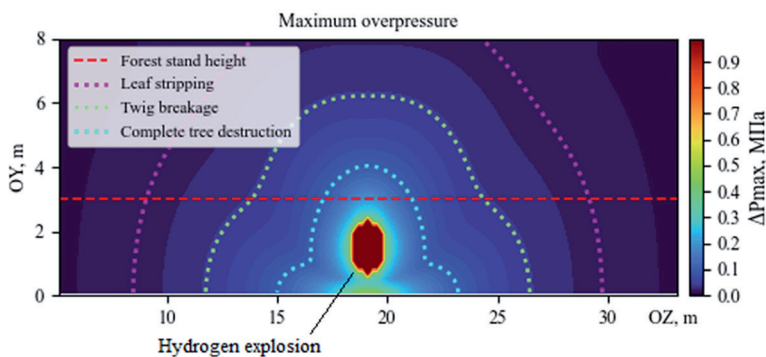
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Abstract – The work presents the results of a numerical study of the spatiotemporal impact of a hydrogen hose charge blast wave on a forest massif to assess the possibility of forming firebreak streaks using a controlled pulse load. The study's relevance arises from the increase in the frequency and scale of forest fires under climate change, which requires the development of new technological solutions to localize their spread with minimal environmental impact. A set of several explosion power configurations (differing in hose-type charge radius) for modelling the hydrogen blast near the ground surface was examined. For each configuration, the spatial distributions of the maximum overpressure and the positive impulse of the shock wave were analyzed within the computed "air-forest cover" domain. Environmental blast impact parameter fields were generated from a hydrogen explosion model and analyzed, accounting for a given forest stand height. Based on maximum overpressure thresholds, zones corresponding to different levels of vegetation damage, including leaf stripping, twig breakage, and complete tree destruction, were identified. The extent of each zone along the ground surface was defined, enabling the quantification of the potential firebreak streak width. A comparative analysis of damage-zone widths as a function of the charge's geometric parameter (hose radius) was performed. Additionally, the time histories of overpressure at a characteristic point near the ground surface beneath the charge were analyzed for all modeling configurations, enabling a comparison of shock-wave dynamics at different explosion powers. Grouped bar charts and trends illustrating the dependence of the impact-zone widths on the radius of the hose-type charge were constructed. The results demonstrate the fundamental feasibility of controlling the extent of damage zones in forest vegetation by selecting hydrogen charge geometric parameters, thereby establishing a scientifically grounded basis for the development of environmental safety technologies for fire barrier formation.

Keywords – *Controlled explosion impact; environmental safety; fire barrier formation; forest fires; hydrogen hose-type charge; maximum overpressure; positive phase impulse; shock wave pressure history; vegetation damage zones*



Forest vegetation damage zones generated by the controlled hose-type hydrogen charge explosion