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Implications of the Crest Reactive-Burn Model

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The CREST reactive-burn model has been remarkably successful in modelling shock initiation and detonation propagation behaviour in plastic-bonded explosives. Previous publications have shown that, using reaction-rate parameters tuned only to a limited set of data, CREST is able to predict the effect of thin-pulse and double-shock inputs, porosity, and initial temperature on one-dimensional shock-initiation experiments. In two dimensions, CREST also matches detonation propagation and failure behaviour. This has been achieved by using a reaction rate that depends on shock strength (measured using a function of entropy of the unreacted explosive) and time since the shock passed, and not on evolving parameters of the flow like pressure or temperature. Such a reaction rate was implied by a detailed analysis of embedded particle-velocity gauge shock- initiation data which identified scaling phenomena that can not be explained using a pressure-dependent rate, as a companion paper will demonstrate. While the majority of reactive-burn models have pressure or temperature-dependent rates, as has been the historical precedence, it is difficult to make direct comparisons between models which use different equations of state. In this paper, one set of equations of state will be used to investigate the advantages and disadvantages of entropy, pressure or temperature-dependent reaction rates for modelling a variety of one and two-dimensional shock initiation and detonation propagation phenomena. The implications for the future development of reactive-burn models will be discussed.