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Steady non-ideal detonations[1]

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Theories for determining the velocity of detonation (VoD) in highly non-ideal explosives, e.g. commercial explosives used in mining, are discussed. Such explosives have critical charge diameters of several centimetres. An analysis of the interaction between detonations and confining materials along the explosive-confiner interface reveals there a two main types of interaction. In the first (denoted here by case 1) the detonation drives an oblique shock into the confiner. For the second (case 2), a wave propagates in the confiner ahead of the detonation in the explosive. Shock polar interactions are examined for commercial explosives and rocks, which shows that a significant proportion of problems are case 2 in mining. For case 1, numerical simulations show that for a given explosive model there is a unique relationship (valid for all charge diameters and confinements) between the VoD and the curvature of the detonation shock at the charge axis. This relationship is shown to be well predicted by a quasi-one-dimensional type analysis. A simple detonation shock dynamics method which uses this relationships predicts well the VoD even in highly non-ideal cases, provided the explosive is sufficiently confined (usually the case in mining), but which is inaccurate in the limit of an unconfined charge. Preliminary results of a novel variational method for solving the unconfined situation are also discussed. Numerical simulations are performed to investigate the coupling mechanisms in case 2 situations, including the influence on diameter effects. It is shown that, in agreement with an approximate theory, the detonation is driven up to VoDs above the confiner's sound speed, and the wave in the confiner weakly pre-compresses the explosive ahead of the detonation front.

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