

A STATE-OF-THE KNOWLEDGE REVIEW ON PSEUDO-STEADY SHOCK WAVE REFLECTIONS

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The dependence of gas-flow dynamics on exothermic reaction kinetics is essential in various detonation processes. The high temperature and pressure dependence of induction lags in combustible gas mixtures adiabatically compressed by shock waves in the main source of detonation-front instability. Chemical factors also play a great part in nonstationary flame-detonation transitions.

The distinguished philosopher Ernst Mach published the first known paper on the phenomenon of planar shock wave reflections over straight ramps over 125 years ago in 1878. In his publication he presented two wave configurations that could result from this reflection process, namely a regular reflection (RR) and a configuration that was later named after him and was called Mach reflection (MR). In 1945, Smith reported on an additional wave configuration, which was slightly different from the just-mentioned Mach reflection. Smith (1945) did not ascribe any special importance to the wave configuration that he observed. The wave configuration that was observed and reported by Smith (1945) was recognized as an independent one only about 5 years later when White (1951) published the discovery of a new wave configuration that was named as double-Mach reflections (DMR) because it had similar features to that of the Mach reflection wave configuration that was discovered by Mach but all the features repeated in it twice. For this reason the Mach reflection wave configuration had been re-named to single-Mach reflection. The discovery of the double-Mach reflection revealed that the wave configuration that was first observed by Smith was an intermediate wave configuration between the single-Mach reflection (MR) and the double-Mach reflection (DMR) wave configurations. For this reason it was named transitional-Mach reflection (TMR).

Since the discovery of the DMR many investigations were aimed at elucidating the exact transition criteria between the above-mentioned four different wave configurations as well as some additional sub-configurations that were discovered later.

In 1991 Ben-Dor published a monograph, entitled “Shock Wave Reflection Phenomena”, that was a state-of-the-knowledge review of the phenomena.

A few years later, in 1995, Li and Ben-Dor modified the analytical approach for evaluating the transition criteria from the single-Mach to the transitional-Mach reflection ($SMR \rightleftharpoons TMR$) and from the transitional-Mach to the double-Mach reflection ($TMR \rightleftharpoons DMR$), and presented some new criteria for the formation and termination of both the TMR and DMR wave configurations.

Experimental results from various sources revealed that the transition boundaries between the SMR, TMR and DMR wave configurations that were based on the modified analytical approach were indeed more accurate than those that were summarized in Ben-Dor’s monograph.

Unfortunately, however, the results of Li and Ben-Dor’s (1995) on the modified analytical approach were not internalized, and publications by various authors in the past decade neglected the revised and better transition criteria, and kept on referring to the wrong criteria that appear in Ben-Dor’s (1991) monograph.

For this reason, the above-mentioned 10-year old work of Li and Ben-Dor (1991) is presented again.