CFD VISUALIZATION FOR INTERPRETATION OF THE LASER SHADOW IMAGES OF THE SHOCK-INDUCED IGNITION

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ABSTRACT: The interpretation of shadow/schlieren images obtained in a non-reactive flow with shock waves should present no difficulties. A different situation arises with visualization of the shock-induced ignition or detonation. The density gradients associated with the combustion products can disturb flow pattern significantly. The interpretation of experimental photo records becomes more difficult if ignition (or detonation initiation) occurs under multiple shock reflections and interactions in mixtures with small amount of fuel. One such example is shock focusing in lean hydrogen-air mixtures [1].

In this study we examine the experimentally obtained laser shadow images [1] coupled with the results of CFD calculations. It was found that the most informative is representation of the calculated flow-field in the form of the combustion products distribution pattern superimposed on the pressure isolines [2]. An example of direct comparison between experimental and CFD results is given in Fig. 1. After reflection of a plane shock wave at a double wedge (90^o-reflector) the mixture under investigation (7%H_2 in air) is ignited in a high-temperature spots generated by shock focusing (intersections). It is seen that the suggested manner of the CFD visualization significantly facilitates location of combustion products and opens a way for getting insight into complicated phenomena of both weak (mild) ignition and detonation onset. Another important application of the described procedure is verification of the used simple kinetics model (one-step Arrhenius equation). Finally, it is demonstrated that the adjusted CFD model describes critical conditions of different explosive regimes at focusing of shock waves in hydrogen-air mixtures.

a *b* *c*

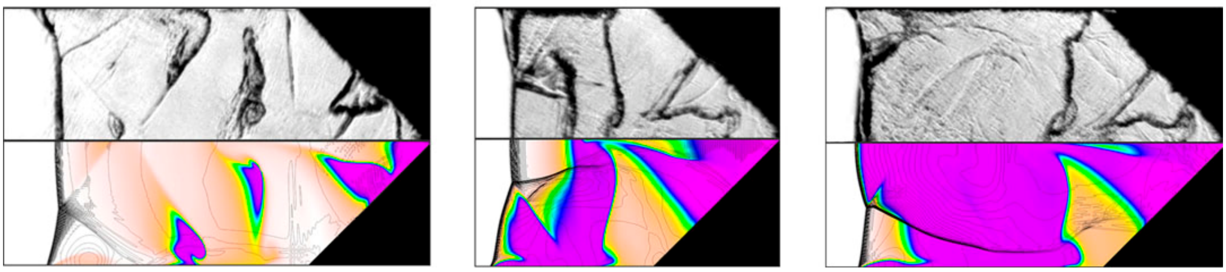

Fig. 1 Laser shadow images (top) coupled with the results of CFD calculations (bottom) by GasDynamicsTool package. Reflected shock wave propagates from right to left, zones of complete combustion are given by violet. *a* - weak ignition; *b,c* – phases of transition to detonation.

References

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