Influence of a Solid Particle on a Shock Wave in Air

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Shock wave interaction with an adiabatic solid microparticle is numerically simulated [1]. In the simulation, the shock wave is initiated by the Riemann problem. The calculation is performed in the two-dimensional formulation using the ideal gas equation of state. The left end of the tube is impermeable, while outflow from the right end is permitted. The particle is assumed to be motionless, impermeable, and adiabatic, and the simulation is performed for time intervals shorted than the time of velocity and temperature relaxation of the particle. The numerical grid is chosen for each particle size to ensure convergence. For each particle size, the calculated hydraulic resistance coefficient describing the particle force impact on the flow is compared with that obtained from the analytical Stokes formula. It is discovered that the Stokes formula can be used for calculation of hydraulic resistance of a motionless particle in a shock wave flow. The influence of the particle diameter on the flow perturbation behind the shock front is studied. Specific heating of the flow in front of the particle is calculated and a simple estimate is proposed. The whole heated region is divided by the acoustic line into the subsonic and supersonic regions. It is demonstrated that the main heat generated by the particle in the flow is concentrated in the subsonic region. The calculations are performed using two different 2D hydro codes. The energy release in the flow induced by the particle is compared with the maximum possible heating at complete termination of the flow. The results can be used for estimating the possibility of gas ignition in front of the particle by a shock wave whose amplitude is insufficient for initiating detonation in the absence of a particle.

[1] Obruchkova L R, Baldina E G and Efremov V P 2017 *Thermal Engineering* **64** 224–233