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Effect of Piston and its Weight on the Performance of a Gun Tunnel via Computational Fluid Dynamics

Authors : A. A. Ahmadi, A. R. Pishevar, M. Nili

Abstract : As the test gas in a gun tunnel is non-isentropically compressed and heated by a light weight piston. Here, first consideration is the optimum piston weight. Although various aspects of the influence of piston weight on gun tunnel performance have been studied, it is not possible to decide from the existing literature what piston weight is required for optimum performance in various conditions. The technique whereby the piston is rapidly brought to rest at the end of the gun tunnel barrel, and the resulted peak pressure is equal in magnitude to the final equilibrium pressure, is called the equilibrium piston technique. The equilibrium piston technique was developed to estimate the equilibrium piston mass; but this technique cannot give an appropriate estimate for the optimum piston weight. In the present work, a gun tunnel with diameter of 3 in. is described and its performance is investigated numerically to obtain the effect of piston and its weight. Numerical results in the present work are in very good agreement with experimental results. Significant influence of the existence of a piston is shown by comparing the gun tunnel results with results of a conventional shock tunnel in the same dimension and same initial condition. In gun tunnel, an increase of around 250% in running time is gained relative to shock tunnel. Also, Numerical results show that equilibrium piston technique is not a good way to estimate suitable piston weight and there will be a lighter piston which can increase running time of the gun tunnel around 60%.

Keywords : gun tunnel, hypersonic flow, piston, shock tunnel
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