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Experimental and CFD Study of the Effects of Design Parameters on Reynolds Number in a Short Duration Hypersonic Test Facility

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Abstract

The first phase of this paper is aimed to develop a standard test procedure to check the effects of the design parameters (e.g. diaphragm pressure ratio, speed of sound ratio, temperature ratios, and geometry) in a short-duration hypersonic test facility that build at the Universiti Tenaga Nasional “UNITEN” in Malaysia on Reynolds number. The facility has been designed, built, and commissioned for different values of diaphragm pressure ratios and Mach number. A theoretical model was developed to evaluate the Mach number values as a function of diaphragm pressure ratio for different working fluids. The second phase is to run experimental tests for different operating conditions. The calculated parameters which are pressure, temperature and velocity were very comparable to the practical results. A high precision in house made thermocouple was used to measure the temperature profile during the facility operation. A numerical transient heat transfer mathematical model was developed to evaluate the heat flux from the surface temperature history. Comparing these results with a CFD model using commercial software Fluent was found to be much matched. The principle of operation and the reasoning behind building such a facility are explained, and the governing equations for the shock tube are presented. The selection of the shock tube parameters is explained.

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