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Blast wave generation and interactions

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Abstract

The design, construction and validation of a non-explosively driven blast tube was undertaken in order to reduce the cost and time of blast wave experimentation as well as to enable the study of blast waves in the test laboratory environment. The design of the blast tube was performed numerically using commercially available CFD software. Numerous different driver shapes and configurations were analysed during the design process including linearly diverging drivers, straight drivers and polynomial drivers.

Based on the results and analysis performed in it was deduced that a driver section required a few key features in order to generate a blast wave with a realistic Friedlander pressure profile namely, the driver section must end in a sharp corner in order to enable expansion focusing to occur, the walls of the driver section must be divergent to cause the expansion waves to reflect downstream almost immediately after the diaphragm bursts as well to drive the expansion focusing, the walls of the driver section must transition smoothly, that is without a corner, into the expansion section walls and the walls of the driver section must be curved in order to induce smooth and continuous expansion wave reflection and focusing.

After some tests were carried out on a few iterations of driver section shapes, three shapes were settled on, namely a concave driver, a linear driver and a convex driver. Once the final design of the blast tube was settled upon, a working prototype was manufactured and assembled in the North West Engineering Laboratories and the prototype was tested. During testing of the blast tube it was found that, despite issues arising due to choice of mechanism employed to pressurise the driver being flawed, there being notches and steps at the joints along the tube length and the downstream end of the test section being closed, the blast tube did in fact generate blast waves with realistic pressure decay profiles and good visual quality. After being validated the blast tube was used to examine the diffraction of the blast wave around a 90◦ corner and the reflection of the blast wave induced upon impinging wedges having angles of 15◦, 30◦ and 45◦. The blast wave diffraction and reflection experimentation were carried out in the $1.2 < M_s < 1.4$ range.