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Development of a test facility for the study of cold gas dynamic spraying: Rig Characterisation.

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2011-10-12
http://hdl.handle.net/10539/10538

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Abstract

In this dissertation a facility for the study of Shock Wave Induced Cold Gas Spraying (SWICGS) is investigated. The objective of the study was to design, construct and test a shock tube rig that will be used to accelerate gas jets to velocities required for deposition in SWICGS applications. The testing of the rig involved using helium and air as gas drivers, and testing for different diaphragm configurations on the rig for best performance.

To understand the problem better a literature review on several aspects surrounding the field of SWICGS was conducted. This involved aspects such as particle critical velocity, deposition efficiency, shock wave production and several other topics. Based on the compiled literature, three conceptual rig designs were generated. Concept B was selected to be developed further into detailed design. The main contributing factors in the decision making with regards to the rig design were the safety of the design, the provision of undisturbed flow in the tube and ease of manufacture.

The final rig has a shock tube with an internal diameter of 5mm. The pressure reservoir of the rig is 0.377 litres, and the total length of the rig is 2 meters, with a safety factor of at least 10 for all components. The rig makes use of solenoid valves to work as diaphragms; the valves have an opening time of 100*ms* and a closing time of 100*ms*. The opening and closing of the valves is controlled by a programmed Moeller controller.

Significantly high jet velocities were obtained at room temperatures using the designed rig, with air as the gas driver jet velocities of up to 516.35 *m/s* were achieved and with helium as the gas driver jet velocities of up to 876.92 *m/s* were achieved within the tested range of 10 to 50 bars reservoir pressure. These high velocities can be achieved at a wave generation frequency of 5 Hz. The rig can generate high velocity jets even at higher frequencies of up to 20 Hz. The single valve arrangement showed to be generally performing better than the double valve arrangement within the tested range and conditions.