Jetting into the Future: Calculating Outlet Air Velocity to Optimize Convergent Nozzle Design for Subsonic Exhaust Flow Efficiency Through Wind Tunnel Testing with Laminar Flow

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The purpose of my experiment was to determine whether I can use the Equation of Continuity as a predictor for convergent nozzle design performance for subsonic exhaust flow during wind tunnel testing. Hypothesis: The Equation of Continuity will be an accurate predictor of convergent nozzle performance for subsonic exhaust flow when evaluating nozzles with varying outlet area but will not be an accurate predictor of performance in nozzles of varying length during wind tunnel testing. Null Hypothesis: The Equation of Continuity will have no predictive bearing on evaluating convergent nozzle design performance. Procedure: Using CAD software and a 3D printer, I created 10 convergent exhaust nozzles, 5 with varying outlet diameters and the same length, and 5 with varying lengths and the same outlet diameter, then calculated the predicted outlet velocity for each. I tested each nozzle in a homemade wind tunnel by using a multimeter to measure volts produced by a DC motor connected to a turbine positioned at the nozzle outlet. Results: Nozzles with smaller outlet areas produced more volts than those with larger outlets. This performance was successfully predicted by the Equation of Continuity. Nozzles with shorter lengths produced more volts than longer ones. This was not predictable by using the Equation of Continuity. Conclusion: The results support my hypothesis. The Equation of Continuity is a useful predictor of the performance of exhaust nozzles with varying outlet diameters, but not for those with varying lengths. A short nozzle with a small outlet diameter is the most efficient.