



UNIVERSITY OF  
NOTRE DAME

AEROSPACE AND MECHANICAL ENGINEERING

PhD Dissertation Defense

“EXPERIMENTAL INVESTIGATION OF THE CAVITATION OF AVIATION FUEL IN A  
CONVERGING-DIVERGING NOZZLE”

By

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Abstract:

A cavitating nozzle flow was studied experimentally with high-speed video, pressure, and void fraction measurements. Results were obtained with both aviation fuel (JP-8) and water. Three different flow regimes were examined: a single-phase liquid flow where no cavitation occurred, fully developed cavitation originating from a pure liquid flow at the nozzle inlet, and a two-phase nozzle flow where gas bubbles were injected in to the nozzle inlet. The majority of the study focused on the fully developed cavitation, where below a certain nozzle back pressure, both fluids obtained a limiting mass flow rate through the nozzle test section as the flow became choked. Throat-to-inlet pressure ratios resulting in choked flow were measured as 0.08 for water and 0.12 for fuel. Under these choked conditions, throat (sonic) velocities of 15 m/s (in water) and 18 m/s (in fuel) were measured. High-speed video showed an abrupt region of bubble collapse (a bubbly shock) in the diffuser section of the nozzle for water cases. In fuel cases, bubbles persisted through the entire length of the nozzle with no obvious collapse region. Centerline axial pressure profiles supported the video evidence; water exhibited a sharp pressure rise across the bubble collapse region to match the nozzle back pressure, whereas the fuel pressure data rose slowly through the diffuser to match the nozzle back pressure. The differences in the cavitation for fuel and water were attributed to the multi-component composition of the aviation fuel, resulting in a spatially distributed bubbly shock that was not visually obvious. Bubble injection experiments revealed a strong sensitivity of both the bubble shock location and thickness to the void fraction in the nozzle inlet for both fuel and water.

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