Lab Report 3: Supersonic Flow Visualization

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**Nomenclature**

= block number

= wedge angle

= shock angle

γ = specific heat of fluid

M = Mach number

1. **Introduction**

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HIS document is a report on the third MAE 352 lab in the Spring 2019 semester.

Talk about what did in the lab, what the goal was, mention that are comparing to previous lab images too. Discuss the objectives of the experiment and the lab report.

1. **Data and Results**

Present the figures that want to talk about. Do a head on wedge, show all shapes tested by paint, need an angled wedge too.

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| **Figure 1. Theta-Beta-Mach Relation.** *Seven Mach numbers are shown above, each calculated using the isentropic calibration equation previously used in Lab 1. The data points show a good overall shape with respect to the theoretical graph, except for Mach number equaling 1.972, which above has a data point that drops low at a wedge angle of zero. The shock angle value for each was based off the tenth image of each picture set.* |

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| **Figure 2. Mach Number vs. Block Number.** *Shown above is the relationship of Mach number and block number. The theta-beta-M relation has discontinuities due to the MATLAB solver, and overall has a lower Mach number distribution than illustrated by the calibration equation from lab 1.* |

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| **Figure 3. Theoretical Theta-Beta-Mach.** *Above is the theoretical relationship image from the lab handout for reference and comparison to Fig. 1. Figure 1 represents only the lower portion of this graph, but compares well to the theoretical shape shape.* |
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1. **Discussion**

Talk about trends, use images from both the previous lab (shock angle analysis) and this lab (paint flow). Streak lines from paint, shock buildup/thickening due to angle (down tilt has thicker shock on top of wedge). Talk about flow separation and where it happens and why.

Compare the different shapes. Compare them at different angles. Compare them at different Mach numbers. Compare them at different stages of the flow, probably focus on the stable flow part (middle pictures).

**Observations**

2D Wedge

* Separation and reattachment on the rod in an arc pattern for some reason
* The 2D wedge seems to have some imperfections that altered the flow pattern
* On the angled one: can see the arcing of the flow. Small front of paint moves backwards with pictures – could this be a semi-separation point that moves backwards as time progresses? Its only a semi though because there are still streak lines after it. That or the streak lines are from previous flow. They seem to change a little bit though but that could just be tip effects.

3D Wedge

Cone

* Rod is shielded by the cone base
* Can observe the flow speeding up as the tip vortices get larger to shield the rod. Especially seen in the angled cone. Also in the angled cone you can see the effects of the vortices on the globule of paint that oscillates

Missile no fins

Fins on missile (back)

Sphere

* Clear separation of flow
* Bluff body, surface roughness could have held the flow longer but it’s a smooth sphere

1. **References**

1Narsipur, Shreyas. “MAE 352 – Experimental Aerodynamics II Lab 2 – Shock Wave Analysis”. *NCSU,* February 5, 2019.