Shear Stress Measurements of a Vertically Impinging Planar Jet

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Background and Motivation
The project is to experimentally validate the findings of a numerical simulation for wall shear stress generated by a vertically impinging planar jet. Successful validation would allow the use of the in-house simulation software to further pursue a fundamental understanding of the physics of a wall jet generated by a vertically impinging planar jet.

Experiment Design and Setup
The general method of this experiment consists of calculating wall shear stress from velocity measurements obtained by a hot-wire anemometry system. The test apparatus consists of:
- Hot Wire Anemometer (Probe) (A)
- Planar jet nozzle and stand (B)
- 3-axis stepper-motor controlled arm (not shown)
- Calibration tube with mass flow meter (C)
- Calibration system

Calibration
The hot wire anemometer probe is a resistor in a wheatstone bridge circuit. In operation, the resistance of the probe is automated, pausing at each point while the voltage across the vertical of the bridge increases. The voltage across the bridge decreases due to convective cooling; the flow velocity is calculated from maximum velocity using the empirical relationship: $u_{max} = u_{avg} (1 + 1.33(Fr)^{1/2})$

Data Collection
The horizontal flow velocity near a wall is tied to the height of a reference point above the laminar sublayer, known as the boundary layer. Fig. 7 below helps visualize this relationship for select discrete x values.

Data Analysis
After the voltage profile is collected, it is then compared against the calibration curve to establish the velocity profile across the plate. This profile is shown in Fig. 6.

Future Work
Next steps for this project include review of the analytical code and assumptions made to diagnose the discrepancy between projected and calculated shear stress. With discrepancies resolved, more data points along the center Y plane will be taken to smooth profile plots for sharper discrepancies resolved, more data points along the center Y plane will be taken to smooth profile plots for sharper divergences resolved, more data points along the center Y plane will be taken to smooth profile plots for sharper divergences resolved, more data points along the center Y plane will be taken to smooth profile plots for sharper

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