Project Goals

- Experimentally determine relationships between stream length, nozzle diameter, and flow rate.
- Use the collected data to design and construct a portable water fountain capable of displaying sequences of water patterns.

Flow Testing and Research

Solid streams of water break up into individual droplets due to a phenomenon known as the Plateau-Rayleigh Instability. The stream breaks up when perturbations within the system overpower the effects of surface tension (σ). Also a relation of density (ρ) and initial stream radius (R₀).

\[ t_{\text{breakup}} = 2.91 \sqrt{\frac{\rho R_0^2}{\sigma}} \]

Tests were performed on a range of nozzle sizes and types to determine key characteristics such as flow velocity and break-up length. High-speed footage was used to compare the theoretical break-up length with the actual break-up length of the stream. The tabulated data were used to identify trends between nozzle diameter, Reynolds Number, and break-up length.

Nozzle Diameter Flow Rate Vs Stream Break-up Length:

The external body of the nozzles that were assembled were constructed of steel and PVC. Each nozzle had three configurations: no manipulation (pipe only), straw-filled (acting as a flow straightener), and filter with straws.

![Nozzle Diameter Flow Rate Vs Stream Break-up Length](image)

Testing Results:

Theoretical calculations indicated that breakup length should increase as either the flow rate or nozzle diameter increase. Actual values from testing did not follow any meaningful trends, although the measured stream breakup lengths were larger than expected. The variations in test data are most likely due to error introduced during the analysis of the high-speed footage. Further testing is required to develop relations between the stream characteristics, although the current data can be used in tabular form. Computational analysis of the high-speed footage should be implemented for future tests.