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DRAG REDUCTION USING FEMTOSECOND LASER SURFACE PROCESSING: EXPERIMENTAL SETUP

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MOTIVATION

- Fluid drag reduction is important in many applications such as reducing the power requirement to pump a fluid through a channel or pipe.

- The Center for Electro-Optics and Functionalized Surfaces (CEFS) at the University of Nebraska – Lincoln uses a femtosecond laser to functionalize 304 stainless steel to become superhydrophilic or superhydrophobic.

- The Processing produces microscale and nanoscale surface roughness that when treated with siloxanes becomes superhydrophobic.

- Small vortices form on the surface when microstructures are introduced.

- This lifts the main fluid vortex away from the wall forming a slip condition at the wall.

EQUIPMENT AND PURPOSE

4. Filter: Filters out impurities in water to provide accurate fluid flow measurements.
5. Sabre Turbine Flow Meter: Measures the fluid flow rate.
6. Omega Differential Pressure Transducer: Measures the pressure drop across the test section.
7. Lab View Data Acquisition: Collects data and calculates actual values measured by the different measurement systems. The Lab View setup is shown below.

Actual Experimental Setup

- Test section is annular flow.
- Test rod is loaded into test section.
  - The rod is functionalized throughout the test section.
  - Prior testing is done to determine the degree of surface hydrophobicity/hydrophilicity.
  - A range of flow rates of de-ionized water is forced through the test section.
  - The pressure drop across the test section is recorded and used to determine the fluid friction factor for the testing conditions.
  - The pressure drop and friction factor is compared between processed surfaces to determine the drag reduction characteristics with respect to surface hydrophobicity/hydrophilicity.
  - The research goal for this project is to modify the fluid friction factor chart (Moody Chart) to account for surface hydrophobicity/hydrophilicity.

Part Location

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