UTSR 2018 Gas Turbine Industrial Fellowship Program

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Fellow Background

• Hometown: Flowery Branch, GA
• Rising 4th year Aerospace Engineering Undergrad at Georgia Institute of Technology
• Undergraduate research assistant at the Ben T. Zinn Combustion Laboratory
Introduction

• Three main tasks performed during research fellowship
  • Axial Compressor Test Demo
    • Design and construction
  • High-Pressure Oxygen Safety Review
    • Literature review and risk identification
  • Original Gas Turbine Design Project Renewal
    • Assistance in preparing project for renewal
Axial Compressor Demo

• Axial compressor demo for turbomachinery design training course
  • Based on cordless leaf-blower with two-stage axial compressor

• Transparent compressor stage gives access to blade geometry for aerodynamics calculations
Axial Compressor Demo (cont.)

- Instrumentation: dP sensor, static pressure sensor, orifice plate, thermocouples, potentiometer throttling

Test Demo P&ID

Completed Axial Compressor Test Demo
Axial Compressor Demo (cont.)

- Theoretical compressor map constructed using velocity triangles and isentropic compressor relationships
- Actual performance roughly half that of the theoretical model

![Model Compressor Map](image1.png)

![Experimental Compressor Map](image2.png)
Axial Compressor Demo (cont.)

• Future Work
  • Reduce vibrations at high speeds that might affect gauge accuracy
  • Consider replacing 0-50 in. H₂O dP gauge with 0-15 or 0-25 in. H₂O gauge
  • Performance is affected by battery charge, so an additional battery would prove useful if the demo needs to run for longer periods of time
High Pressure Oxygen Safety Review

• Background
  • Oxy-fuel supercritical CO₂ gas turbine combustor
  • Reduced flow test loop
  • Oxygen supplied at pressures as high as 31.6 MPa
  • Components and materials reviewed for safe use and operation
High Pressure Oxygen Safety Review (cont.)

- At high pressures, gaseous and liquid oxygen is an incredibly potent oxidizer
  - At 100% oxygen concentration, most nonmetals are flammable
  - As pressure increases, metals will also become flammable

(IGC Doc 13/12/E)
High Pressure Oxygen Safety Review (cont.)

• Material Selection
  • Nickel, Monel, brass, and Inconel metals are more resistant to ignition than stainless steel, carbon steel, and aluminum
  • Carbon and stainless steels can be used at low pressures and velocities
  • All nonmetal components should be tested in before use

• Component Selection
  • High risk components include valves (globe, butterfly, ball, check, relief), regulators, filters, and fittings

• Particle impact ignition risk can be mitigated through thorough chemical and mechanical cleaning
Great Horned Owl (GHO)

• IARPA program focused on the development of systems that can be utilized in a small UAV

• SwRI developed a prototype small, lightweight gas turbine generator for use in an electric hybrid propulsion system
  • Features novel single disk radial flow design
  • Simple construction, lightweight, rugged design
  • Novel bearing lubrication system using two peristaltic pumps

• Photos and details are limited due to IARPA requirements
GHO (cont.)

- Fellowship tasks
  - Experimental setup for project renewal
    - Computer installation for DAQ and controls
  - Repaired bearing lubrication system and visually inspected bearings to ensure proper delivery of lubrication oil
  - New fuel tank installed and connected to boost pump supply
  - Prepared GHO for rotor balancing process
Miscellanea

• Modal testing for tie bolt rotor
  • Ping testing and ANSYS analysis

• Literature Review
  • Relationship between axial preload and angular contact bearing stiffness
  • Strong disparity between experimental data and theoretical models
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