Solar Turbines Internship
Exit Presentation

Geoffrey Potts

Heat Transfer
Aero/Thermal & Performance

Mentor: Yong Kim
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● Saint Louis University
  – Parks College of Engineering, Aviation & Technology
    ● B.S. Mechanical Engineering (May 2012)
    ● M.S. Mechanical Engineering (May 2014)

● Undergraduate Research w/ Solar

● University Turbine Systems Research
Projects
- Turbine Blade Thermal Imaging
- Thermal Imaging ANSYS Application
- Splash Plate SLA Design

What I Learned

Time in San Diego

Special Thanks

Questions
1 Turbine Blade Thermal Imaging
● **Background**

- An early thermal paint test showed high temperatures on the leading edge of the turbine blade
- Design team moved to address durability concerns in certain parts of the turbine
- **Objective**
  - Lower leading edge temperature

- **Deliverable**
  - Compare internal HT coefficients to current production blade, validate design

- **Testing and verification**
  - Transient liquid crystal paint test used to verify design
    - 5x scaled steriolithography (SLA) model
    - Liquid crystal paint changes colors at certain temps
    - Heat Transfer Coefficient (HTC) or Nusselt Number (Nu) can be determined
<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Flow Rate [pps]</th>
<th>Reynolds Number</th>
<th>Camera Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>5X SLA w/ Trip Strip + Fillet Geometry</td>
<td>Low</td>
<td>0.042</td>
<td>27510</td>
<td>A, B, C</td>
</tr>
<tr>
<td>5X SLA w/ Trip Strip + Fillet Geometry</td>
<td>Nominal</td>
<td>0.060</td>
<td>38983</td>
<td>A, B, C</td>
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<tr>
<td>5X SLA w/ Trip Strip + Fillet Geometry</td>
<td>High</td>
<td>0.077</td>
<td>49275</td>
<td>A, B, C</td>
</tr>
</tbody>
</table>
Turbine Blade Thermal Imaging

5x Model w/ trip strip and fillets @ .060 pps, Re = 38983

6x As-Cast Model @ .072 pps, Re = 38370

28% Increase
Thermal Imaging ANSYS Classic Application
● Thermal model of Turbine Blade

● Boundary Conditions applied in ANSYS Mechanical APDL
  – Remove elements from mesh to simulate swirl cool slot expansion
  – Application of Nu increase across leading edge
Recommendation

- It is acceptable to widen swirl cool slots as long as the radial trip strip is added

Benefits

- Save time in the manufacturing of the blade
- Save cost because the core die does not need to be replaced as frequently
- Keeps the blade below oxidation temperature
Helmholtz Liner New Splash Plate SLA
- **Background**
  - Excessive splash plate impingement air
  - Dome “flow guides” do not flow properly

- **Objective**
  - To reduce cooling flow and prevent hot-gas ingress
Liner Splash Plate SLA
Learning Experience

- Group Interactions
  - Department 208
  - 3D Printing Lab
  - Development Test

- Programs Used
  - ANSYS 14.5
  - Creo Parametric 2.0
  - Finesse
  - Mathcad
  - Xming
  - Windchill
Summer Fun

- Kayaking
- Snorkeling
- Bike riding
- USS Midway
- Boat rides
- Coronado Island
- San Diego Beaches
- Sea World
- Taco Tuesday
- Big Bay Boom Fireworks
- Intern & Rotation Outings
- …and more!
Thank you!!!

- Yong Kim
- Trey Bolchoz
- Gina McGee
- Andrea Auclair
- Archie French
- Gail Doore
- Charmaine Gary
- Hee-Koo Moon
- Klaus Brun
- Andrea Barnett
- Phil Ligrani
- Tim Bridgman
- Tom Iske
- UTSR
- All Interns
- Anyone else who helped!
Questions?