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The UTSR Impact: Key Accomplishments, Benefits to OEMs and Status of the Fellowship Program

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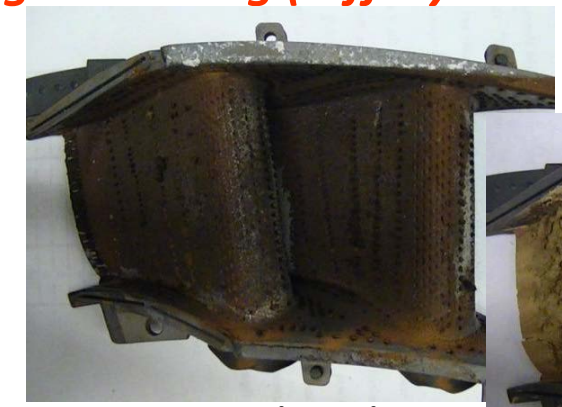
Key Accomplishments

- Since the program started in 1992 over 100 research projects have been completed
- The following slides summarize two examples in each UTSR technology area from recently completed projects
  - Aerodynamics / Heat Transfer
  - Combustion
  - Materials

Deposition Resistant Turbine Designs

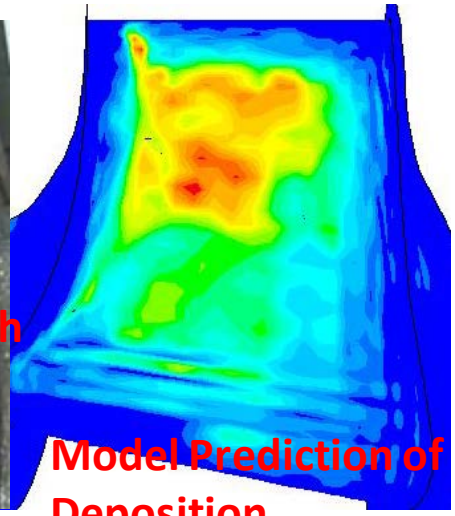
Ohio State and Brigham Young (Jeffrey Bons #5055)

- Improved understanding of deposition may lead to more deposition-tolerant designs and improved turbine performance with various feedstocks.
- OSU's rig simulates a deposit-laden turbine flowfield with real turbine hardware.
- BYU's rig simulates deposit-laden operating environments up to 2500F
- **Turbine hardware supplied for evaluation by GE, SPG, and Praxair**



Exposure to Bituminous Ash Particulate at 2050F

Exposure to Lignite Ash Particulate at 1950F



- Results show significant effect of coal ash grade on deposition…at lower temperatures for lower rank coal.
- New deposition model captures deposition buildup
- **Computational results provide OEMs with capability to assess deposition-resistance during component design.**
- **Computational model will allow design of deposition resistant turbines**
- **Results solicited by GE, P&W, SPG for potential use.**

New Deposition Model Validated at OSU for Predicting Turbine Deposition Including Endwall Accumulation

Ohio State / Brigham Young

- Deposition testing on actual nozzle guide vanes from GE
- Deposition follows the coal rank
  - Less from bituminous
  - More from lignite
- Data provided critical validation for computational models developed under this program

Improving Durability of Turbine Components through Trenched Film Cooling and Contoured Endwalls

U. of Texas at Austin

- With syngas, contaminant particles will adhere to turbine components – increased roughness and partial blockage of film cooling holes
- Project has successfully simulated the deposition and impact on cooling performance
- Results:
  - TBC has a dominating effect; film cooling geometry has little impact on cooling effectiveness
  - Deposition of contaminants improves cooling effectiveness due to insulating effect

Effect of Impurities on Syngas Ignition and Flame Speeds
Texas A&M

- The composition of syngas can vary depending on the gasification and cleanup process
- Ignition delay times were measured at up to 30 atm for biomass-based syngas constituencies
- Results:
  - Mixture composition can have an important effect on the ignition delay time, with most of the effect being due to addition of CH_4
  - Ammonia addition has little effect

Critical Parameter Proposed to Delineate Ignition Regimes for H2/CO Fuels

U. of Michigan

- In H2 and CO fuel blends, the amount of H2 is critical for ignition delay time but difficult to predict.
- Rapid compression facility experiments were conducted up to 26 atmospheres and varying oxygen and H2:CO mole ratios
- Results:
  - Strong and weak ignition regimes are delineated by a critical H2 mole fraction of 1.5%

Atmospheric Plasma Sprayed Process Maps Enable Tailored Thermal Barrier Coating Architectures

Stony Brook University

- A key TBC requirement is understanding how processing conditions impact coating microstructure and performance.
- Process maps were developed to link particle and coating states to material properties in thermally sprayed TBCs
- Results:
  - Multifunctional coatings have been designed, fabricated and tested to meet the requirements of thermal cycle durability and erosion resistance

Thermal Barrier Coating Structures Optimized To Achieve Low Thermal Conductivity

University of Connecticut

- Objective: Create TBCs that have lower thermal conductivity, higher allowable operating temperature, and better resistance to high temperature contaminants.
- In the 1st year of the project, coatings were successfully made with the desired conductivity-lowering microstructure, achieving very significant reductions in conductivity
- Structures are now being optimized to achieve the lowest possible conductivity.

Benefits to OEMs

- The following slides summarize the benefits to the OEMs from the UTSR research projects and from the Fellowship Program

Benefits to OEMs: Research Projects (1/3)

- Help shape annual UTSR solicitation research topics – Within the program scope focus solicitation research topics to meet your companies' gas turbine technology needs.
- Participate in UTSR proposal evaluations – Substantial involvement in the proposal evaluation process, insuring the best proposals are selected to meet program goals.

Benefits to OEMs: Research Projects (2/3)

- Participate in the UTSR Industry Committee Meetings – Meet and collaborate with industry peers to help guide and focus UTSR research and workshops to meet industry goals.
- Participate in UTSR Workshop Planning Meetings – Interact with DOE, universities and industry to suggest better ways to conduct the annual workshop and the UTSR Program.

Benefits to OEMs: Research Projects (3/3)

- Participate in the UTSR Workshop – Help inform university researchers on industry needs and priorities by participating in UTSR Workshop plenary panels.
- Host students in the Gas turbine Industrial Fellowship Program – following slides

Benefits to OEMs: Fellowship Program (1/2)

- Host student Fellows proportional to dues level – Work with and assess some of the best students in the nation for future employment as they work on real world problems.
- The students have been encouraged by their professors to apply and are interested in the gas turbine industry; an advantage in recruiting future employees.

Benefits to OEMs: Fellowship Program (2/2)

- Historically, 80% of the UTSR Fellows benefit the gas turbine industry
  - 70% of them accept jobs with companies in the gas turbine industry
  - Another 10% stay in academia, teaching and researching on gas turbine topics

Status of the Fellowship Program

- Since the fall of 2010, Southwest Research Institute is implementing the program for NETL, with oversight from LTI, site support contractor for NETL.
- 2012 Fellowship Program data:
  - 69 Eligible applicants (vs. 28 last year)
  - 14 Fellows selected
  - 12 Universities
  - 10 Host Companies

Fellowship Host Companies 2012

- GE
- Siemens
- Solar Turbines
- FlexEnergy
- Woodward governor
- Southern Co.
- Parker Hannifin
- EPRI
- Clean Energy Systems
- Florida Turbine Technologies

2011 Fellows (1/4)

Fellow	University	Company
Bolin, Christopher	Michigan State	FlexEnergy
Busche, Mitch	U. Of North Dakota	Woodward
Claretti, Roberto	U. Of Central Florida	Florida Turbine Technologies
Draa, Phillip	U. Of Florida	Siemens

2011 Fellows (2/4)

Fellow	University	Company
Hodge, Brett	California Polytechnic State U.	Clean Energy Systems
Karalus, Megan	U. of Washington	Solar Turbines
Kimsey, Grant	U. of California , Santa Barbara	EPRI
Moualeu, Leolein Patrick	U. Of of North Dakota	Siemens Energy

2011 Fellows (3/4)

Fellow	University	Company
Nelson, Shelby	U. Of Nevada	GE Energy
North, Andrew	UC Berkeley	P&W Power Systems
Repko, Timothy	West Virginia U.	Solar Turbines
Sarker, Sudipa	U. of Texas at El Paso	Parker Hannifin

2011 Fellows (4/4)

Fellow	University	Company
Vo, Garret	Montana State U.	P&W Power Systems
Youngblood, Collins	West Virginia U.	GE Energy

Summary

The UTSR Program is alive and well, developing both technology and people for the benefit of the gas turbine industry