LCRI LOW-CARBON RESOURCES INITIATIVE

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EXECUTIVE SUMMARY

Gas Turbine Design Considerations for an All-Green, Dual Fuel Combustor Configuration

Liquid Renewable Fuels

PRIMARY AUDIENCE

Low-carbon fuels producers and users, gas turbine power plant owners and operators, energy company planners, energy company research and development organizations

SECONDARY AUDIENCE

Gas turbine equipment manufacturers and hardware maintenance/repair organizations, engineering procurement and construction companies

KEY RESEARCH QUESTION

What are the combustion characteristics and performance impacts of current liquid fuels and emerging low-carbon liquid fuels in gas turbines, and how do these compare to natural gas in terms of efficiency and emissions?

RESEARCH OVERVIEW

This report has three main emphases. The first is to detail the landscape of liquid fuel combustion in gas turbine power generation assets today. The second is to provide background on liquid fuel combustion in gas turbines. The operation, design and performance parameters are described. Finally, the impact of green fuels such as renewable diesel, methanol and ethanol are discussed. Their properties and the impact on the gas turbine are described.

This report focuses on three main areas of interest within the realm of liquid fuel combustion in gas turbine power generation:

Current Landscape of Liquid Fuel Combustion: This section provides an overview of the current state of liquid fuel combustion in gas turbine power generation assets. It examines the types of liquid fuels currently in use, their availability, and their performance characteristics. The analysis includes a discussion on the operational challenges and benefits associated with using liquid fuels in gas turbines.

Background on Liquid Fuel Combustion in Gas Turbines: This section covers the fundamental aspects of liquid fuel combustion in gas turbines. It includes operational principles, design considerations, and performance parameters that are critical to the efficient functioning of gas turbines using liquid fuels. Key topics include combustion efficiency, emissions, fuel handling, and maintenance requirements.

Impact of Low-Carbon Liquid Fuels: The final section explores the potential of low-carbon fuels such as renewable diesel, methanol, and ethanol in gas turbine applications. It discusses the properties of these fuels, including their chemical composition, energy content, and environmental benefits. The section also evaluates the impact of these green fuels on gas turbine performance, including any potential modifications required for their use, changes in emissions profiles, and overall efficiency.

By addressing these three areas, the report aims to provide valuable insights into the current and future role of liquid fuels in gas turbine power generation. It highlights the importance of continued research and development in this field, particularly in the context of transitioning to more sustainable and environmentally friendly energy sources.

KEY FINDINGS

- Utilization of Liquid Fuels: Liquid fuels are used in gas turbine power generation at a non-trivial level. Although their usage is significantly lower than natural gas, liquid fuel combustion still accounts for nearly 3% of overall power generation in gas turbines today and often are deployed when energy is required for resiliency purposes.
- Design Parameters: The design parameters for liquid fuel combustion differ substantially from those for natural gas, particularly in the design of fuel injectors.
- Atomization: Liquid fuel atomization is a critical factor influencing combustion efficiency and emissions performance.
- Renewable/Low-Carbon Liquid Fuels: Renewable and low-carbon liquid fuels differ from distillate fuel oil not only in lifecycle and stack CO_2 emissions but also in:
  - Their impact on gas turbine performance
  - Their storage and handling requirements
  - Their design requirements in the combustor and fuel delivery system

WHY THIS MATTERS

Certain aspects of gas turbine liquid fuel operation are not as well understood as natural gas combustion. While the community has extensively investigated low-carbon gas fuels as replacements for natural gas, similar studies are now being undertaken for liquid fuels. Therefore, understanding liquid fuel combustion and design considerations is crucial when considering liquid fuel replacements. It is also important to understand the characteristics of leading renewable liquid fuels, such as renewable diesel, methanol, and ethanol, as these fuels have the potential to scale and provide near-term carbon emissions reduction capabilities for the gas turbine power generation industry.

HOW TO APPLY RESULTS

These results can be utilized to gain a deeper understanding of the current state of liquid fuel operations in gas turbines. By analyzing these findings, companies could expect to enhance their knowledge of liquid fuel combustion, including their efficiency, emissions, and performance characteristics. Additionally, companies could evaluate the properties and potential of emerging liquid fuels, such as biofuels or synthetic fuels, and their suitability for use in gas turbines. This information aims to help optimize fuel selection by developing an understanding of efficiency and reliability implications. Furthermore, the insights gained can inform future research and development needs aimed at advancing liquid fuel technologies. Finally, these results provide valuable insights to support decision-making in policy making, regulatory decisions, and investment strategies related to liquid fuel use in gas turbines. By leveraging these results, stakeholders can make more informed decisions that consider the performance, reliability, and cost of liquid fuel technologies in gas turbines.

THE LOW-CARBON RESOURCES INITIATIVE

This report was published under the Low-Carbon Resources Initiative (LCRI), a joint effort of EPRI and GTI Energy addressing the need to accelerate development and deployment of low- and zero-carbon energy technologies. The LCRI is targeting advances in the production, distribution, and application of low-carbon energy carriers and the cross-cutting technologies that enable their integration at scale. These energy carriers, which include hydrogen, ammonia, synthetic fuels, and biofuels, are needed to enable affordable pathways to economy-wide decarbonization by mid-century. For more information, visit www.LowCarbonLCRI.com.

LCRI CONTACT

Robert Steele
Technical Executive
980.229.9261
rsteele@epri.com

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EPRI Customer Assistance Center
800.313.3774 • askepri@epri.com

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EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 USA • 650.855.2121 • www.epri.com