Flexible CHP System with Low NO_x, CO and VOC Emissions

Utilizing Supplemental Ultra-Low-NO_x Burner Technology to Meet Emissions Standards and Improve System Efficiency

This project developed a Flexible Combined Heat and Power (FlexCHP) system that incorporates new burner technology into a 65-kilowatt (kW) microturbine and 100-horsepower (HP) heat recovery boiler.

Introduction

A combined heat and power (CHP) system can be a financially attractive energy option for many industrial and commercial facilities. This is particularly the case in areas of the country with high electricity rates. However, regions with air quality concerns often have strict limits on criteria pollutants, such as nitrogen oxide (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). In order to meet these emissions standards, additional control systems often need to be incorporated into CHP systems that are installed. Such systems, however, make CHP installations more expensive and often decrease system efficiency, making installation of a CHP system less attractive financially.

The CHP system developed by Gas Technology Institute (GTI) and its project partners aims to address this challenge by incorporating a supplemental Ultra-Low-NO_x (ULN) burner into a 65 kW microturbine and a heat recovery boiler. The ULN burner helps the CHP system meet stringent emissions criteria and improves overall system efficiency in a cost-effective manner.

Benefits for Our Industry and Our Nation

The developed FlexCHP-65 system provides the following energy, economic, and environmental benefits:

- NO_x emissions as low as 2.1 parts per million by volume (ppmv), or 48 percent reduction compared to a turbine without the supplemental burner
- CO emissions reduced by 97 percent compared to a turbine without the supplemental burner at full load conditions
- Negligible VOC emissions
- Seven percent fuel savings for heat recovery boiler
- Seven percent reduction in greenhouse gas (GHG) emissions for heat recovery boiler
- Decreased CHP system cost due to avoided emissions control equipment

The FlexCHP-65 system consists of Johnston Boiler Company 100-horsepower firetube boiler, GTI-developed supplemental Ultra-Low-NO_x burner, and Capstone C65 microturbine.
Photo courtesy of Gas Technology Institute (GTI)

Applications in Our Nation's Industry

The FlexCHP-65 system can be utilized by a wide range of industrial as well as commercial facilities that use boilers for heat or steam production and are interested in generating electricity onsite; sites with steam demand between one and 200 tons per hour are the best candidates for the technology. The system will be particularly well suited for geographic areas with high electricity rates and stringent air quality standards, such as California and the Northeastern states.

Project Description

The project team developed a FlexCHP system to deliver power and steam keeping criteria pollutant emissions below the 2007 Fossil Fuel Emissions Standard targets for microturbines. The FlexCHP-65 system incorporates GTI's supplemental ULN burner technology into a Capstone C65 (65 kW) microturbine and a 100 HP heat recovery boiler by Johnston Boiler Company.

Barriers

The project sought to overcome the following barriers to successful implementation of the proposed FlexCHP concept:

- Reaching ULN emissions targets without the use of additional emissions control technologies, such as Selective Catalytic Reduction
- Scaling up of a laboratory-tested ULN burner to a commercial prototype
- Keeping costs of the new supplemental burner on par with conventional duct burner models and designs
- Integrating different system components into a packaged design

Pathways

GTI had already tested its ULN burner design in a laboratory. For this project, GTI developed a commercial-scale prototype of the new supplemental burner, which was integrated into a CHP system that consists of Capstone Turbine Corporation's C65 microturbine and Johnston Boiler Company's 100 HP heat recovery boiler. Cannon Boiler Works and Integrated CHP Systems Corp. (ICHPS) were responsible for the system integration.

The integrated commercial prototype was first tested at GTI's laboratory to verify that it meets the emissions and performance requirements. A host site demonstration was conducted at Inland Empire Foods, a food processing facility in Riverside, California.

Milestones

- Laboratory validation of FlexCHP-65 system
- Field unit installation, data collection, and analysis
- Completion of engineering designs for production units
- Preparation of commercialization readiness plan

Accomplishments

- Field test demonstrated 84.2% efficiency for the integrated system; turbine alone had efficiency of 23.6%
- Achieved NO_x and CO emission levels that are far below California Air Resources Board (CARB) 2007 limits and VOC levels near zero (< 0.5 ppm uncorrected)
- Demonstration host site has taken ownership of the system and intends to keep it operational

Commercialization

Based on a market study conducted by GTI, the new technology will have greatest potential in the replacement boiler market in regions with high electricity costs and stringent emissions standards, such as California and the Northeastern states.

The new ULN burner design will be incorporated into project partners' product lineups. Cannon Boiler Works has a strong presence in the boiler market, and Capstone Turbine Corporation is an established vendor in the power generation market. These two companies will be the primary conduits for the technology to enter the market. In the first three years of commercialization, GTI, Cannon Boiler Works, and ICHPS will actively assist the market channel partners in identifying sales opportunities. In addition, project partners will conduct a market outreach program through appropriate industry associations. Full market potential for the new technology is estimated to be 60 units per year.

Project Partners

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