PROPANE education & research COUNCIL

Propane Engine-Driven Heat Pump

Propane-fueled rooftop units offer efficient, cost-effective cooling and heating

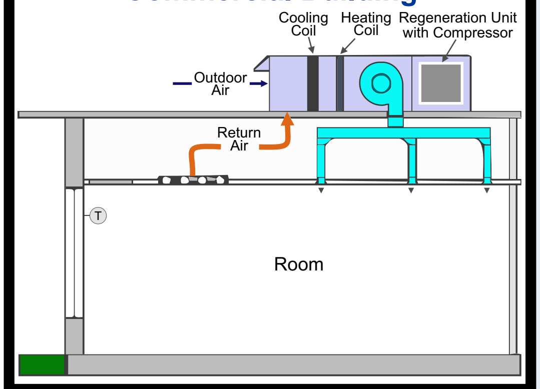
About half of the commercial buildings in the U.S. utilize rooftop package units for their cooling needs. Rooftop units (RTU) are relatively inexpensive and can easily be integrated into many commercial buildings to avoid taking up valuable internal space. However, efficiency, electric grid reliability, peak electric demand, and even water use concerns have made next generation high-performance RTUs a national priority. Recent developments in compressor and energy management technologies have paved the way for propane to address these concerns.

To become more efficient, the propane-fueled engine uses improved variable-speed operating capacity, enabling the system to reduce its power consumption when operating at partial loads and to extend equipment life. Because most of a RTU's power consumption is from the compressor, dramatic reductions in both summertime peak electric demand and electric power plant water use can be achieved by switching to propane. During winter operation, the engine jacket water and exhaust heat is recovered, resulting in significant energy savings and an increase in supply air temperature and comfort.

By maximizing efficiency, the propane-fueled rooftop system can greatly reduce electricity demand and operating costs for small commercial or large retail buildings. Using reliable propane enables the system to be powered on-site and off-grid.

The propane-fueled RTU is based on over 20 years of Japanese development in compressor, engine, and microprocessor innovation, as well as recent investments by the U.S. Department of Energy (DOE) and the U.S. Department of Defense (DoD). The commercialization of this technology can serve as a platform for future propane-based engine-driven heat pump products for both commercial and residential markets.

Rooftop Unit Serving a Small Commercial Building



Project Description

To develop this propane-fueled system, the Propane Education & Research Council (PERC) has initiated the *10 RT Gas Engine Driven Heat-Pump Product Development Project* (**Docket 12314**). Through the combined efforts of Blue Mountain Energy (BME), Southwest Gas, and the DOE, Phase One of this project seeks to accomplish the following objectives:

- Design and develop two 10-ton propane-engine RTU prototypes.
- Undergo third-party testing of prototype to achieve certification.
- Build pre-production unit for field testing.

10-Ton Propane Unitary Package Rooftop Heat Pump

The propane-fueled rooftop unit comprises three major components, including:

- An air supply section (heat exchanger with refrigerant and heat recovery circuits and an air blower driven by a high-efficiency multi-speed motor)
- A condensing section (dual heat exchangers and multiple fans driven by high-efficiency motors)
- An engine compressor section (internal combustion engine with engine exhaust, waste heat recovery components, and refrigeration components)

Replacing traditional electric RTUs in strip malls, small commercial buildings, churches, schools, or large retail operations with a propane-fueled package can reduce operating costs.

Total Life-Cycle Cost Advantage

10-Ton Gas Engine-Driven AC Heat Pump Assembly

Rooftop propane engine-driven heat pumps make an ideal choice for applications where electric service is limited or unreliable, and where high electric demand charges make commercial air conditioning and heating expensive. These savings are attributed to the energy efficiency provided by:

- Variable speeds to match loads
- Advanced R-410a scroll compressor technology
- System-rated cooling capacity at 110°F compared to 95°F with electric units
- Heat recovery

Project Implementation

This project relies on the previous development of similar gas engine-driven heat pump (GHP) prototypes. After Southwest Gas and DOE developed better-performing, environmentally friendly R-410a refrigerants, they designed the GHP model and began testing. This project will modify that design using propane fuel.

Phase One of the project includes three parts: prototype design, production, and field testing. The design and development of an ETL/UL-certified 10-ton propane engine-driven heat pump will take place in 2008 and will include:

- Developing engine fuel and control strategies based on typical propane applications
- Integrating engine control with the rooftop's programmable logic controller
- Conducting design reviews with PERC and BME

After the design is complete, two prototypes will be created:

- One will remain at BME for performance, emissions, and reliability tests.
- One will be fabricated by BME's manufacturing partner and installed at Ft. Irwin, CA for extensive field testing and demonstration in conjunction with a DoD project.

Following revisions in the above prototype, a new pre-production system will be created and sent to ETL for safety and performance testing and labeling. Upon completion of certification, the unit will be provided to PERC for a field demonstration at a site of their choice.

Project Status: In Progress

Work has begun on designing the initial prototypes and testing is expected to begin by the summer of 2008. The work is based on previous research in the PERC report, *Study of Propane-Fired Gas Cooling Technologies* (**Docket 11957**).

Next Steps

Pending a successful Phase One, PERC may work with project partners to begin commercial production of the unit. Phase Two also has the potential to continue development of a family of propane engine-driven heat pump products, including:

- Development of a use for engine heat for domestic water heating, swimming pool heating, or desiccant dehumidification
- Development of various tonnage sizes and configurations
- Design of a split system that can service more than one air handler for residential applications
- The evaluation of adding a generator for power generation
- Development of a model that will start and run off-grid without an external power source

Maximizing Energy Efficiency

Energy efficiency in the RTU is maximized by varying the number of compressors running as well as varying compressor speed, which controls the refrigerant flow rate through the circuits to satisfy both the heating and cooling load requirement of the conditioned enclosure.

Additionally, the following helps maximize energy efficiency by integrating high- efficiency system designs, such as:

- The use of high-efficiency multi-speed fan motors
- Efficient scroll compressor technology
- Using R-410a refrigerant
- High efficiency fit-for-purpose propane engine
- Additional heat exchanger surface area
- Programmable Logic Controllers that improve engine fuel and overall system operation control
- Heat recovery

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