21st International Congress of Refrigeration
Session 10: Energy-Efficient Heating and Cooling Systems for Buildings

ICR0203

Laboratory Research on Integrated Cooling, Heating, and Power Systems

Abdolreza Zaltash, Research Staff Member; tel.: 865-574-4571, fax: 865-574-9338, e-mail: zaltasha@ornl.gov (corresponding author).
Andrei Yu. Petrov, Research Associate; tel.: 865-576-5861, fax: 865-574-9338, e-mail: petrovay@ornl.gov
D. Tom Rizy, Research Staff Member; tel.: 865-574-5203, fax: 865-574-9338, e-mail: rizydt@ornl.gov
Solomon D. Labinov, Staff Member; tel.: 865-576-4908; fax: 865-574-9338, e-mail: labinovsd@ornl.gov
Edward A. Vineyard, Research Staff Member; tel.: 865-574-0576, fax: 865-574-9338, e-mail: vineyardea@ornl.gov

Cooling, Heating and Power (CHP) Group
Engineering Science and Technology Division (ESTD)
Oak Ridge National Laboratory
Bethel Valley Road, P.O. Box 2008, MS-6070
Oak Ridge, TN 37831-6070

Abstract

The goal of the Cooling, Heating, and Power (CHP) Program launched in 1999 by the US Department of Energy is to provide research, development, and implementation of distributed electric generation with thermally-activated technologies (TAT) for waste heat recovery, i.e. combination of onsite electric power generation and waste heat recovery utilization to drive various TAT units (heat exchanger, HVAC, desiccant, absorption chiller units etc.). CHP, in conjunction with other new energy efficient building technologies, will maximize the efficiency of energy use, reduce emissions of harmful substances to the environment, improve power quality and reliability and provide flexibility for meeting electric power peak load demands as compared with large central power plants. The research performed at Oak Ridge National Laboratory's CHP Integration Test laboratory, a National User Facility, is focused on assessing the operational and emissions performance of current distributed generation and TAT (both individually and operated as an integrated CHP system); developing and verifying mathematical models of the individual devices and integrated CHP system; and developing test protocols and contributing to standards development for assessing current CHP technologies.

The CHP Integration Test Laboratory at Oak Ridge National Laboratory is flexible in the configuration of the distributed generation unit (presently a natural gas-fired microturbine) with the various thermally-activated units (presently an air-to-water heat recovery unit, direct- and indirect-fired desiccant systems, indirect-fired absorption chiller). The heated exhaust gas from the microturbine is used to drive either the air-to-water heat recovery unit or used directly. The hot air and hot water flows from the heat recovery unit can be varied and directed via automated damper controls in order to test various CHP configurations and operating modes.

The CHP testing results produced so far show that both operating parameters and efficiencies of the whole system and separate units depend on electric and thermal loads, as well as on outdoor temperature and humidity. Outdoor temperature is a major factor since the microturbine is located outside and no attempt is currently being made to adjust its inlet air temperature via air cooling from the TAT units. Under certain conditions and combinations of CHP equipment the efficiency of the overall system can be as high as 56% (based on higher heating value of the natural gas including all the parasitics). The pollutants in the flue gas exiting the CHP system at full power output of the microturbine is within the limits specified by the US Environmental Protection Agency but increases as the microturbine's power output is lowered.