PROJECT PROFILE

University of Missouri

300 kW Backpressure Steam Turbine Added to Expand CHP System

CENTRAL

CHP Technical Assistance Partnerships

Project Overview

The University of Missouri (MU) in Columbia is Missouri's largest university with an enrollment of more than 30,000 students. MU has been meeting its energy needs using various forms of CHP since 1892. The total nominal capacity of the current system is 66 MW. It serves more than 15 million square feet space of campus facilities - including hospitals and clinics, a nuclear research reactor, research laboratories, academic buildings, residential halls, dining facilities, athletic facilities, computing center and administrative buildings - with an electric reliability >99.995%.

Even with an award-winning district energy system that has saved nearly $100 million in cumulative energy cost savings since 1990, the University of Missouri (MU) has continued to improve its CHP system to reduce its energy costs and increase environmental benefits. In keeping with such efforts, in 2017 MU decided to install a 300 kW backpressure steam turbine CHP system to replace a pressure-reducing valve (PRV). While it represents only a small part of the total campus CHP capacity, it generates enough electricity to supply the annual power needs of the Ellis Library, the main library for the campus.

Quick Facts

LOCATION: Columbia, Missouri

MARKET SECTOR: Colleges/Universities

STUDENT ENROLLMENT: 30,000

CHP GENERATION CAPACITY: 300 kW (added to its existing 66 MW system)

CHP PRIME MOVER: Back Pressure Steam Turbine

STEAM SOURCE: 66 MW District Energy CHP System

USE OF RECOVERED THERMAL ENERGY: Boiler Feed Water Deaerator

AREA SERVED: Generates enough power for campus library

ENVIRONMENTAL BENEFITS: Annual savings of 1550 tons of coal or 21 million cubic feet of natural gas and 4,200 lbs. of CO_2

CHP START YEAR: 2017

Steam Pressure Reduction Need and Options

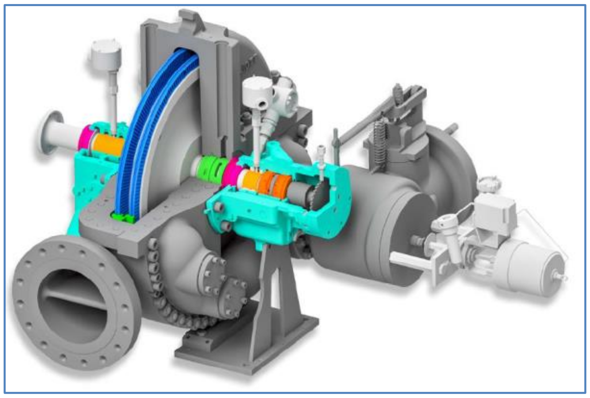
One of the critical processes in a CHP system is deaeration of the boiler feed water. Deaeration removes oxygen and other dissolved gases from the water. Without deareation, the boiler feed water causes serious corrosion damage in the boiler tubing and other parts of the steam system. The deaeration process at MU needs a large amount of steam at 5 psig. However, MU's CHP plant produces steam at 60 psig for distribution to campus buildings and facilities. Therefore, it was necessary to reduce the steam pressure for the deaeration equipment. MU has been using a PRV to reduce the steam pressure from 60 psig to 5 psig. MU evaluated the potential of using a backpressure steam turbine for reducing the steam pressure instead of a PRV. The advantage of using a backpressure steam turbine is that it not only reduces the steam pressure, it also converts some of the energy in the high-pressure steam to electric energy. Of course, a backpressure steam

Ellis Library at University of Missouri
Photo Courtesy of University of Missouri

turbine costs more than a PRV. However, the overall economics of replacing the PRV with a backpressure steam turbine was very attractive for MU. The backpressure steam turbine at MU produces up to 300 kW and meets the steam flow and pressure reduction needs of the deaeration process.

Backpressure Steam Turbine Operation

A backpressure turbine operates in much the same way as a conventional steam turbine. The high-pressure steam enters the turbine and spins a set of blades that turn a shaft which is coupled to a generator rotor. The spinning rotor generates an electromagnetic field and produces high-value electricity. The lower pressure exhaust steam is then available to be used at the facility. The amount of electricity produced depends on the steam flow rate and the difference between the pressures of the inlet and exhaust steam. The greater the difference between the inlet and exhaust steam pressures, the greater will be the amount of electricity produced per unit flow rate of steam. Also the greater the steam flow rate, the greater will be the amount of electricity produced for a fixed differential pressure between the inlet and exhaust steam. Backpressure steam turbines are designed for a service life of greater than 20 years and are known for requiring low maintenance.



BPT-1 Backpressure Steam Turbine
Photo Courtesy of Elliott Group, Ebara Corp.

Economic and Environmental Benefits

The backpressure steam turbine CHP system at MU produces electricity and thermal energy. The electricity produced by the backpressure steam turbine helps save fuel and reduce emission. The electricity generated by the backpressure steam turbine is equivalent to annual benefits of:

- Savings of 1,550 tons of coal or 21 Million Cubic Feet of Natural Gas
- Reduction of 4,200 lbs of CO_2

Based on these figures, the turbine will pay for itself in less than four years, adding to the $10.4 million in annual savings from energy efficiency measures previously adopted at the campus.

Our innovative staff continually seek ways to provide the MU campus with reliable, cost effective, and sustainable energy. This recent successful efficiency addition to our CHP operation demonstrates our proactive financial stewardship while continuing to preserve our environment.
Ken Davis, PE
Sr. Assistant Director, Energy Management

"It is extremely rewarding for our campus district energy system to be recognized by IDEA as one of the best of the best. I'm very proud of our staff's contribution in helping us win this prestigious award by delivering highly reliable, cost-effective and sustainable utility services to the Mizzou campus."
Gregg Coffin, Campus Facilities Energy Mgt. Director

Accolades

MU has received numerous accolades for its energy efficiency efforts. In 2017, the International District Energy Association (IDEA) presented MU with its "System of the Year Award." MU is one of only 5 universities to receive this prestigious award and the only university to be recognized twice by IDEA, in 2004 and 2017. US EPA has also twice recognized MU as an "Energy Star Partner of the Year" for its energy efficiency efforts and in 2010 presented it its "Energy Star Combined Heat and Power Award."

For More Information

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