Crothall Laundry Services, Tennessee, USA

A gas absorption heat pump is retrofitted to operate as a pre-heat system for an existing gas boiler in a commercial laundry facility.

Key facts

Building

Location	Johnson City, TN, USA
Construction	unknown
Heat distribution	forced air
Heated area	unknown
Level of insulation	unknown

Heat pump and source

Number of heat pumps	1
Installed capacity	41 kW
Operation mode	monoenergetic
Heat source	Outside air
Brand and type	SMTI Gas Absorption Heat Pump
Refrigerant	Ammonia-water
Sound level	unknown

Heating system

Heat demand	N/A
Heating temperature	N/A

Domestic hot water

Type of system	Heat recovery + GAHP + steam boiler
Max. Temperature	60°C
Legionella measures	N/A
Storage size	16,000 L
Number of storage tanks	4
Storage losses	6% from GAHP tanks (located outdoors due to space limitations inside facility)
Temperature control	tank thermostats

Other information

2019 ACEEE Hot Water Forum Presentation
2018 ACEEE Hot Water Forum Presentation

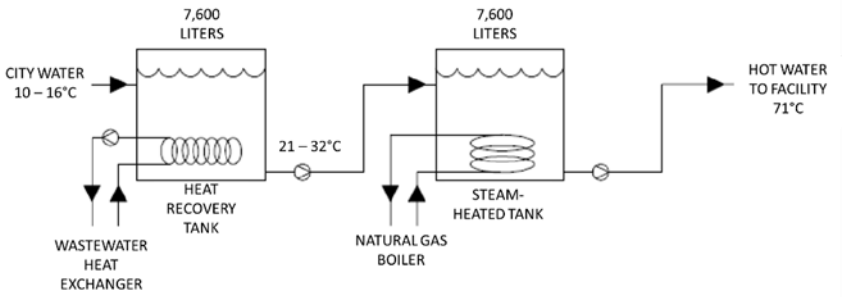
Crothall Laundry Services is a commercial laundry facility located in Johnson City, Tennessee, USA. The facility owns and washes linens for surrounding healthcare facilities. It typically operates 14.5 hours per day and 6 days per week, using 190,000 – 230,000 liters (50,000 – 60,000 gallons) of hot water daily. The targeted water heating system provided (10,000 – 20,000 gallons) of hot water daily and consisted of a waste water heat recovery loop coupled to a 7,600 liter (2,000 gallon) storage tank and an 80% efficiency, 6.2 MW (21 million Btu/h) natural gas steam boiler coupled to a separate 7,600 liter (2,000 gallon) storage tank. Cold water is supplied to the heat recovery tank and then pumped to the steam-heated tank. The boiler is used to heat the water in the steam-heated tank to 71°C (160°F) before it is pumped to the rest of the facility for use.

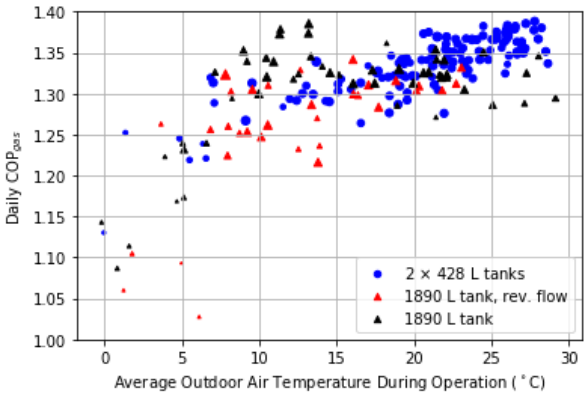
Given the large hot water use of the facility, it was an excellent candidate for the addition of a heat pump. Stone Mountain Technologies, Inc. provided a 41 kW (140,000 Btu/h) gas absorption heat pump (GAHP) to serve as a pre-heat system, reducing the load on the less efficient steam boiler. The initial GAHP system consisted of an air-to-water GAHP connected to two hot water storage tanks with internal water-to-water heat exchangers. The two hot water storage tanks (~430 L each) were plumbed in parallel to the GAHP and these three components were all placed on a skid outside of the facility. The GAHP hot water storage tanks were fed by the hot water recovery tank inside the facility and the GAHP-heated water was delivered to the steam-heated tank for final heating and delivery to the facility. This initial configuration was installed at the field test site in 2018.

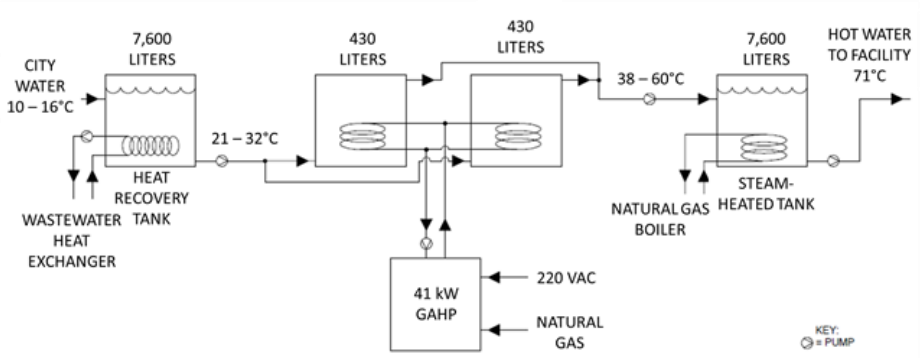
During the course of the field test, it was identified that the performance of the system could potentially be improved by using a larger storage with the GAHP. In 2019, the two small tanks were replaced with a single ~1890 L tank. This single tank had more heat exchanger surface area than the two smaller tanks combined and was also expected to reduce mixing in the tank, reducing the incoming water temperature to the GAHP and increasing the temperature of the hot water delivered to the steam-heated tank.

The GAHP system has operated for over 5000 hours and is saving the facility an estimated 60 MWh/year in natural gas.

Crothall Laundry Services, Tennessee, USA, Technical details







Figures on the left show schematics of the original water heating system (top) and the original retrofit GAHP system with two tanks (bottom). The top right plot shows daily COP_{gas} values for three different configurations; the original setup with two ~430 L tanks, an intermediate configuration with the single 1890 L tank but with reversed flow, and the final configuration with proper flow through the 1890 L tank. The size of the points indicate the heating load provided by the GAHP each day.

Description of the technical concept

Data collected on the initial system configuration showed daily average COP_{gas} values between 1.2 and 1.4 for an outdoor temperature range of 5°C to 30°C. The system delivered an average of 333 kWh/day of heated water to the steam boiler. Due to minimal available space in the facility, the GAHP storage tanks were installed outside resulting in measured heat loss of 6%.

Efficiency of the GAHP system is dependent on several factors including outdoor air temperature, inlet water temperature, cycling, duration of steady-state operation, and heat losses. Optimal storage tank design is an important factor to minimize the inlet water temperature to the GAHP and maximize the heat exchange effectiveness. Hot water usage that allows the system to operate at steady-state conditions with minimal cycling will result in the best performance.

Applications with large hot water use such as hotels, universities, hospitals, and laundry facilities will have the best return on investment for GAHP water heating systems.