COLD CLIMATE HOUSING RESEARCH CENTER

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Promoting and advancing the development of healthy, durable and sustainable shelter for Alaskans and other circumpolar people.

Masonry Heater Thermal Monitoring at the CCHRC Research and Testing Facility

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Masonry heaters have been used for thousands of years. Basic designs have not changed for hundreds of years, but precise methods and documentation to measure in-place energy efficiency of different designs and natural building materials is not available. A masonry heater (Figure 1) is located in the front entrance of the CCHRC Research and Testing Facility (RTF). This masonry heater demonstrates some of the key CCHRC concepts of using natural building material, proven design, energy efficiency and excellence in design.

Figure 1.
Masonry Heater located in the front entrance at the CCHRC Research and Testing Facility. The firebox entrance is located on the southwest side of the heater. The firebox is relatively small and intended for burning a single load of wood, followed by a cooling down period where captured heat in the rock mass continues to heat the surrounding living space over a longer period of time. The more heat retained from the burn (Thermal Storage) and released into the room, the more efficient the masonry heater.

Air quality is an important design element with masonry heaters, which are the cleanest cord-wood burning appliances available. The exhaust air quality is related to the temperatures reached in the firebox (where the wood is burned), through the heat exchange chambers, and into the stack. The type of wood burned and the moisture content of the wood is also important for both air-quality and energy-efficiency objectives. This Snap Shot is focused on the thermal monitoring taking place at the RTF, which will help improve the understanding of energy efficiency of in-place masonry heaters.

Building a fire is called a "burn". Typically, a burn is developed to quickly burn the wood hot enough that complete combustion is achieved and the air pollution out of the stack is reduced. Outside air is brought into the firebox through vents in the basement and controlled at the front of the firebox. A series of chambers in the masonry heater direct the gases and air flow from the firebox to a warm side of the masonry heater. For the heater at CCHRC, this is on the northwest side, or opposite the front entryway (Figure 2). Hot gases and air continue to travel through to the "cool" side of the masonry heater, located on the southeast side of the heater, facing the front entrance. The hot gases continue to go through chamber in the top of the masonry heater until entering the stack at the top. The stack then directs the gases out through the roof to the outside. Clean, efficient burning is needed to reduce maintenance cleaning in the stack.

Related Topics:

SnapShot
- RTF Energy Use, RS 2009-01

Website
- http://www.cchrc.org/masonry-heaters

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A Campbell Scientific Inc. CR1000 datalogger is used to record measurements of non-contact infrared sensors measuring a location on each face. Raytek MI infrared sensors measure an area roughly one-foot in diameter on the rock face and provide an average temperature for this area. A K-type thermocouple is located in the stack above the masonry heater in the center of the second floor. This sensor is measuring the temperature inside the stack. Sensors are measured once a minute. 1-minute, hourly, and average hourly data are saved for the five temperature monitoring locations. Hand-held IR sensors are used to help verify the Raytek MI sensors, and to measure temperatures at other locations on the masonry heater. The temperature data helps demonstrate the warming and cooling of the rock faces and the slow release of heat back into the living space. The southwest face, where the firebox entrance is located, reaches the highest temperatures. The northwest face warms up just after the southwest face. This is due to the gases exiting out of the firebox on this side of the heater. The northeast face is the next warmest face, closely following the northwest face. The coolest side of the masonry hater is the southeast, which also faces the main entrance and is exposed to cooler air temperatures in the winter. The masonry rock faces will typically reach temperatures over 100 ºF. Temperatures in the stack exceed 350 ºF, depending on the type of burn and if the heater had been used the previous day.

[1] Geo-Watersheds Scientific
[2] Cold Climate Housing Research Center

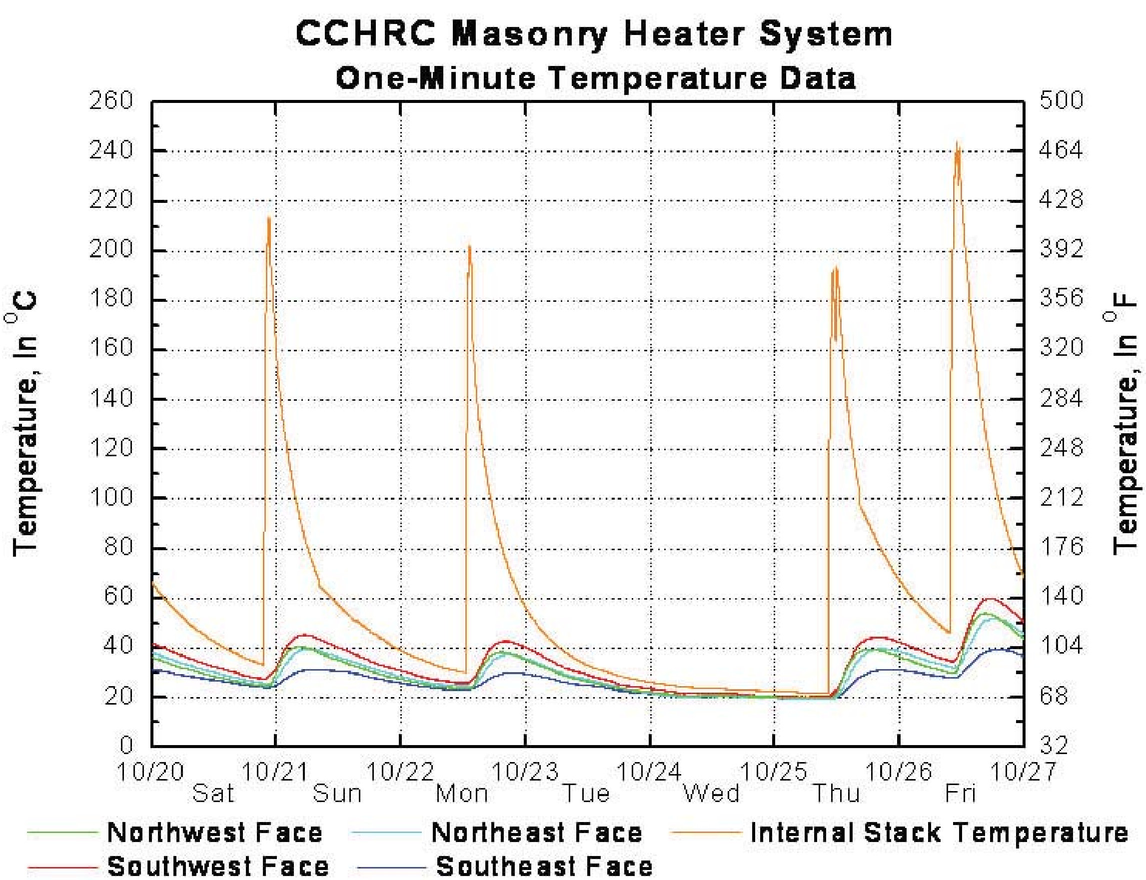

Figure 2. Temperature data for the masonry heater rock faces and stack. Measurements are taken every minute. Each increase in temperature is a unique burn. The cooling of the rock faces takes more than 24 hours to go back to ambient room temperature.