Performance Measurements using ASHRAE Standard 155p

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Objective

The purpose of this study was to evaluate the performance of two high efficiency wood boilers of capacities 150 kW and 500kW installed at the Clarkson Walker Center and the Wild Center, Tupper Lake, NY, respectively, using the new protocol ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) Standard 155p. ASHRAE Standard 155p is a new provisional protocol. It provides a method to determine the full load, partial load, and seasonal efficiency. It also includes methods for interpolating and extrapolating test data.

Measurement Methods

Thermal efficiency s defined as the ratio of heat output to heat input at steady state It is the measure of overall efficiency of the boiler. Mathematically expressed as :

$$\eta_T = \frac{heat\ output}{heat\ input}$$

$$heat\ output = Q * C_p * \Delta t * \rho$$

$$heat\ input = GCV\ (or)\ NCV * m$$

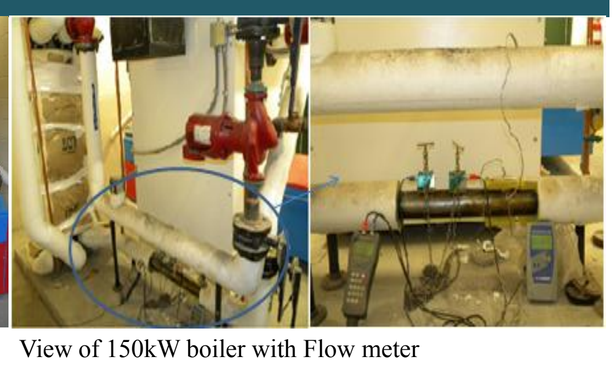
Cp-specific heat of water (Btu/kgK)
Δt-temperature difference (K)
Q-flow rate of water (L/min)
ρ-density of water (kg/L)
GCV-gross calorific value (Btu/lb)
NCV-net Calorific value (Btu/lb)
Fuel feed rate-rate of fuel input (lb/min)

Fuel properties were determined using ASTM standard methods.

Fuel Property	Walker – 150 kW	Wild Center – 500 kW
Heat Content (MJ/lbs)	8220±1.5	8060±3
Moisture (%)	4.67±0.9	5.1±1.1
Ash (d.w. %)	0.57±0.07	0.6±0.13
Carbon (d.w. %)	51.5±0.21	48.74±0.36
Nitrogen (d.w. %)	0.13±0.034	0.15±0.03
Sulfur (d.w. ppm)	70.1±0.017	67.1±0.027
Bulk Density (lb/L)	1.583	1.487

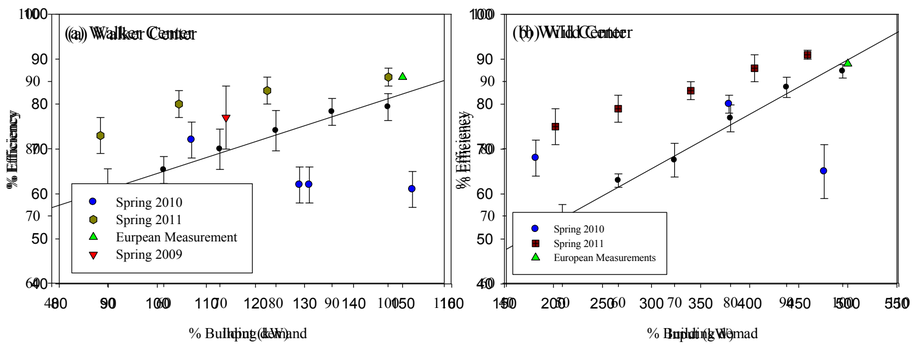
Experimental Methods

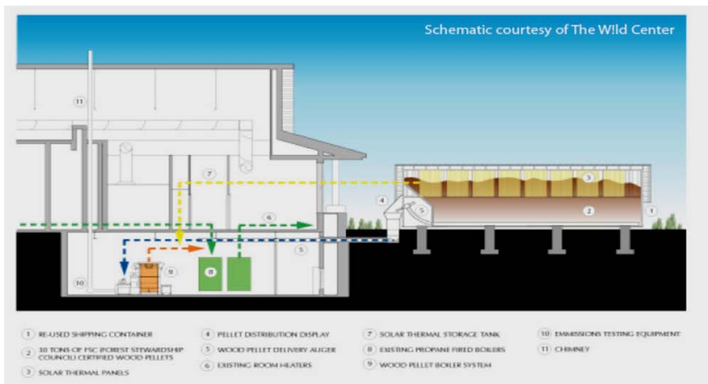
Photo of 500kW (left) and 150 kW (right) boilers

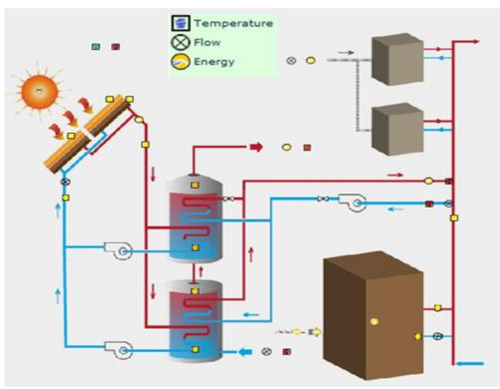


View of 150kW boiler with Flow meter and Thermocouples

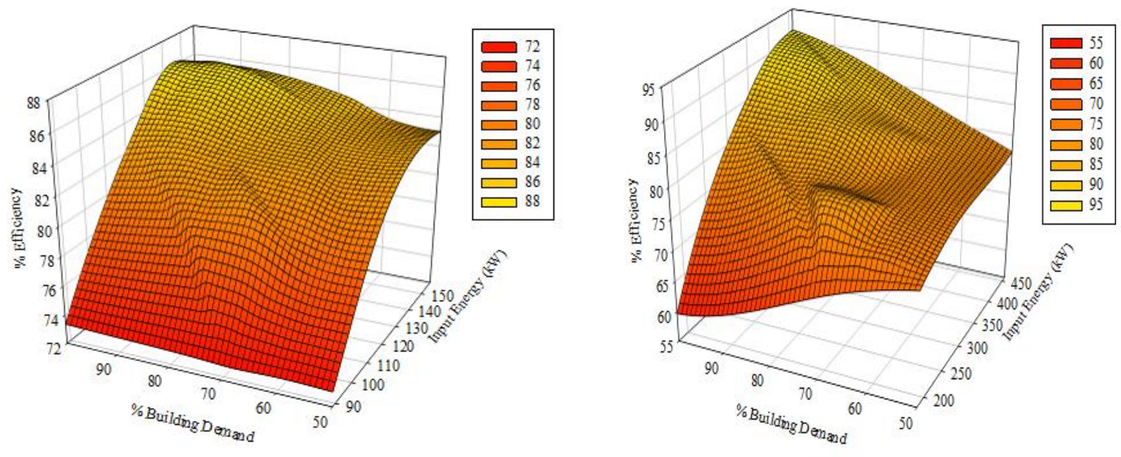
Results and Discussion







Optimization



Optimization of operating parameters in CAT 150 (Walker Center boiler) and CAT 500 (Wild Center boiler)

Conclusion

- In this study, two-stage combustion, commercial pellet boilers having capacities of 150kW and 500 kW were tested for efficiency using the new ASHRARE 155p standard protocol.
- There was a linear relationship between the boiler input and output from both the boilers.
- The efficiency ranged from 75% to 86% for the 150kW boiler and between 75% and 91% for the Wild Center boiler . Boiler capacity and had no significant effect on efficiency.
- The operating conditions such as the fuel feed rate, building heat demands, and the outlet water temperature did affect the results.

Publication

Chandrasekaran, S.R., Laing, J.R., Holsen, T.M., Raja, S., , Hopke, P.K. (2012) Emission Characterization and Efficiency Measurements of 2 High-Efficiency Wood Boilers, *Energy and Fuels* DOI:10.1021/ef2012563

Acknowledgements

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