Environmental, Energy Market, and Health Characterization of Four Wood-Fired Hydronic Heater Technologies

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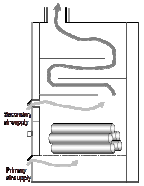
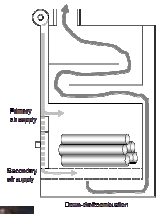
•Conventional, Single Stage HH
•Single stage combustion
•Fan-assisted, natural updraft
•250,000 Btu/h
•Damper-regulated




Red Oak

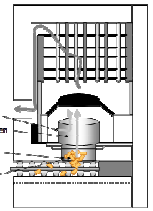

White Pine


Red Oak with Refuse



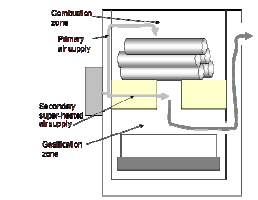
•Three Stage HH
•Three stage combustion
•Primary stage gasification
•Second stage superheated air mixing
•Third stage combustion chamber.
•160,000 Btu/h
•Damper regulated


Red Oak



European 2-Stage Pellet Burner
•2-Stage combustion
•Wood pellets
•137,000 BTU/h
•EN303-5, Class 3

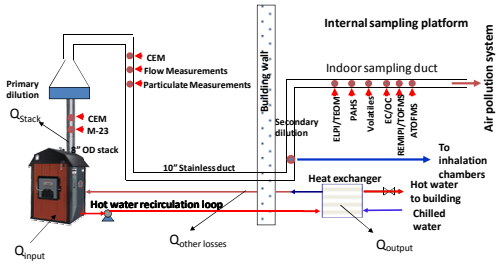

Hardwood Pellets



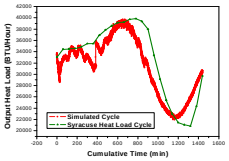
U.S. 2-Stage Downdraft Burner
•Staged combustion, combustion and gasification.
•Cord Wood
•Heat Storage used
•150,000 BTU/h

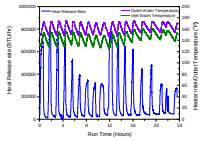

Red Oak

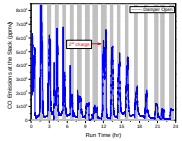
Emissions during a 24-h winter cycle were measured under realistic firing scenarios. Cumulative and temporal measurements: CO, CO2, Heat, PM, PM(t, N), THC, OC/EC, CH4, N2O, PAHs, Volatiles, Semi-Volatiles, PCDD/PCDF.



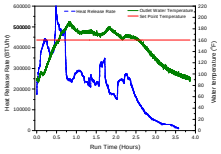
Sampling system and heat load curve. The heat load profile was for a 2500 sq-ft area home in Syracuse, New York (BNL).



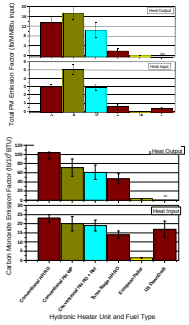




The heat release rate and emissions correlate with damper openings.. CO emissions surpass 5%. Emissions are related to time from charge rather than magnitude of heat load.



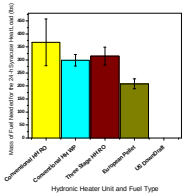
The heat release rate on the US Downdraft unit.

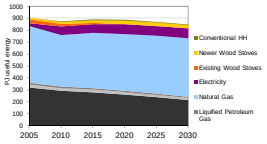


PM emissions are higher for the damper units and, in particular, for white pine.

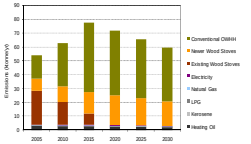
RO= red oak
WP = white pine
Ref= refuse

Units with greater combustion efficiency release less CO and generally require less fuel to meet the demand.

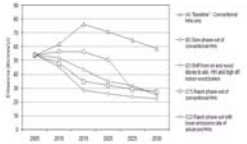

Hydronic Heater Unit and Fuel Type



Wood heat is likely to remain a relatively small market share of total residential space heating demands.



However, wood heat emissions dominated the total PM emissions from total residential energy usage over all scenarios.



The evolution of the technology mix within the market for wood heat will have a major impact on both residential PM emissions, and total PM emissions. Depending on the rate of changeover from less efficient, higher emitting units, and emissions performance of newer units, residential PM emissions could increase substantially, peaking in the next 5-10 years, or drop by nearly half.

Conclusions

•Emissions from hydronic heaters are a strong function of technology type and can be significant for units with cyclical damper openings.
•For these same units, nuisance odor can be troublesome
•The magnitude of the emissions are related more to the duration since the last fuel charge, rather than the heat load. Fuel type also plays a minor role.

•CO values up to 8% by mass and CH4 values up to 10% of the total hydrocarbon emissions were observed.
•Wood heat is expected to remain a small and declining share of the residential heating market, yet be a significant contributor to pollution.

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