Advanced Low-Emission Residential Fluid-Bed Biomass Combustor

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Abstract

NtreTech, B&W and OSU (Team) recognize the limitations of current residential wood-fired heater designs and their fixed bed (stoker) type operation. To achieve a step-change reduction in emissions and to achieve higher efficiencies, heater designs need to evolve towards a more advanced combustion technology. The project Team proposes the *novel* application of fluidized bed technology to residential wood-fired central heaters to meet current and future regulations. Although fluid bed technology is currently offered commercially for large-scale utility applications, there are significant challenges to overcome in order to adopt the technology in residential applications.

In the proposed fluidized bed combustor, wood pellets or chips would be introduced into a hot mildly fluidized bed of material such as silica sand, alumina or designed particles with catalytic properties. The bed material provides high heat transfer rates and high thermal inertia that result in more uniform and efficient burning conditions. Innovations in fluid-bed heaters at the residential scale would consist of developing and testing design concepts related to the furnace geometry, configuration, incorporation of heat exchanger and emission control features and operational considerations related to the fluidization regime, operating temperatures and pressures, air staging and bed materials. Sensors and smart controls will be incorporated to provide autonomous control of load, combustion efficiency and emissions.

Fluid bed operation improves air/fuel mixing and increases heat transfer which results in more complete combustion of the fuel. Due to the fluidization properties of the bed, the combustion temperature can be controlled more uniformly which reduces the formation of NOx. Higher combustion rates also result in lower CO and VOC emissions. Moisture content, air velocities / staging, and bed temperature can be adjusted to control the combustion process and the emissions. The potential to use different types of bed materials including catalytic bed additives, can enhance combustion and further decrease emissions. Due to the improved combustion process in a fluidized bed, the uncontrolled NOx, CO and VOC emissions are typically 10% to 25% less for a given biomass fuel than for a stoker. The use of fluidized bed technology in residential wood-fired central heaters or boilers enables a step-change in emission reductions. Although fluid bed operation may be more complex, the use of automotive sensors and low-cost microprocessors would provide an autonomous control package to overcome the traditional challenge of operational complexity of fluid bed wood-fired heaters.

The work scope will focus on 1. The design and development of the novel fluidized bed system incorporating the innovative features 2. Performing testing and analysis on the hydrodynamics, bed material, and individual components and 3. Constructing & testing a prototype in order to validate performance against the baseline. The funding will allow the project team to bridge the technological gaps by prototyping a transformative approach to firing wood in residential hydronic or forced air central heater applications. The prototype and performance data would convince stakeholders that the technology can be applied to these small residential applications. Funding towards the design, development and testing of a working fluid-bed wood-fired heater prototype will reduce financial risks and allow the team to introduce a *novel* technology for the residential market.