Wood Boiler Sizing - Partial Load Bin Analysis

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Introduction

Boilers are usually sized based on the heating load of the building or buildings that they serve. The engineer will evaluate the heating load, factor in a degree of safety and select a boiler or boilers that will maintain the building at a the design temperature on even the coldest days of the year. In this case the boiler is sized to provide 100% of the annual heating energy.

In recent years, as energy costs have risen, the use of alternative fuel boilers such as those burning wood chips or pellets has become more prevalent. These boilers are often used as the primary boiler with a secondary fossil fuel boiler to provide additional heating capacity and back-up. In these cases, or other situations where the boiler size does not need to meet the full design heating load, it can be useful to evaluate the boiler size based on the percent of the annual heating load met by the boiler.

Analysis

To answer this question a bin analysis was performed using weather data for Concord, NH TMY. The building was assumed to be a school and the temperature data was grouped into "occupied" and "unoccupied" periods so that internal gains could be factored into the heating load during occupied periods and night setback could be factored for the unoccupied period. The weather data was sorted using BinMaker Pro by InterEnergy.

Assumptions:

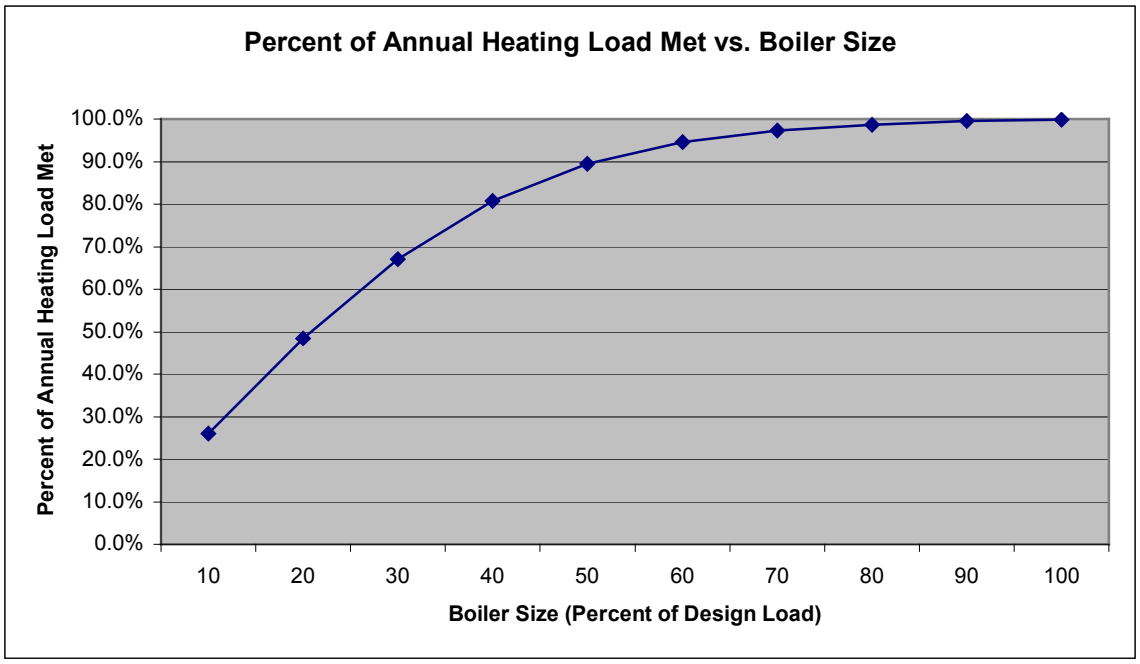
- Design Outside Air Temperature = -7 °F
- Design Load = 50 Btuh/sq-ft
- Internal Gains = 5.5 Btu/sq-ft
    - Lighting Density: 1 watt/sq-ft = 3.413 Btuh/sq-ft
    - Occupant Density: 200 Btuh/person; 20 people/2,000 sq-ft
- Occupied Period: 7am-5pm, M-F, September-June
- Occupied Setpoint = 72 °F; Unoccupied Setpoint = 55 °F

The bin temperature data is grouped by temperature and occupancy period. For each bin the outside air temperature is compared to the design outside air temperature and the "percent of design load" was calculated. During the occupied period the percent of design load is adjusted for internal gains and the number of "load hours" is determined. For example, during the occupied period there are 100 hours per year when the temperature is between 54 and 56 °F and the adjusted percent of design load at this temperature is 11% which results in about 10.5 "load hours" for this bin.

The next step is to determine how many of the annual load hours will be met by a given boiler size as the sizes range from 10% to 100% of the design heating load. This is determined by comparing the design heating load to the boiler size and calculating the number of hours met for each boiler. By comparing the "total annual load hours" to the "annual load hours met" the "percent of heating load met" is calculated for each boiler size.

Results

The results for this analysis indicated a steady, almost linear increase in percent of load met from 25 to 90% as the boiler size increase from 10% to 50% of the design load. Increasing the boiler size to 60% of the design load will satisfy an additional 5% of the annual heating load, but further increases in boiler size provide minimal benefit.



The results of this analysis are encouraging for building owners who want to decrease their fuel costs by installing an alternative heat boiler. It demonstrates that by adding a boiler equal to only half of the design heating load, fossil fuel usage can be reduced by about 90%. Since alternative fuel boilers can increase dramatically in cost as their capacity increases these results could be useful for owners trying to make a cost effective boiler selection.