2015-2016 Total Heat Data logging Report
Location: Rogers, Minnesota
Facility Type: Warehouse
Application: Space Heating

Abstract

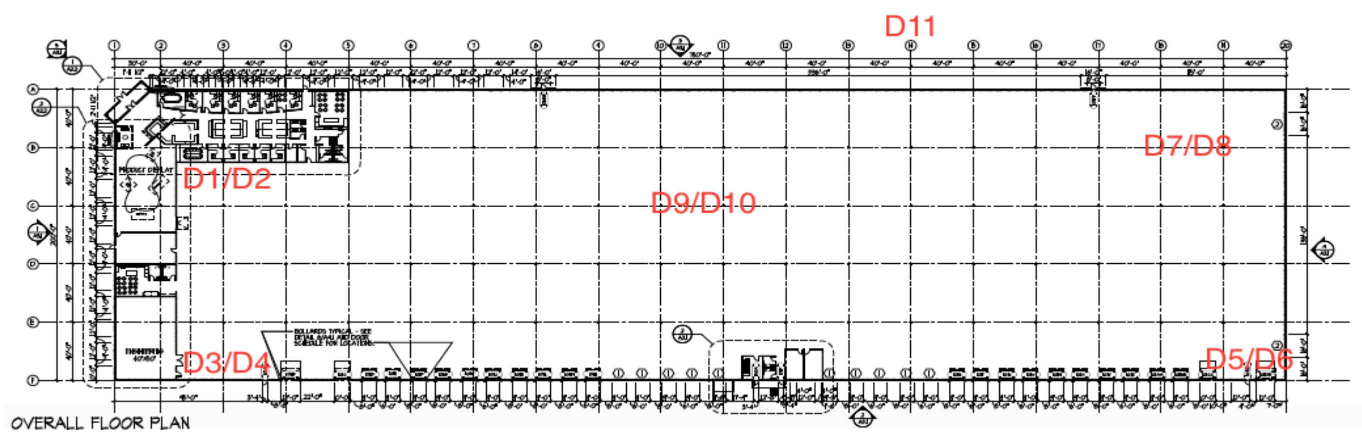
A warehouse in Rogers, Minnesota had data logging devices installed in the space in order to observe the effect of its direct fired heating equipment on space temperature and moisture. The collected data shows consistent floor level temperatures throughout the facility, minimal stratification, and indoor moisture consistent with ASHRAE and OSHA recommended winter design levels.

Background

The Rogers, Minnesota warehouse is a tilt-up style building with a concrete slab and membrane roof. The building is divided into 13,347 square feet of office space and 136,477 square feet of warehouse. The warehouse is heated by two 18,000 CFM direct fired recirculating heaters. 22 dock doors are present along one side of the building, as detailed in the plan view below.

Introduction

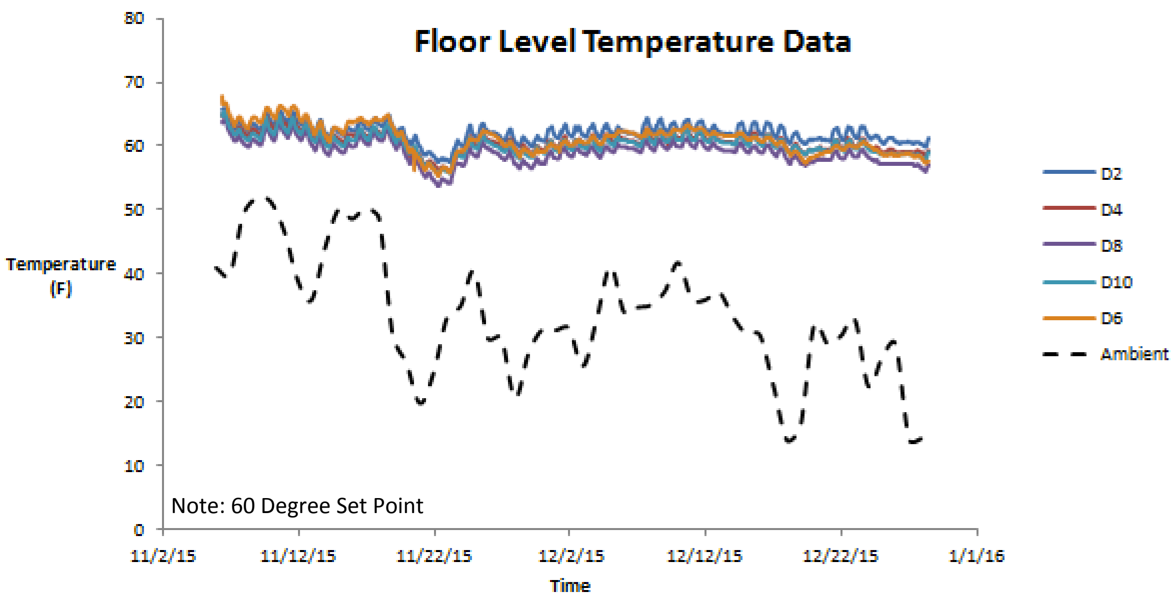
Data logging devices were installed in the facility in order to analyze heating system operation. Eleven data loggers were installed on site from November 6th, 2015 until December 2015. One pair of data loggers was installed in each of the corners of the warehouse. An additional pair was installed in the center of the warehouse. The remaining data logger was placed on the rooftop to collect ambient data. Even numbered data loggers were installed at the 10' level to capture floor level data while mitigating tampering. Odd numbered data loggers (with exception of D11 on the rooftop) were installed at a 30-40' elevation to capture ceiling level data. Dataloggers were placed according to the following diagram:



Findings

Temperature

Floor level temperature data throughout the facility is one of the primary concerns of this study. Floor level temperature represents the most immediate interaction that most building occupants have with the building's heating equipment; large temperature swings typically lead to worker discomfort. In the plot below, a temperature variation of around 2 degrees can be seen throughout the logging period. Day/night fluctuations create the higher frequency oscillations common to each of the data sets.



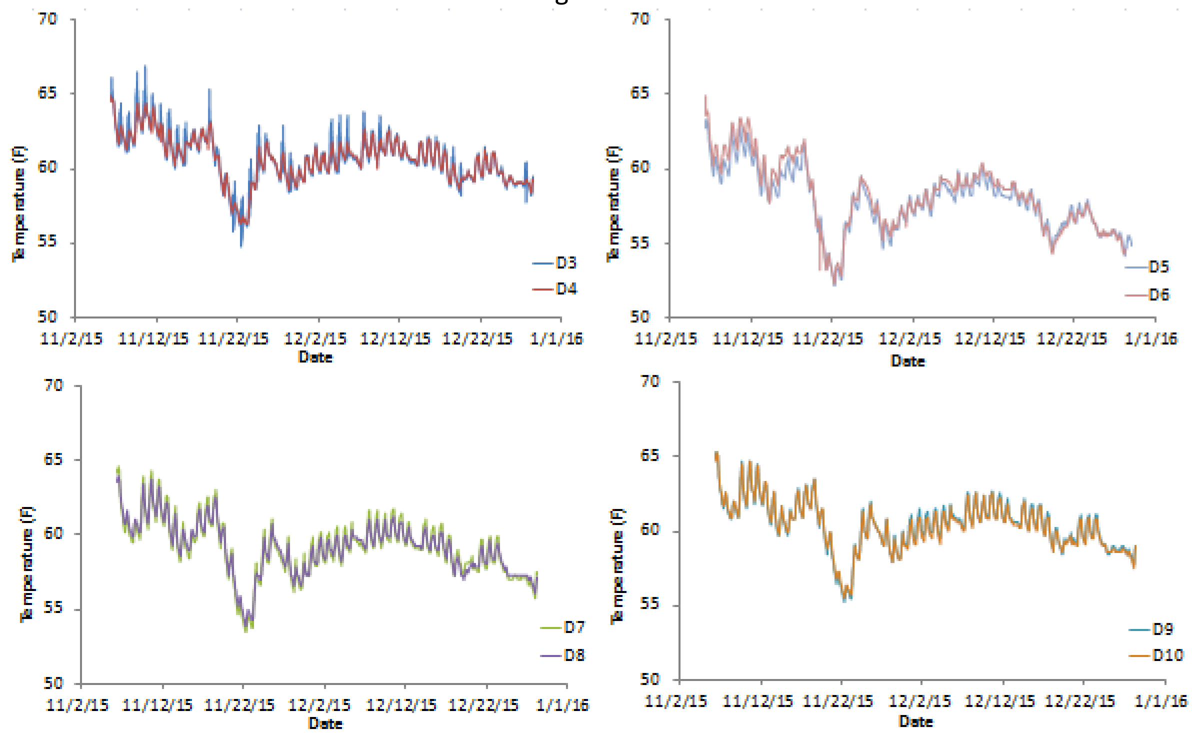
Note the time lag between the ambient overlay data and the indoor data sets. This lag in temperature change is a result of the thermal mass of the building. Larger building thermal mass results in more resistance to temperature swings, while buildings with smaller thermal mass will adopt the ambient conditions more rapidly.

Stratification

While floor level temperatures are important for worker comfort, the temperature of the building near the ceiling is just as important for minimizing energy costs. Natural convection causes heat to rise to the ceiling, creating a much warmer layer of air in a process known as thermal stratification. If left unchecked, this hot layer of air leads to a drastic increase in heat exchange with the colder ambient air outside the facility. This in turn results in increased cost to heat the building. Rupp Total Heat units re-circulate this hot air, using it to temper cold outdoor air, thereby reducing both fuel costs and stratification.

Stratification was measured at the facility through the use of sensor pairs, with one sensor being placed at floor level and the other sensor being elevated near the ceiling. While one pair experienced sensor failure (D1), four sets of dataloggers returned data, displayed below.

Building Stratification

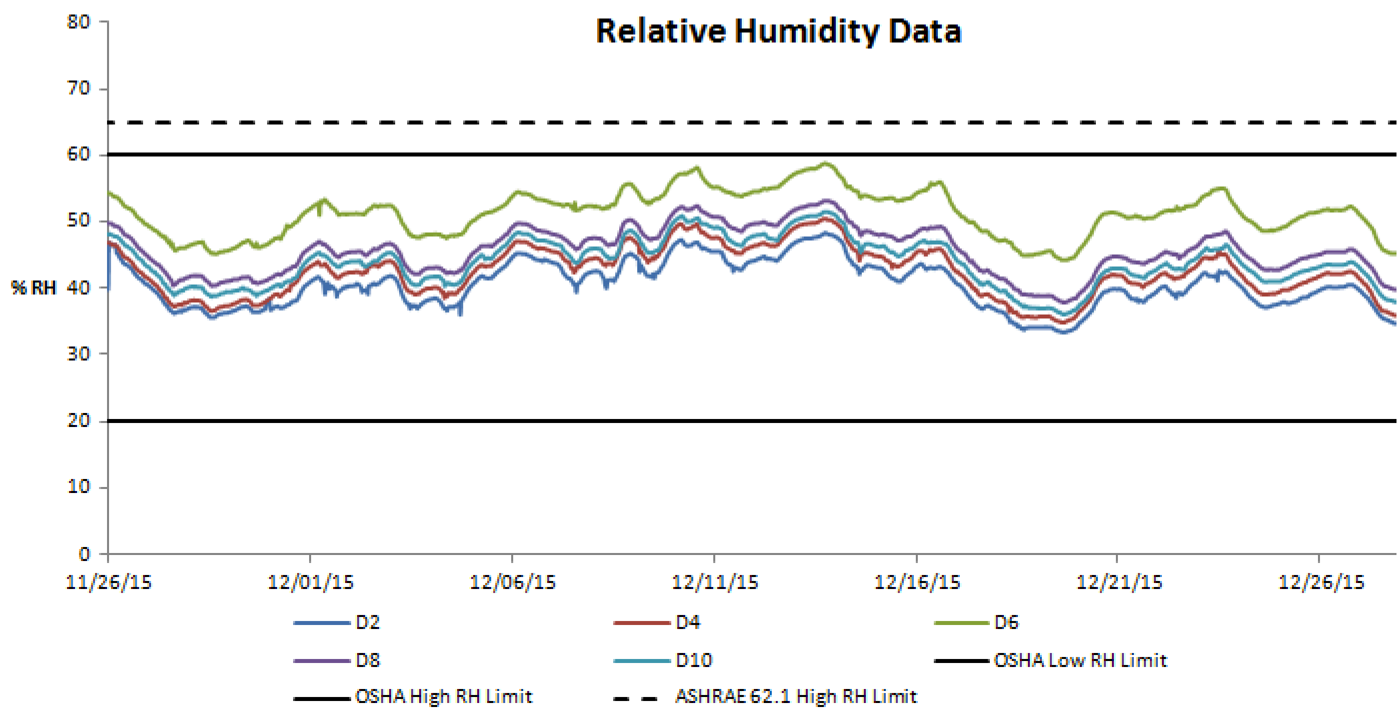


The figures above displays the minimal amount of stratification present in the facility. Each pair of sensors records nearly zero stratification. This is consistent with previous case study findings for this facility, demonstrating the effectiveness of the recirculating heating equipment at reducing stratification.

Relative Humidity

Indoor relative humidity is important both in regards to occupant comfort and in terms of application requirements. RH that exceeds ~65% places a facility at risk of mold growth during the heating season as a result of condensation on cool surfaces (walls, glazings, etc.). Conversely, RH less than 35% results in a dry environment that may be uncomfortable for employees. In the following, RH data from each of the sensors is plotted alongside the superimposed ASHRAE and OSHA design recommendations.

Comparison of ambient temperature and indoor RH values in the figure results in a strong correlation between the interior humidity and the changing ambient conditions. This trend highlights the ability of warmer air to “hold” greater

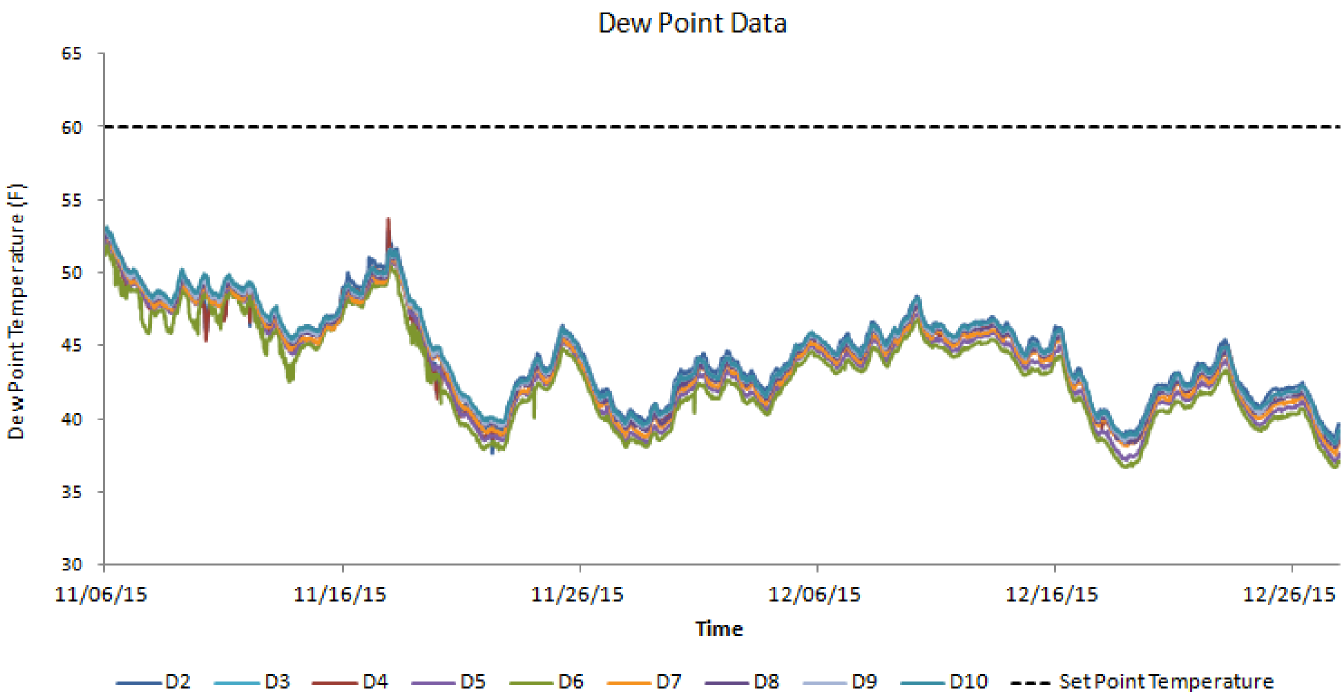


amounts of water. While RH varied over the course of the data collection period, sensor readings remained consistent at each logging interval. Elevated sensors typically recorded 10% higher relative humidity than their floor level counterparts.

Ambient conditions play a much stronger role than the heating system in determining indoor RH levels, which is to be expected as Total Heat Units have no direct humidity controls. For the month snapshot shown above, indoor RH levels are consistent with all regulating body’s published recommendations.

Dew Point

Dew point measures the absolute amount of water in the air, as opposed to the relative amount calculated by relative humidity. Dew point measurements indicate the temperature to which air must be cooled in order for its water vapor to condense. In a facility, this means that condensation will occur when the measured dew point temperature is greater than the set point temperature of the space.



Condensation is undesirable indoors, as it may result in product spoilage, mold growth, and other safety concerns due to slippery floors and walkways. The figure above displays the dew point data collected from this facility. In contrast to the relative humidity measurements, the dew point in the space can be seen to be nearly identical despite vast differences in sensor location and elevation. These data indicate that condensation is not likely in this space.

Conclusion

Winter 2015 data collected from the warehouse demonstrates consistent floor level temperatures throughout the facility. Minimal stratification was also measured, with all locations reporting negligible temperature differences between floor and ceiling. Dew point and RH data were found to represent indoor conditions consistent with ASHRAE and OSHA recommended winter design levels.