Investigation of Destratification in Warehouses

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Abstract

A significant source of energy consumption comes from maintaining desired indoor environment conditions in warehouses and other industrial facilities. In efforts to combat the raising energy costs, studies into more efficient heating and cooling strategies has been a topic of consideration for many years. One of the areas of investigation is the implications of a thermally stratified environment. In heating, removing the stratification phenomena has been linked to savings in the cost of fuel to heat an environment. Whereas in cooling a highly stratified environment is desired.

The primary method of destratification is the utilization of ceiling fans. The use of fans reduces the overall savings of destratification for heating purposes. A solution to offset the reliance on grid power is the use of solar powered ceiling fans. The challenge with utilizing solar power during heating seasons is a reduction in the time the sun is available to charge and store energy to run the fans. While there are studies into the impact of thermal stratification, with air as a medium in an indoor environment, there is a lack of information on the frequency at which the ceiling fans need to operate to maintain a destratified environment. The determination of a fan operation frequency, to maintain a destratified environment, informs potential designers on the viability of installing solar powered fans as an alternative to grid powered fans. In the event that solar powered fans were not a viable option, it also provides information on the frequency that a grid powered fan would need to run to maintain destratification.

To determine a fan operating frequency, a numerical analysis was performed. This numerical analysis assessed the time required to maintain a destratified environment based on inputs such as flow rate and spatial considerations. In order to establish the quality of the numerical analysis, two experiments were created to observe the impact of destratification. One experiment was located at a large distribution center, the other was a small classroom. The data collected from these experiments was be compared to the models developed to validate the findings. It was found that a destratification fan could maintain a destratified environment by operating at a 35% fan duty cycle.

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