Optimizing Winter Heating: Is reversing the direction of your ceiling fan the best way to achieve thermal destratification?

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Discussion

Effectiveness versus Draft Risk

Both the Haiku fan operating in the forward direction and the paddle fan operating in reverse were able to achieve destratification of the three different test spaces almost immediately after being switched on. At the lowest settings on both fans, the air remained stratified by 5-9°F (between 12” below ceiling and 4” AFF); however, at the highest settings, air velocities were too high and would be uncomfortable for occupants during the winter. The settings most effective at destratifying the room without creating uncomfortable drafts were medium for the paddle fan operating in reverse and either 1.5 or 2 for the Haiku fan operating in the forward direction (Figures 1 and 2).

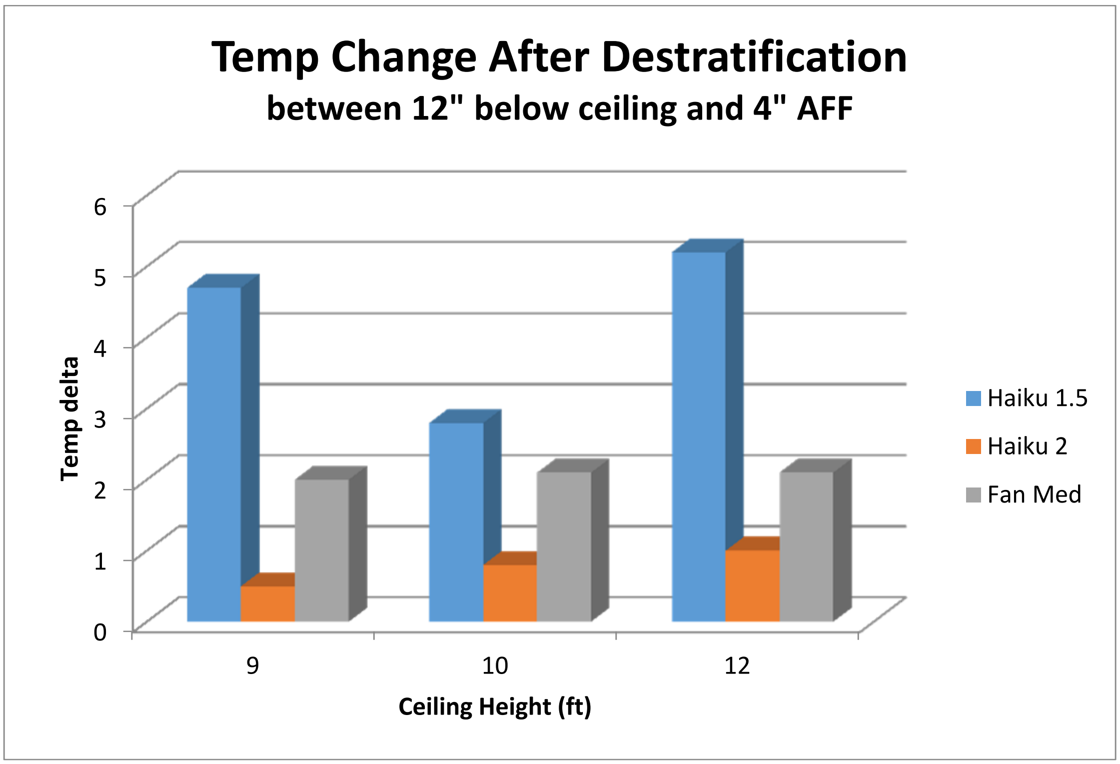

Figure 1. The effectiveness of destratification can be displayed by the temperature difference between the 12” below ceiling sensor and the 4” AFF sensor.

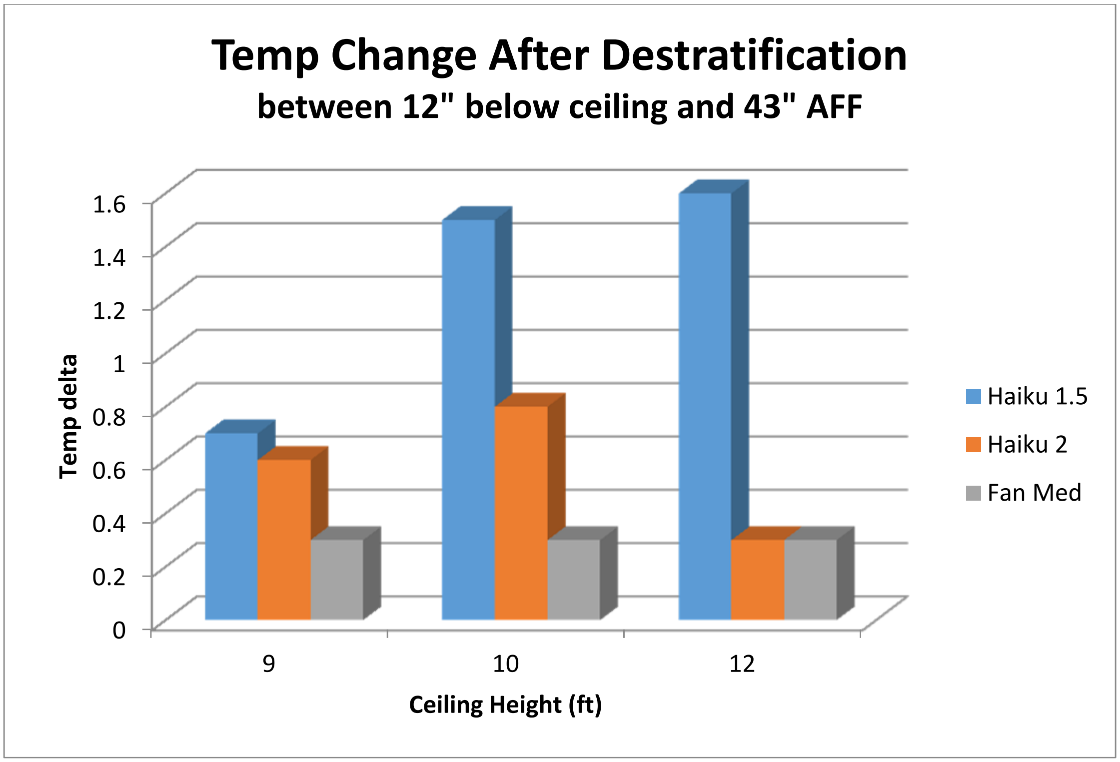

Figure 2. The temperature change between 12" below the ceiling and 43" AFF (thermostat-height) is important for energy saving considerations.

At speed setting 2, compared to medium for the paddle fan, the Haiku fan consistently had a lower temperature difference between 12" below the ceiling and 4" AFF (Figure 1), as well as between 12" below the ceiling and 43" AFF (Figure 2). The Haiku fan at setting 2 created perceptible air movement (30 fpm or above) at an average of 11/36 of the test locations, while the paddle fan on the medium setting created a draft at 14/36 locations. On average, air velocities in the entire room were slightly higher using the Haiku fan at setting 2 than the paddle fan on the medium setting, except in the 12' room (Figure 3). This was because velocities directly below the fan and 22" from the center were much higher for the Haiku fan than for the paddle fan (except in the 12' room). Directly below the fan, the Haiku fan operating at speed 2 produced air velocities on average double the air velocity produced by the paddle fan at 67" AFF (standing height), but even the paddle fan exceeded 30 fpm at these locations. The paddle fan produced higher air velocities near the walls of the room, as predicted; on average, the air velocities near the walls were five times as high using the paddle fan than the Haiku fan on speed setting 2.

The Haiku fan operating in the forward direction at speed setting 1.5 was slightly less effective at destratifying the space as the paddle fan operating in reverse on the medium setting (Figure 1). However, it still performed well, particularly in the 10' room. In addition, the Haiku fan at setting 1.5 only created perceptible air movement at an average of 6 test locations out of 36. The air velocity averages for the entire room were by far the lowest with the Haiku fan operating at speed setting 1.5 (Figure 3), which would be most comfortable for occupants during the winter months.

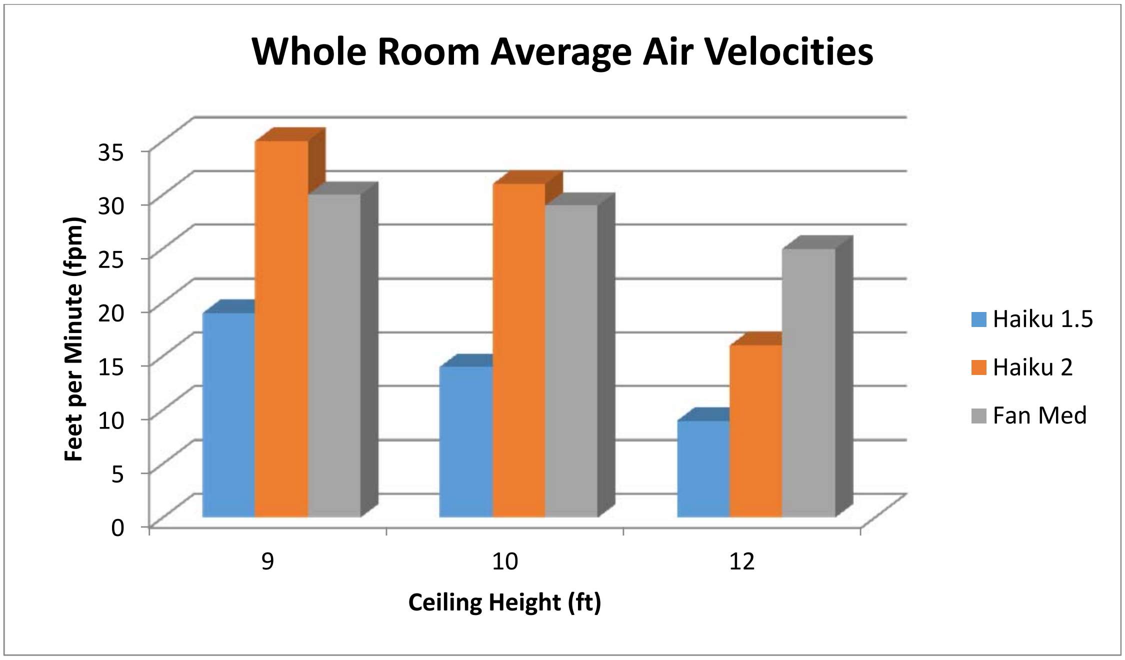

Figure 3. For each room, the average of the horizontal and vertical air velocity measurements taken at heights of 4", 43", and 67" at six locations moving radially outward from the fan center is shown for different fan types and speed settings.

The maximum air velocity recorded for both fans occurred directly below the fan, usually at 67" AFF. The Haiku fan operating in the forward direction resulted in higher maximum air velocities, except for the in the 12' room (Figure 4). Challenging popular belief, this study shows that running a paddle fan in the reverse direction does not eliminate drafts in the center of the room; only operating at the lowest speed setting, which does not successfully destratify the room (and therefore is just a waste of energy), can ensure no drafts in the entire room. While both the Haiku fan (at settings 1.5 and 2) and the paddle fan caused drafts directly below the fan, the paddle fan also caused drafts near the walls of the room, which is likely where people sit in a living room.

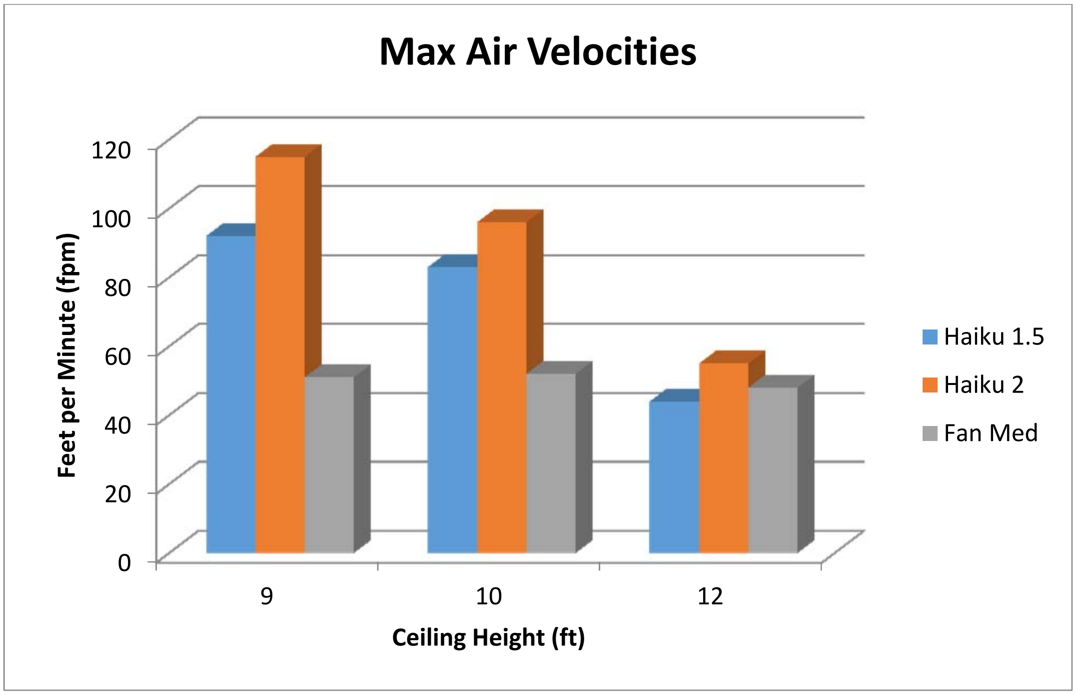

Figure 4. For occupants to not feel a draft, air velocity should not exceed 30 fpm. Both the fans tested created air velocities above 30 fpm directly below the fan, usually at 67" AFF.

Energy consumption

In each room configuration, the Haiku fan operating in the forward direction was able to destratify the room using a much lower amount of power than the paddle fan operating in reverse. The Haiku fan at speed 2 not only performed better (achieving lower temperature differences between the floor and ceiling); it used 1/12 of the power used by the paddle fan on the medium speed setting. The Haiku fan at speed 1.5 used only 1/17 of the power used by the paddle fan.

Conclusion

Effectively fighting heat stratification in the winter requires a compromise with draft risk. Even the fan produced by the most well-known residential ceiling fan brand, tested in this study, could not destratify a room without creating a draft in the center of the room as well as (in all but the 12' room) near the walls. This study also demonstrates that ceiling height, room purpose, and layout should be considered when deciding whether or not to invest in a new fan. In some situations—if the ceiling is low, drafts directly below the fan are a major concern, and the amount of power used by the fan is not a concern—it may be more comfortable to operate a paddle fan in reverse. For higher ceilings or where drafts near the walls of the room are a concern, a Haiku fan operating in the forward direction at a low speed is more effective and more efficient.

The common belief that a fan *must* operate in reverse to destratify a room without causing a draft is disproven by this study. The Haiku fan operating in the forward direction at low speeds was able to achieve similar or better results as a paddle fan running in reverse at the lowest speed possible to successfully destratify the room. Therefore, blanket legislation requiring all ceiling fans to have a reverse function is misguided. A reverse function should be an option for fans with limited speed settings, such as the paddle fan tested in this study. Operating in the forward direction on the low speed setting, such a fan is likely not able to effectively destratify a room, but at a higher speed, it produces drafts that adversely affect occupant comfort in the winter—at least, that is perceived to be the reason why customers are instructed to operate the fan in reverse. For customers who already own such a fan and do not want to buy a new one, reverse operation during the winter is still the only option. Big Ass Fans, however, have designed fans to operate most efficiently in the forward direction, and with so many speed settings to choose from, made it possible to fight heat stratification in the winter using a fraction of the power needed by a paddle fan, while also not dramatically exceeding the air velocities caused by a paddle fan operating in reverse.