January, 2006

Temperature Effects on Air Outlet Throws

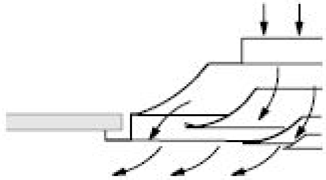
The industry standard for testing and cataloguing throw is to test and present the information at isothermal conditions. Most recently, isothermal air has been used because ARI Standard 890, "Rating of Air Diffusers and Air Diffuser Assemblies", specifies it. Prior to the adoption of this Standard, isothermal air was used since it made for the easiest testing. If the testing were performed at cooling, or heating conditions, the test room temperature would change during the course of the test, unless there were some loads added to the room to maintain the desired temperature difference. This could get very complicated, so isothermal air was preferred.

Outside of the testing laboratory, in the real world, air outlets do not often deliver isothermal air to the space being served. Depending on the time of year, location, and processes in the room being served, the air delivered to the space could be cooled, or heated, a majority of the time. At these non-isothermal temperature conditions, is the catalogue performance data still valid? Can it be used to select air outlets for these applications?

The industry standard is to catalogue the throw at isothermal conditions, to terminal velocities of 150, 100 and 50 feet per minute. At an air velocity of 150 feet per minute, a difference between the supply air temperature and the room temperature will have minimal effect on the throw. There will be only a slight difference in the throw to a terminal velocity of 100 feet per minute due to a temperature difference between the supply air and room air. The throw to 50 feet per minute however, can be significantly different, depending on the magnitude of the temperature difference between the supply air and the room air.

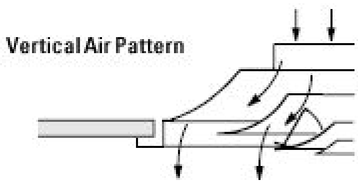
A good rule of thumb to approximate the throw to a terminal velocity of 50 feet per minute at non-isothermal conditions is that the throw, in feet, will change one percent for every degree Fahrenheit difference between the supply air and room temperatures. Whether the change in throw will be an increase or decrease will depend on the temperature difference and discharge pattern. If the supply air is heated, the discharge air is going to be less dense and more buoyant. This will give the air the tendency to rise upwards. If the supply air is cooled, the discharge air is going to be denser, less buoyant, and will tend to fall.

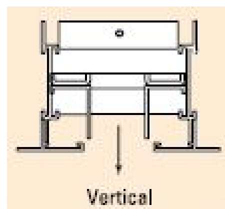
Horizontal Air Pattern



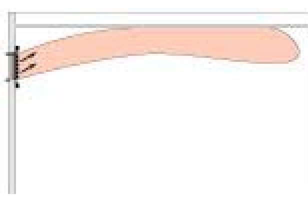
If we have a ceiling mounted air outlet which is discharging air horizontally along the ceiling, heated supply air is going to extend the throw to a terminal velocity of 50 FPM 1% for every 1 °F temperature difference between the room air and supply air. The heated air is more buoyant and will stay up at the ceiling longer travelling further than the isothermal air would have.

If the supply air is cooled, the resulting throw to a terminal velocity of 50 feet per minute is going to be reduced 1% for every 1°F temperature difference between the room air and supply air. The cool air is denser and will tend to fall away from the ceiling giving shorter throws than with isothermal air.

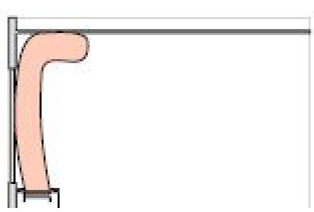




If the ceiling mounted diffuser was discharging the air vertically downwards, we will have the opposite effect. The buoyant, heated air will now tend to shorten the throw. If the supply air is cooled in this situation, the resulting throw will be increased. The denser, cool air tends to fall away from the ceiling, which increases the throw over that of isothermal air.



A sidewall grille, mounted at high level, discharging horizontally is going to perform similar to the ceiling mounted diffuser, discharging horizontally. Heating the supply air is going to increase the throw to a terminal velocity of 50 feet per minute, while cooling the supply air will decrease the throw to a terminal velocity of 50 feet per minute.



The final case is a floor mounted, or sill mounted grille, discharging vertically upwards. In this case, the natural rise of the heated air will increase the throw to a terminal velocity of 50 feet per minute while the tendency of cool air to fall will shorten the throw to a terminal velocity of 50 feet per minute.

1% Change to Isothermal Throw* for Every 1°F Difference in Temperature

Installation	Discharge	Heating DT	Cooling DT
Ceiling	Horizontal	Increase	Decrease
Ceiling	Vertical Down	Decrease	Increase
High Sidewall	Horizontal	Increase	Decrease
Floor / Sill	Vertical Upwards	Increase	Decrease

* Throw to a terminal velocity of fifty feet per minute.

The application where a temperature difference can have the most effect is an application with a vertical down discharge with heating. Heating temperature differentials can be as high as 40°F ΔT, which means throws can be reduced by up to 40%.

The vertical down discharge can become even more difficult if the air system is used for both heating and cooling. At the same air volume there will be a significant change in throw between heating and cooling operation. The designer must check that the throw under both conditions is within acceptable limits.