Blender Products, Inc.

HVAC MIXING UPDATE

Mixing and Sensor Errors - Velocity Stratification

In a recent HVAC Mixing Update article (available at www.airblender.com), sensor error was discussed along with a few of the problems that can result when a Mixed Air Temperature sensor reports extreme temperature reading to the DDC control system from temperature stratification. A quick synopsis of that article is that your MAT sensor is susceptible to "sensor error" due to the wide range of temperatures at the point where the sensor is located. If the temperature reported to the DDC system is inaccurate, the result is poor economizer control leading to unnecessary energy consumption.

This month we will discuss the other contributing factor to sensor error, which is due to an uneven velocity profile of the stratified air streams in the plenum. Air stream velocity is often overlooked as the contributing cause for the MAT sensor problem, but it is a fundamental consideration for ensuring efficient operation of an air handling unit system. Gil Avery identifies this fact in the December 2002 ***ASHRAE Journal*** article, "Do Averaging Sensors Average?" In this article, he states, "To provide acceptable performance, they (the MAT sensors) must be installed so that they sense the average ambient air temperature and the average temperature of the mass flow of air. Because sensing the average temperature of the mass flow of air is the criterion for satisfactory control, the installation of the sensor is critical." Without the consideration of the "mass flow of air", the MAT sensor cannot be considered reliable.

Economizer systems present the greatest difficulty in ensuring uniform velocity. As economizer dampers modulate to allow larger volumes of outside or return air, the pattern of velocity stratification changes in an unpredictable way. Therefore, it is nearly impossible to ensure that the averaging sensor is installed to sense the weighted mass flow mixed air temperature of the air stream over the entire economizer span. Furthermore, MAT averaging capillary tubes are usually sold in set lengths that will not allow for an optimal manufacturer recommended installation for many plenum shapes and sizes.

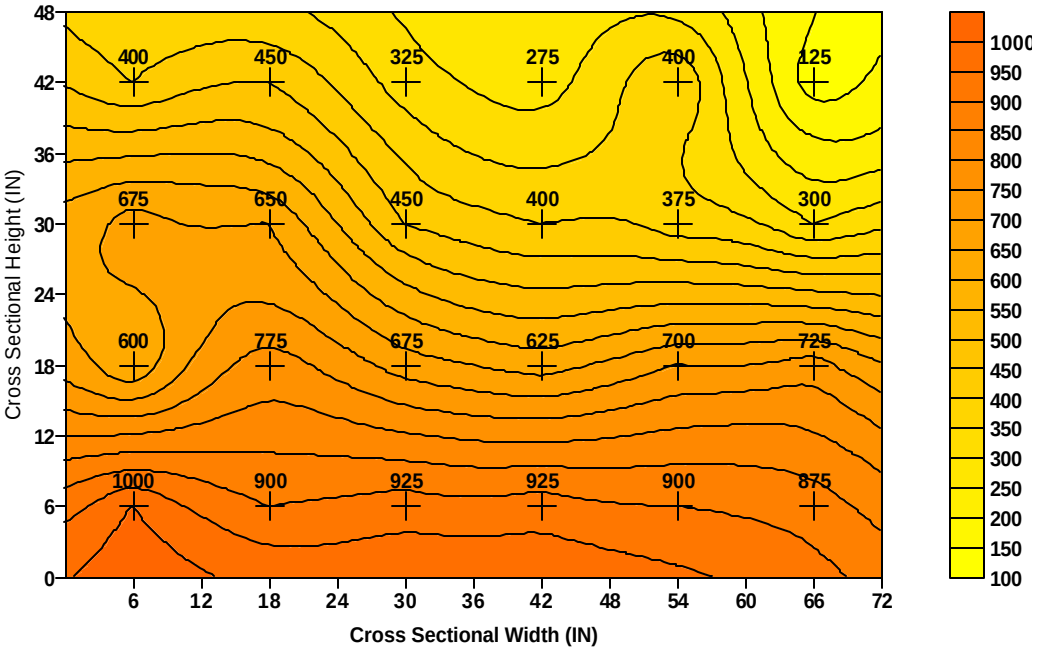

FIGURE 1: Velocity traverse **without** Air Blender mixer (12,500 CFM)

To illustrate the impact of velocity on MAT sensor readings, Blender Products, Inc. performed a test to record the velocities in the mixed air plenum of a unit with and without Series IV Air Blender® mixer. The outside air was brought in from the back of the unit and return air from the top. The dampers were fixed at 50 percent open with the blades directing the streams toward each other. The velocities (in Feet Per Minute) are shown in FIGURE 1 above.

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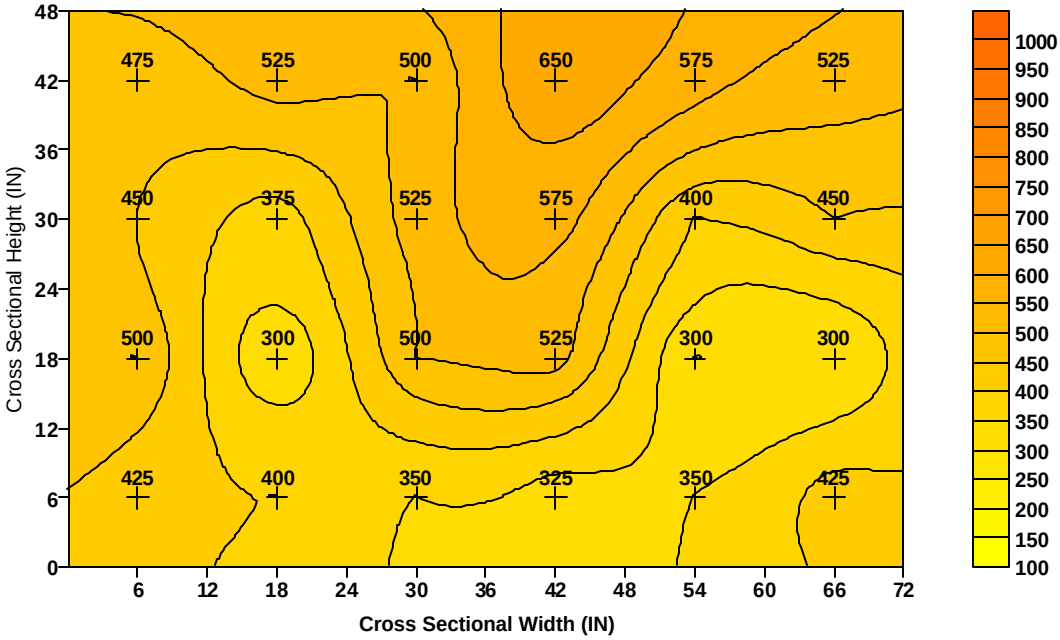
Notice that the flow along the bottom of the unit is significantly higher than the middle region and drastically higher than along the top. The lack on velocity uniformity throws into question the ability of the MAT to get an average reading of the temperature of the mass air flow. The MAT sensor averages temperatures and has no capability to take velocity into account. Therefore, if a variation in velocity exists, , there likely will be a pronounced difference between the MAT sensor reading and the true mixed air temperature of the mass air flow. As a result, the DDC system will be operating on incorrect information. Therefore, in order for the MAT sensor to get an accurate reading of the mass flow temperature, the velocity needs to be fairly uniform.



One way to achieve velocity uniformity is by applying the Series IV Air Blender® mixer in the mixing box prior to the MAT sensor. The above diagram shows how the velocity pattern changed through the application of the Air Blender® mixer. At 50 percent outside air, the velocity range was reduced by 60 percent. The velocity profile created by the Air Blender® mixer provides greater certainty that the MAT sensor is measuring the average temperature of the mass air flow. The MAT sensor performance is further enhanced by the narrowing of temperature range provided by the mixer. The net effect of applying the Air Blender® mixer is greater accuracy of the MAT sensor, thereby allowing the DDC system to control the air handling unit with maximum efficiency.

FIGURE 2: Velocity traverse **with** Air Blender mixer (12,500 CFM)

In conclusion, sensor error has two primary contributing factors. The first is the tendency of MAT sensors to miss temperatures that exist within the air handling unit discussed in our previous article. The second is the inability of MAT sensors to account for differences in velocities. The application of the Series IV Air Blender® mixer addresses both of these factors, thereby increasing the accuracy and reliability of the MAT sensor. This in turn provides a reduction in the use of mechanical heating or cooling any time both return and outside air are being introduced together in the air handling unit. The net result is energy savings in all phases of system operation.