ENGINEERING BULLETIN

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SUBJECT: Single Duct VAV Terminals with Hydronic Heating Coils Performance

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A recent ASHRAE Journal article exposed a little-known fact for many years, which had not been studied. Single duct VAV terminal units with a single blade VAV damper significantly decrease the efficiency of a hot water reheat coil downstream of the damper. An opposed blade damper design completely eliminates this effect with full water coil efficiency. With reduced water temperature now being a more common design parameter, the difference is significant.

In many building designs single duct hydronic reheat terminal units (SDHRTUs) provide conditioned air to commercial offices. At the perimeter, these coils provide heat to offset the heat loss through exterior envelopes when outside temperatures produce heating demand loads. In interior spaces, ventilation air and low interior loads require heating to overcome the minimum airflow rates that are greater than the space loads. The hot water coils are used to offset sub cooling that results in more cooling than the space loads require.

The room thermostat and the unit's system controller regulate the air and hot water flow rates through the coils. SDHRTUs have either a single blade damper where the damper closes at 90° from full open or two opposed blade dampers that close at 45°. Recent testing has compared the performance of hot water coils when airflows are controlled by both available options. A single blade damper performance test was presented in the ASHRAE Journal, December 2025. Subsequently, Nailor repeated the test at the Energistics Laboratory using the same testing techniques as the previous test. The Nailor unit had an opposed blade damper. The performance of hot water coil downstream of the opposed blade damper was very different. See figure 1.

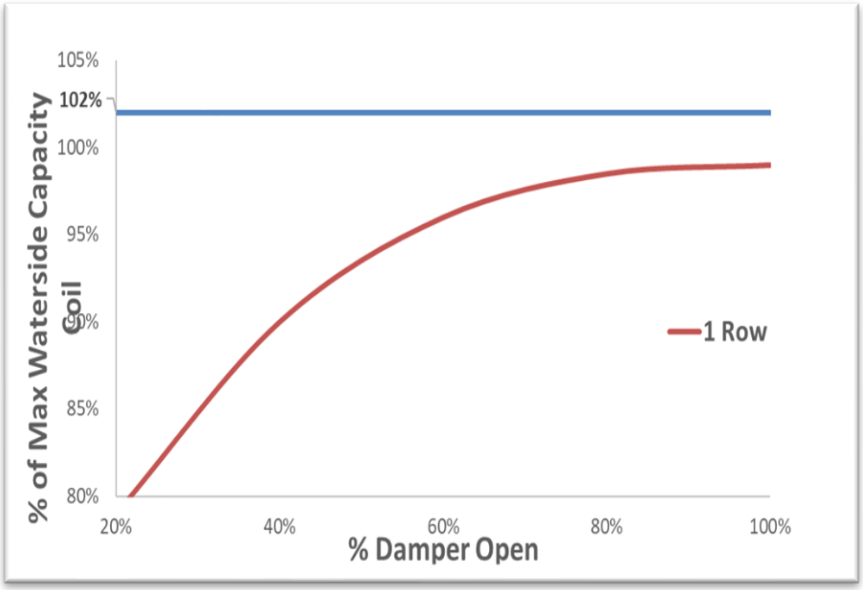

Figure 1

- The OBD has a more linear control of the air flow. For instance, when the damper is opened 50% the airflow is 50%, this makes it easier for the unit to find the right set point when conditions in the space change. See figure 2.

- The opposed blade damper controls lower airflows allowing the terminal unit to be controlled accurately in low flow conditions where ventilation airflows dominate. See figure 2.

- The opposed blade damper is effective with a wider range of useful strokes, 52% versus 40%. See figure 2. The opposed blade damper has a better discharge pattern distributing the air evenly across the heating coil. This limits the highest airflow areas (blast areas) at the coil, which reduces coil pressure drop and increases the heat exchange in the coil.

- The single blade damper distributes the air to the top or bottom of the coil, creating blast areas and reducing heat transfer. See figure 3.

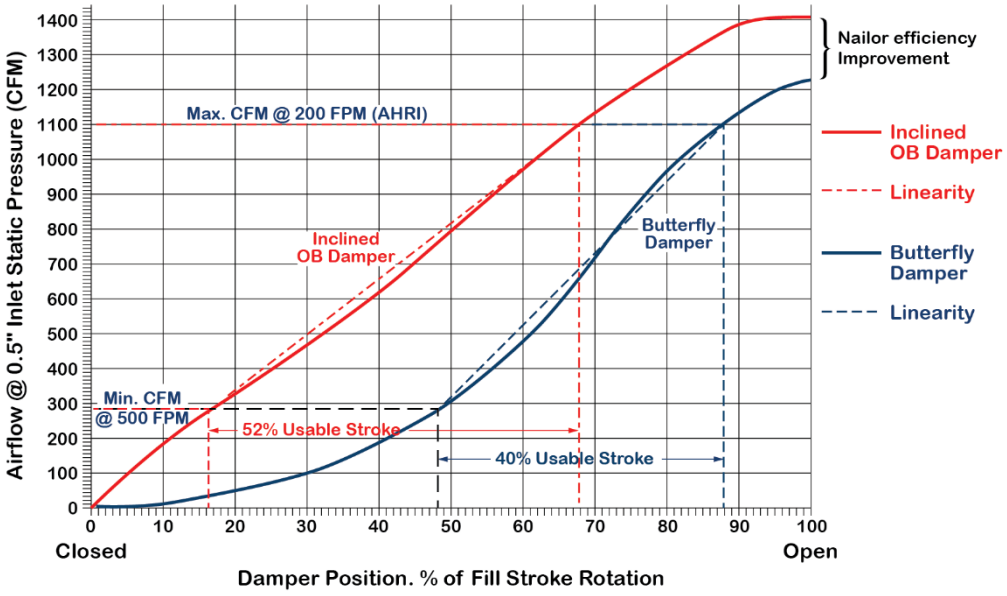

Figure 2

As the energy efficiency of lighting (LEDs) and equipment (computers and air handling fans and pumps) has increased, the sensible loads in our interior spaces have drastically declined. As a result, minimum ventilation required for a space frequently overcools the interior occupied spaces causing thermal dissatisfaction. For optimum comfort single duct units with reheat heating coils, either hot water or electric, are frequently in the heating mode in shoulder and cooling periods.

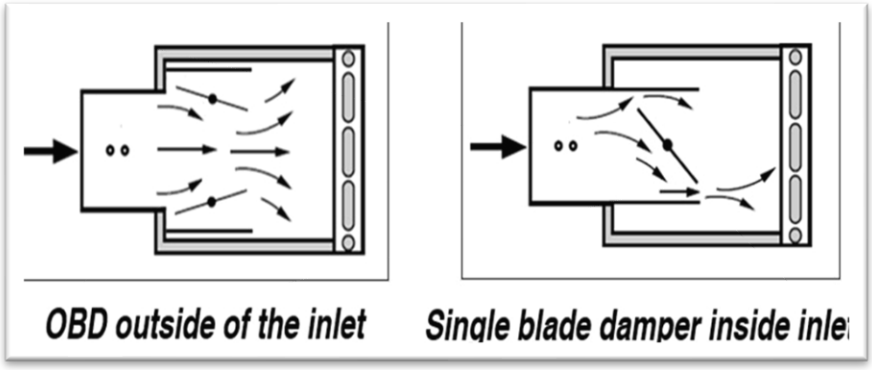

Figure 3

This is not an isolated issue; it is prevalent in all climate zones. Millions of square feet of interior office spaces are in reheat mode daily due to conflicts between minimum ventilation rates and reduced space loads. With single blade dampers hydronic heating coils are operating today in a reduced efficiency state.

The ASHRAE Journal article laid out the issue with single blade dampers and hot water coils. As the interior zones will likely be operating at or near minimum airflows, the degree of energy loss will be highest, around % in these applications because the air control damper position will operate near the 70% closure point. See figures 1-3 above.

An opposed blade damper will also be mostly closed in these applications, but the discharge from the damper will be very evenly spread on the downstream hot water coil. The testing at the Energistics lab, conducted in the same manner as the tests reported in the ASHRAE Journal, but with an opposed 2 blade damper with 45° closure, showed no negligible degradation in hot water coil performance at mostly closed damper positions.
The redline in figure 1 above is from the ASHRAE Journal article showing the test results of a single blade damper position vs. coil efficiency. The blue line shows the test results from the Energistics laboratory for an

opposed blade damper in the same conditions. The air handler supplies both perimeter and interior loads simultaneously. When the interior zone loads are significantly lower in the interior versus the perimeter, the interior units will be operating at very low airflows but higher air handler static pressures. The result will be that interior zone control dampers will be mostly closed. With single blade dampers, this will result in hot water coils operating at lower efficiency, 18% reduction or greater, returning warmer water to the boiler and requiring higher water flow to achieve the same room temperature control when compared to the opposed blade damper.

The issue is exacerbated when reduced hot water temperatures are encountered, as we see in new building designs. Higher water flow rates due to higher return water temperatures affect boiler efficiencies and require higher energy pumping. It is easy to conclude that the use of opposed blade Single Duct VAV Hot Water Coil terminal units will result in significantly higher overall energy efficiency than with single blade reheat units.

END OF ARTICLE