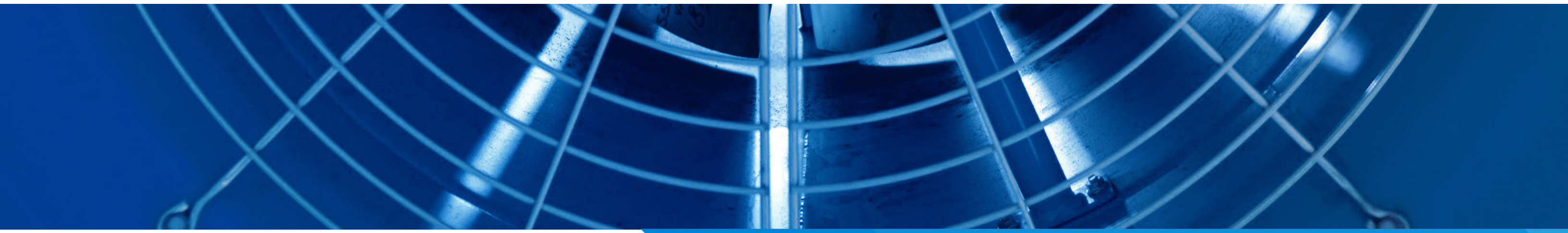
WHITE PAPER | THERMAL DAMPER EFFICIENCY

Per AMCA 511/500-D

TAMCO



Dane Carey, Director of Engineering | JANUARY 2016

EXPERIENCE TRUE EXCELLENCE IN SERVICE, QUALITY,

AND MAINTENANCE-FREE PERFORMANCE.

"How do you test the thermal efficiency of a damper, and what do the results actually mean?"

The Question

There are a variety of methods of measuring and defining thermal efficiency for dampers. But what do these methods measure? What do they actually mean? This white paper will explore and explain the following:

- What is the Thermal Efficiency Rating, as specified in AMCA 500-D and AMCA 511?
- Will AMCA's Thermal Efficiency Rating determine "R" or "U" Value?
- Is a damper with the highest Thermal Efficiency Rating always going to be the best damper for the application?
- Will a damper with the highest Thermal Efficiency Rating save the most money from an energy usage perspective?
- Will a damper with thermal breaks in the blades and frames perform better than dampers without them?

Background

In 2007, AMCA's Damper Engineering Committee identified a need for a standardized test method that would measure the thermal efficiency of insulated blade dampers. At the time, several companies were manufacturing dampers with truly thermally insulated blades that incorporated thermal breaks that effectively separated the hot and cold sides of a damper. In response, other manufacturers began to offer imitation products. In reality, these were nothing more than standard dampers, whose non-thermally broken blades had been filled with duct liner or Styrofoam insulation. When insulated blades are manufactured without thermal breaks, cold or heat is conducted around the entire blade perimeter, essentially bypassing the insulation. The insulating material, regardless of its composition or thickness, is rendered ineffective at keeping the cold outside and the heat inside.

The challenge was to devise a test method that would:

a. *compare dampers on an even playing field*
b. *identify dampers that delivered true thermally insulated performance*
c. *effectively measure the effects of extreme cold environments on a damper assembly*
d. *render repeatable results*

Committee members reviewed and evaluated several ASTM and European test standards for applicability and repeatability. They also discussed whether it would be best to compare thermal efficiency based on leakage rate, "R" or "U" Value, or condensation resistance. Although ultimately, not all of the above objectives were met, the committee devised a test procedure based on the European Standard, EN 1751, that uses a hot box to establish the thermal efficiency ratings.

What is the Thermal Efficiency Rating, as specified in AMCA 500-D and AMCA 511?

The purpose of the Thermal Efficiency Test is to compare the energy loss through the damper being evaluated with that of a predetermined reference damper. (Test methodology is in accordance with AMCA 500-D and results are certified to AMCA 511.)

Reference Damper: Single skin, steel, triple-V, 36" x 36" *(914 mm x 914 mm),*
AMCA Leakage Class 2 – 10 cfm/ft^2 at 1" w.g. *(50.8 l/s/m^2 at 0.25 kPa)*

The reference damper was tested to establish the reference wattage required to maintain a constant 30 °F *(16.7 °C)* difference between the temperatures inside and outside a thermal hot box apparatus, for a period of 10 minutes. The test results showed that 760 watts of energy were required.

To obtain the Thermal Efficiency Rating, a test damper is subjected to the same hot box test described above. The number of watts required to maintain the 30 °F temperature differential for test damper is recorded. This wattage value is then divided by the reference damper wattage to calculate the percentage improvement in efficiency.

Test damper installed on thermal hot box

Thermal hot box interior

Will AMCA's Thermal Efficiency Rating determine R- or U-Value?

No, this test will not determine a damper's R-Value or U-Value.

AMCA's Thermal Efficiency Rating is expressed as a percentage that represents the ratio of the efficiency of a given damper over the efficiency of the reference damper.

R-value is a measure of resistance to heat flow (by conduction only) through a given thickness of material. It is measured in metres squared Kelvin per Watt *(m^2K/W)* and is calculated by dividing the thickness of a material by its thermal conductivity (hr °F Ft^2/BTU). R-value is usually used in reference to construction components that are made up of a single material.

U-Value measures how much heat is lost through a given thickness of a material by conduction, convection and radiation. It is expressed in Watts per metre squared Kelvin *(W/m^2K)* (BTU/hr °F Ft^2) and is calculated by taking the inverse of the R-Value and adding convection and radiation heat losses (R=1/U). U-Value is typically applied to construction components such as windows, which are made up of multiple materials.

It should be noted that R-Value does not define a damper's insulating ability, since dampers comprise multiple materials and thicknesses. Many damper manufacturers publish an R-Value for the insulation used in the blades. This can be deceptive on two fronts. Firstly, the R-Value for a given material is typically published as a value per inch of thickness. So if there is less than one inch of insulating material in a blade, the actual R-Value will be less than the published number. The second and possibly more important consideration is that many manufacturers neglect to publish the actual R- or U-Value for the damper as a whole. The R-Value of the insulating material cannot be considered the R-Value for the entire damper assembly, as it does not account for the insulating capacity (or lack thereof) of blade and jamb seals, air gaps, frame gaps, or even the aluminum or steel shell used for the blade.

The R-Value of the insulating material cannot be considered the R-Value for the entire damper assembly.

Is a damper with the highest Thermal Efficiency Rating always going to be the best damper for the application?

Although a certified Thermal Efficiency Rating does introduce a degree of standardization when comparing different insulated dampers, it does not paint the entire picture. There is more to consider when evaluating a damper's suitability for an application than just its Thermal Efficiency Rating.

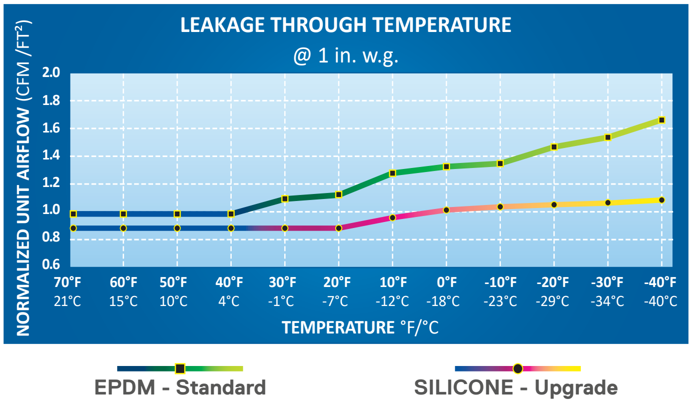
Remember, this test method only measures thermal efficiency for a 30 °F *(16.7 °C)* difference between interior and exterior temperatures. If the temperature difference is greater or less, the thermal efficiency percentage may be different as well. If the air temperature on the exterior of the test box were in the freezing range, 32 °F *(0 °C)*, or at a lower temperature, the Thermal Efficiency rating would be much lower. When TAMCO conducted leakage testing, we found that different blade and frame seal materials had varying leakage performance at temperatures ranging between 70 °F *(21 °C)* and -40 °F/°C. *(See chart below.)*

One must also bear in mind that only one damper size was tested, namely a 36" x 36" *(914 mm x 914 mm)*. Larger dampers may have higher air leakage and will be less efficient at maintaining a constant temperature differential.

Furthermore, the test method does not account for the aging of blade and frame seals. The longer certain seal materials are exposed to significant temperature fluctuations between hot and cold extremes, the more their physical properties may deteriorate. Seals may shrink, become brittle, or be prone to thermal expansion. Any of these changes will increase leakage rates and adversely affect a damper's thermal efficiency over time.

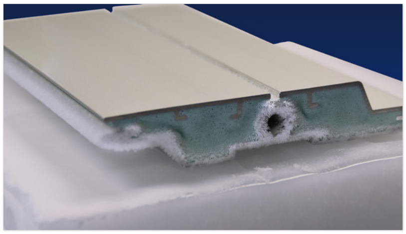
Interior and exterior temperature differentials (ΔT), and humidity levels must be taken into consideration. Conduction combined with humidity may cause condensation to accumulate on damper frames and blades. Condensation is particularly problematic in cold weather environments, where moisture build-up freezes. This will cause the blades to freeze shut and will interfere with normal damper operation. Thermal breaks are effective in preventing condensation from forming on the damper surfaces. If condensation or freeze-up is a concern, a damper with a high Thermal Efficiency Rating may work, but a thermally efficient damper that also has thermally broken frames and blades will be the best choice.

TAMCO SERIES 9000 - LEAKAGE COMPARISON GRAPH
STANDARD VS. SILICONE UPGRADE OPTION SEALS



Damper tests were conducted in a laboratory cold room to determine the effects of severe cold temperatures, down to -40 °F *(-40 °C)* on sealing gaskets and leakage rates.

TAMCO Dry Ice Test:



TAMCO thermally insulated, thermally broken blade.

TAMCO thermally broken frame.

Complete isolation of warm and cold sides creates a thermal barrier to condensation and freeze-up.

Leading Competitor Dry Ice Test:

Leading competitor's thermally broken frame damper on dry ice.

Close-up of frost build up linkage.

Condensation and frost build-up on blades and linkage parts due to thermal bridging.

Will a damper with the highest Thermal Efficiency Rating save the most money from an energy usage perspective?

99% of the time, the short answer to this question is: yes. Nonetheless, this is where interpreting and using AMCA's thermal efficiency test results becomes a little tricky.

The current thermal efficiency test, as listed in AMCA 500-D and AMCA 511, can be an effective method of comparing various damper models. It can also be useful in calculating payback periods for replacement dampers, when updating or retrofitting older outside wall dampers installations.

When using AMCA Thermal Efficiency Rating data, one must remain mindful that it is primarily a leakage/infiltration test for new products, and only applies under certain conditions. More precisely stated, the Thermal Efficiency Rating is affected more significantly by energy loss due to air leakage through the damper, than by the thermal conductivity of the insulating material used. This means that a low-leakage damper that is not thermally insulated can easily have a higher Thermal Efficiency Rating than a thermally insulated damper with a higher leakage rate.

Every opening or crack in a building, be it large or small, is a space for energy to escape, and every bit of energy loss adds up to increased costs for building owners. Therefore, it stands to reason that building owners and HVAC system designers are very interested in minimizing energy costs by minimizing opportunities for air leakage. The Thermal Efficiency Rating can be used to help determine how damper leakage rates can affect the operating cost of a building.

Ten to fifteen years ago, dampers similar to the AMCA Reference damper *(AMCA Leakage Class 2)* were the industry standard. These were typically single skin, triple-V blade dampers, constructed with jamb seals, but without blade seals. As energy costs have skyrocketed and as energy codes have become ever more stringent, infiltration has become a major concern to building owners. In response, almost all damper manufacturers now offer commercial dampers that are rated AMCA Leakage Class 1 *(maximum air leakage rate of 4 cfm/ft² at 1" w.g.)* and many offer dampers that are rated Leakage Class 1A *(maximum air leakage rate of 3 cfm/ft² at 1" w.g.)*. Therefore, it is no surprise that dampers with an AMCA Leakage Class 1A rating will have a better Thermal Efficiency Rating than the Leakage Class 2 reference damper.

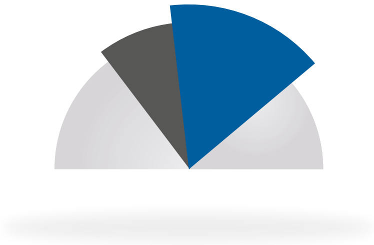
When comparing the Thermal Efficiency Rating of any two dampers, it is also important to understand how significant the difference between the two numbers really is. Every watt of energy required to maintain the 30 °F temperature difference within the test apparatus, will result in an approximate 7% decrease in efficiency rating. This means that dampers whose Thermal Efficiency Ratings are within 30-40% of each other will essentially have the same level of performance. The difference in Thermal Efficiency Ratings will need to be far greater to become truly meaningful in terms of energy savings.

Thermal Efficiency Rating

The Thermal Efficiency Rating is affected more significantly by energy loss due to air leakage through the damper, than by the thermal conductivity of the insulating material used.

Energy Costs:

The Thermal Efficiency Rating can be used to help determine how damper leakage rates can affect the operating cost of a building.



Thermal Efficiency Rating must be considered along with a number of other factors to thoroughly assess a damper's true thermal performance.

Conclusion

AMCA's Thermal Efficiency Test Rating provides valuable information when evaluating the performance of outside wall dampers at ambient air or moderately higher temperatures. However, this rating does not tell the whole story! In order to thoroughly assess a damper's true thermal performance, all of the following factors must be considered:

AMCA Certified Leakage Rating

TAMCO Thermally Insulated Dampers are AMCA Certified Leakage Class 1A. Ultra-low leakage performance directly influences thermal efficiency.

AMCA Thermal Efficiency Rating

The TAMCO Series 9000 Thermally Insulated damper has a Thermal Efficiency Rating of 640%, compared to the two leading competitors' equivalents which are rated at 345% and 593% efficiency.

Thermal Insulating Material Used In Blades

TAMCO's thermally insulated blade combines an aluminum shell, polyurethane foam with an R-Value of R-6.6 , and three thermal breaks that result in a true R-Value of 2.29 for the damper as a whole assembly.

Thermally Broken Blades and Barriers to Conduction

Any blade that is not completely thermally broken will not isolate the warm and cold sides of a damper, even if it is insulated. The optimal placement of three thermal breaks along TAMCO's thermally insulated blades provides an effective barrier to conduction and prevents heat loss across the damper.

Thermally Broken Frames and Condensation Resistance

TAMCO Series 9000 BF dampers, with thermally broken frames, provide effective condensation resistance in conditions of high ΔT's across the damper, further enhancing thermal performance.

TAMCO

If only one or two of the listed factors are considered in isolation, the assessment of a damper's thermal performance will be incomplete. This is especially true where there is potential for condensation and freeze-up. When all of the above are considered in concert, it is easy to see that TAMCO thermally insulated dampers check all the boxes and why they are the obvious choice for applications that call for a thermally efficient damper.

TAMCO was the first company to introduce thermally insulated dampers and there are countless installations where our dampers have been providing consistent thermally efficient performance for more than 25 years. TAMCO was also the first company to introduce thermal break technology to eliminate condensation transfer across the damper frame. We have been committed to providing excellent thermal performance and energy efficient products since the beginning. It is nice to see that others in the industry are finally taking strides towards catching up!

TAMCO,
the first company to introduce
thermally insulated dampers.

Still the industry leader.

THERMAL DAMPER EFFICIENCY

SPX ENGINEERED AIR MOVEMENT
80 Lorne Street
Smiths Falls, ON K7A 5J7, Canada
800 561 3449
tamcodampers.com

TA-WP-THERM-EFC-24 | ISSUED 01/2024

SPX TECHNOLOGIES