TAMCO White Paper

JAMB SEAL PERFORMANCE

TAMCO Silicone vs. Aluminum or Stainless Steel

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"Why does TAMCO use silicone jamb seals for their air control dampers, rather than aluminum or stainless steel ones?"

The Question

We have been asked on more than one occasion, *"Why does TAMCO use silicone jamb seals for their air control dampers, rather than aluminum or stainless steel ones?".* This question arises, because many consumers of air control dampers are most familiar with compression type, metal jamb seals. For many years, the standard jamb seal material used by most manufacturers in the industry has been either aluminum or stainless steel.

- Which material lasts the longest?
  Silicone? Aluminum? Stainless steel?
- Which material outperforms the others?
- Does the amount of force required to compress different jamb seal materials affect damper longevity?
- Is thermal expansion a concern?

These are all excellent questions that I will address in this white paper.

Background

Control dampers with high leakage rates are directly responsible for increased building operating costs. Blade and jamb seals are the two principal elements that influence a control damper's leakage rates. Therefore, it is extremely important that optimal materials are used to ensure a tight seal between each damper blade and everywhere the blades come into contact with damper frames.

Jamb seals are used to seal the gap between the blades and the side jamb, when the damper is in the fully closed position. Blades are always in contact with the jamb seal, whether they are at rest or rotating between the open and closed positions. Even the slightest degree of rotation produces friction. Over the course of many years of operation, this may wear away at the blades or the jamb seals. This is why a jamb seal's durability and resistance to wear will determine a system's performance over the service life of the damper.

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Which Jamb Seal Material Lasts the Longest?

For the purposes of comparing the longevity of each type of jamb seal, we are going to assume that dampers are shipped and installed perfectly square and are free of any racking. This way we can compare jamb seal durability and longevity based on ideal installation conditions. To begin, we must determine which components and materials come into continuous contact with each other. Then we must evaluate the effects of prolonged friction on each type of component and how this affects a damper's overall performance.

Aluminum:

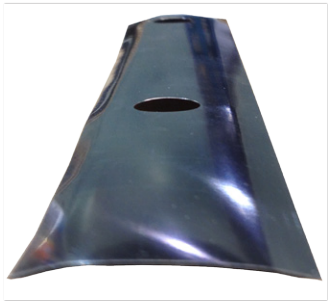
Aluminum jamb seals will be in continuous contact with metal blades. To create a seal between the steel blades and the side frames, the aluminum jamb seals must compress slightly as the blades rotate across them. As you can imagine, the thin aluminum seals are much softer than the steel blades. As a result, the blades will slowly cut into the jamb seals and eventually cause the aluminum jamb seal to tear or rip. It usually does not take more than a few cycles before you begin to see the blade scraping the paint off the aluminum seal. Once the aluminum jamb seal is torn, it no longer provides an effective seal and air leakage rates will increase significantly.

Aluminum jamb seals

Stainless Steel:

Stainless steel jamb seals function by being compressed in much the same way as aluminum seals. They are typically made using a 2B hard type 302 or 304 stainless steel, which has a much harder composition than the steel or aluminum used for damper blades. As the blades rotate repeatedly across the jamb seals, the blade edges will begin to wear away. Evidence of this wear can be seen on the stainless steel jamb seals as accumulated aluminum or steel dust particles. This dust mixes with the moisture in the air to produce a hardened residue that may be detrimental to damper operation. The hardened residue will affect jamb seal function, thereby increasing leakage rates. The build-up also increases friction between the blades and jamb seals, adding to the force required to operate the damper. Everything considered, this will result in reduced energy efficiency and higher operating costs.

Stainless steel jamb seals



TAMCO Silicone:

The design and chemical composition of TAMCO silicone jamb seals are specifically engineered so that very little compression is required to create a tight seal between the blade and side frame. As the extruded aluminum blades rotate across the silicone jamb seals, the seals flex and gently compress with the blade rotation. The profile design, flexibility, smoothness, and durability of TAMCO silicone jamb seals ensure that they will exhibit minimal wear and will never tear over the service life of the damper. And, just as importantly, TAMCO jamb seals will never wear away at damper blades, no matter how many times the blades cycle across them.

TAMCO silicone jamb seals

TAMCO has conducted extensive cycle testing on a broad range of TAMCO products, to determine the longevity of our silicone jamb seals and to assess the effect of prolonged cycling on air leakage rates. Following more than 158,000 cycles (the equivalent of more than 158 years of service life) the appearance of TAMCO's silicone jamb seals showed only slight scuff marks, and air leakage rates remained virtually unchanged. *(Refer to TAMCO's White Paper entitled, "TAMCO Silicone Jamb Seals: Longevity and Performance".)*

Which material outperforms the others?

In general, silicone jamb seals will outperform aluminum and stainless steel ones. Two of the main factors that affect jamb seal performance are how well a damper is manufactured and how well it is installed. Problems arise if dampers ship from the factory assembled out of square, if blades are cut too short, or too long, if blades are installed out of square, or if the holes in the jambs are punched off-center. Sometimes, properly manufactured dampers are improperly installed by being forced out of alignment to fit into an out-of-square duct or opening. Dampers may be damaged in transport. Or, they might even be used as a step ladder. (Yes, I have seen this!) Ideally, a damper should be square, plumb, and free from racking. Whenever a damper is installed out-of-square, it causes additional forces to be exerted on the linkage, blades, jamb seals, and actuators. This leads to premature damper failure.

Aluminum or Stainless Steel:

Aluminum and stainless steel jamb seals typically have a curved shape, and range in thickness from .005" to .010" *(.13 mm to .25 mm)*. This thin profile provides a degree of flexibility, allowing them to compress and form a seal as damper blades close across them. Both aluminum and stainless steel jamb seals can only create a proper seal if they are installed on a flat frame surface, and if the blades are perfectly perpendicular to the jamb, permitting the seals to expand outward fully and evenly as they are compressed.

After aluminum or stainless steel jamb seals have been shaped, axle/bearing holes must be punched in them. Corresponding holes must also be punched in the jambs, in a separate operation. The concern here, is to ensure that the holes on both the seals and the jambs are punched on the exact same centers. If the holes do not align perfectly, the jamb seals may buckle during the manufacturing process, or later on when the damper blades rotate during operation. Sometimes bearing holes are enlarged to allow for excessive manufacturing tolerances. In either case, this misalignment will hinder proper jamb seal performance, increasing air leakage and the probability of premature wear.

When dampers are forced to operate while twisted, or installed out of square, the blades (especially triple-V steel types) will catch on the edges of the metal jamb seals, snagging and ripping them. This often obstructs blade operation, preventing them from closing fully.

Visible residue on stainless steel jamb seals

Torn aluminum jamb seals obstructing blade operation

TAMCO Silicone:

TAMCO's silicone jamb seal is engineered so that its shape conforms perfectly to the blade profile, creating a tight seal where the blades meet the damper frame. The specifically designed silicone extrusion features ribs and highly flexible external flaps, which not only reduce air leakage, but also resist wear and eliminate tearing. This silicone extrusion slides and fits securely in an integral slot within the aluminum frame, ensuring that it will remain firmly in place for the life of the damper. Bearing holes are punched in the damper frame and the silicone jamb seal simultaneously. This ensures that the bearing holes are always perfectly aligned, preventing air leakage in this area.

So, what happens to TAMCO silicone jamb seals if installation is less than perfect? TAMCO performed cycle testing on a damper that was forced $^{11}/_{16}$" out of square. The image to the right shows the jamb seals of this out-of-square damper after more than 70,000 cycles. Even under these extreme conditions, the seals remained intact. There were no cuts or tears, and the seals held fast within the integral slots in the aluminum frame.

TAMCO Series 1000 SW assembled out of square

Appearance of damper seals after cycle testing

Does the amount of force required to compress different jamb seal materials affect damper longevity?

Definitely! How?

Jamb seals provide an effective seal against air leakage by being compressed between the jambs and blades. When additional torque must be applied to compress rather inflexible materials such as aluminum or stainless steel, it can cause linkage components, actuator connections, and even actuators to wear out sooner, because they have to work harder.

TAMCO's Silicone Jamb Seals are designed to flex easily with blade movement, thereby reducing torque requirements. As a result, less force is exerted on damper and actuator parts. This minimizes wear on the damper and increase service life.

Highly flexible TAMCO silicone jamb seals: Virtually unaffected by temperature changes at 100°F to -40°F

More rigid stainless steel seals require additional torque and are affected by thermal expansion as temperature increases

Is thermal expansion a concern?

Different materials expand and contract at different rates as temperature changes. The thinner a material is, the more it will be affected by temperature variations. Aluminum will expand and contract more rapidly than steel. Both aluminum and stainless steel jamb seals will lose flexibility and become more rigid as temperature decreases. Of the three materials, silicone jamb seals demonstrate the least change in size and flexibility as temperature changes. TAMCO silicone jamb seals remain virtually unaffected by temperature variations between 100°F and -40°F *(38°C and -40°C).*

Thermal expansion or contraction is of particular concern when there is more than a 30°F *(16°C)* difference between the warm and the cold sides of a damper. This will also be true if the operating temperature on one side of the damper is greater than 100°F *(38°C)* or less than 0°F *(-18°C)*. The difference in the thermal expansion rates of the jamb seal and damper frame materials, under these conditions, could cause interference issues. I have seen the spacing between the bearing holes on metal jamb seals expand more than the spacing between the corresponding holes punched in the frames. This caused the metal seals to buckle. In this case, jamb seals tore and interfered with blade operation.

In contrast, TAMCO silicone seals maintain flexibility under these conditions and do not expand. There will never be any danger of misalignment between the silicone jamb seal and the damper frame. In addition, since TAMCO's jamb seals are firmly secured in channels in the frame sides, they will never buckle. TAMCO dampers will continue to seal tightly and perform effectively, even in environments with significant temperature differentials and fluctuations.

There is one more thing to consider. Metal side seals will act as a thermal bridge, essentially providing a path for cold or heat to travel from one side of the damper to the other. This will reduce the thermal efficiency of the damper. It may also cause condensation and freeze-up in cold weather climates. The danger when condensation builds up and freezes, is that the blades will be frozen shut and the damper will become inoperable.

Heat or cold cannot be transferred across TAMCO silicone side seals. Not only do TAMCO seals provide low air leakage and durability, they also help to protect against condensation and damper failure due to freeze-up.

Conclusion

TAMCO evaluated all three jamb seal materials – aluminum, stainless steel, and silicone – to determine which would provide long-lasting, consistent performance. It is definitely not enough for jamb seals to deliver published air leakage performance on the day a damper comes off the assembly line. Jamb seals must be engineered so that the material and the profile design combine to ensure a tight seal for the life of the damper, while providing a degree of flexibility that will help to reduce the effects of possible racking or skewing of the damper that may occur at the time of installation.

Although aluminum jamb seals may have a slightly lower manufacturing cost, the material is fragile and prone to buckling and tearing, especially if the damper is not installed square and true. When this happens, damper longevity and sealing performance is compromised. This will quickly translate into increased replacement costs when the damper seals fail and cause other components to wear prematurely. One can also count on increased energy costs, due to high leakage rates. Dampers with aluminum jamb seals can be considered an entry level product. These will soon need to be replaced with an upgraded damper that will be able to deliver the performance you need.

Stainless steel jamb seals might be deemed a good option. With respect to material composition alone, stainless steel can last as long as silicone and the manufacturing costs are very similar. However, stainless steel jamb seals tend to wear away at the softer blade material causing a hardened residue build-up on the seals. This residue interferes with seal function and increases leakage rates. Stainless steel seals are susceptible to premature wear and tearing if the damper is installed out of square, or if the bearing holes in both the seals and the frames do not align correctly. This results in the same type of failure, elevated leakage rates, increased energy costs, and damper replacement requirements as in the case of aluminum jamb seals. Nor should we forget the detrimental effects on damper longevity caused by the additional force required to compress stainless steel and aluminum jamb seals.

TAMCO silicone jamb seals are designed and engineered specifically for TAMCO dampers. They are extremely flexible and continue to provide a tight seal, even if the damper is installed slightly out of square. There is virtually no compression required to seal the damper that would elevate the torque necessary to operate the blades. They also have the added benefit of protecting against condensation and freeze-up.

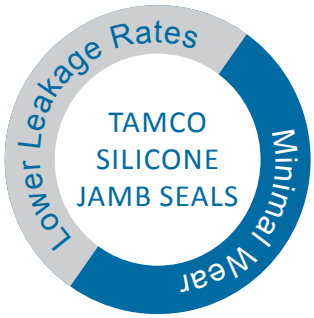
TAMCO silicone seals will not wear out and will never tear. They will deliver AMCA Certified Class 1A leakage performance on the day the dampers are delivered and for many years thereafter. TAMCO silicone jamb seals are the superior, energy efficient, economical choice for dependable and consistent damper performance.

Aluminum Jamb Seals:

Once an aluminum jamb seal is torn, it no longer provides an effective seal and air leakage rates will increase significantly.

Stainless Steel Jamb Seals:

Susceptible to premature wear, leading to higher operating costs and reduced energy efficiency.



TAMCO Silicone Jamb Seals:

Exhibit minimal wear and will never tear over the life of the damper. Silicone seals have an estimated service life of 30 years.

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