WHITE PAPER | BLADE OPERATION

Parallel Blades vs. Opposed Blades

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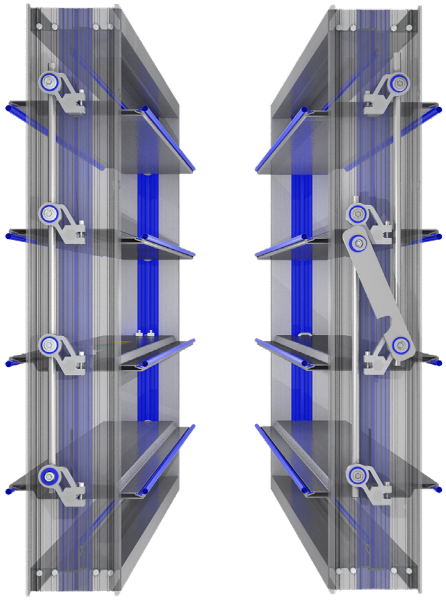
Parallel blade operation or opposed? That is the question. How do they differ? Which is better? How do we choose?

Fully Open Two-Position Dampers

Parallel Blades *Opposed Blades*



The Question

What is the difference between parallel blade and opposed blade damper operation (other than the obvious!) and when should one type be used over the other?

Air control dampers are used in HVAC applications such as outside or supply air, exhaust air, return air, generator sets, zone pressurization, lab exhaust, and fire/smoke control, to name a few. Many designers and specifiers think the only difference between parallel blade and opposed blade dampers is the direction in which the blades rotate. Many do not consider what is actually going on within the damper, or what is actually happening to the airflow as it travels across the damper blades. Damper manufacturers receive scores of calls about humming and whistling noises coming from installed dampers, blades that vibrate or flutter, systems that do not achieve the desired volume of air when the damper is partially open, or simply not getting any airflow downstream. Granted, a very few of these could be chalked up to damper defect, but the vast majority of these issues are related to flawed system design, improper applications, or something as basic as the wrong set point on an actuator.

In this paper, I aim to clarify how parallel blade dampers differ from opposed blade dampers and how each one affects airflow. With a thorough understanding of these basic principals, engineers and specifiers are able to select the most appropriate blade action for any given damper application.

The Facts

Two-Position Applications:

There are three things to consider when determining whether a parallel or opposed blade damper is the best choice for a two-position application.

1. Airflow volume and pressure loss
2. Air leakage
3. Torque requirements

AIRFLOW & PRESSURE LOSS: If the only differences between a parallel blade and opposed blade damper is the blade rotation, then airflow and pressure drop will be the same for both when the blades are fully open. Although this should be the case for most manufacturers, some companies fabricate dampers using partial blades, blade stops of varying sizes, linkage in the airstream, or blade seals that are different, depending on blade operation. These differences might alter air volume and pressure drop.

As a side note, if pressure drop is a concern, it is best to specify flanged to duct install type rather than installed in duct type dampers. Free area and airflow are significantly reduced for installed in duct dampers, because the frame is in the airstream. Pressure drop can be as much as 70 to 700% higher for installed in duct type dampers that are less than 48” x 48”.

LEAKAGE: A few manufacturers' dampers have identical leakage rates for both parallel and opposed blade dampers. This is the case for TAMCO control dampers. However, design differences between other manufacturers' parallel and opposed blade dampers do affect leakage performance. If leakage rates are critical, it is advisable to inquire which blade rotation has lower leakage.

TORQUE REQUIREMENTS: If minimizing torque requirement is an influencing factor, it is important to consider that parallel blade dampers can require up to 35% more torque to open than an opposed blade damper.

Free Area Considerations:

It is important to consider effective free area when deciding whether a parallel or opposed blade damper is most suitable for an application. Let us consider an example where one or more blades are vibrating violently. This is sometimes referred to as the rubber band effect and occurs when the blades are too long, the blades are barely open, and the back pressure is elevated.

These conditions combine to create air pressure that is stronger than the damper blades. *(The longer the damper blades are, the more prone to deflection they will be.)* The air pressure pushes on the weakest blade until it bows out slightly. Then, the adjacent blade becomes the weakest and bows out to relieve some pressure from the first blade, allowing it to begin to return to its original position. The pressure reverts to the original blade and the process repeats. If this cycle is permitted to continue for very long, the bearings may be damaged, the blades will develop a permanent deflection and eventually become dislodged from the damper frame, making the damper unusable. The more free area a damper in operation has, the less likely it is to vibrate, whistle, or choke out a system with no airflow.

There are four solutions to this scenario:

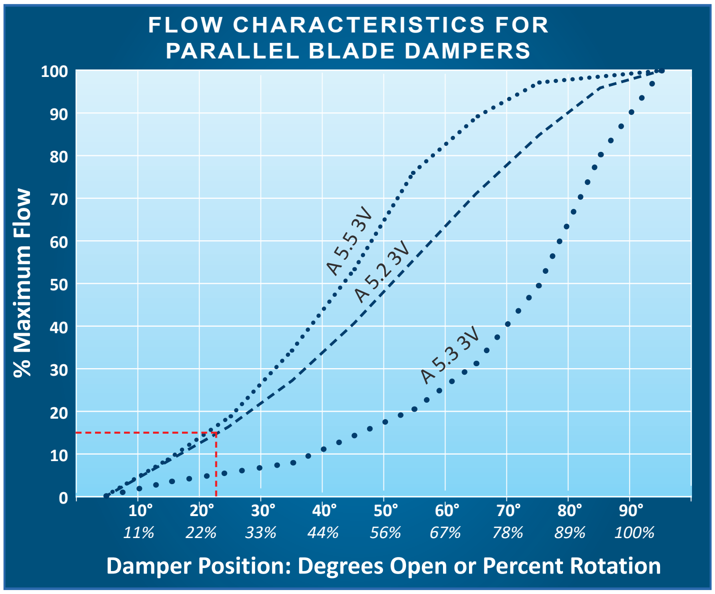
1. Reduce the airflow and pressure upstream of the damper.
2. Set the blades at a minimum open position, providing sufficient free area to eliminate vibration.
3. Order the damper as multiple sections wide. The reduced blade length per section will reduce the amount of deflection.
4. Order a parallel blade damper.

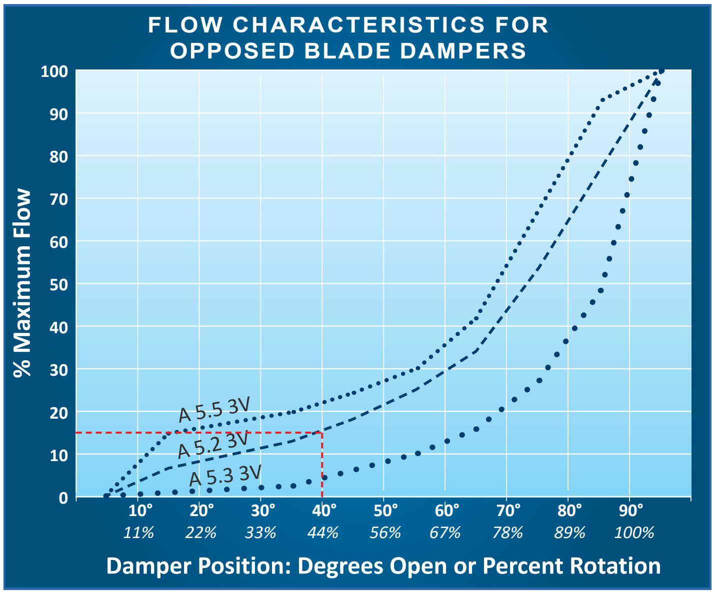
In this instance, the geometry of a parallel blade damper makes it a more suitable choice than an opposed blade damper. When designers have to ensure a specific minimum outside air intake, they typically do so by providing:

- Two individual dampers – a small parallel blade damper with a two-position actuator, combined with a larger opposed blade damper controlled with a modulating actuator. This method is more costly, but is easy to set up and control. It also provides more reliable results.
- A single opposed blade damper with a modulating actuator. Although this is normally more economical, it is more difficult to achieve an accurate minimum airflow. It can also cause vibration and noise issues at minimum settings.

When opting for the single damper solution, the designer will often try to use an opposed blade damper. This may be problematic, because it is very difficult to find the exact angle at which the blades must be set to achieve a specific percentage of airflow. The relationship between the percentage of blade rotation and percentage airflow achieved is not 1 to 1.

For example, if a minimum of 15% outside air demand is specified, trying to find the perfect setting for 15% airflow will be a process of set, test, adjust, and try again, until the correct airflow is obtained. It is difficult to find the exact point where a large opposed blade damper is open at 15% of the free area. As shown in the graph below *(results from ASHRAE Research Project 1157)*, blades open at 15% does not equate to 15% airflow.





A parallel blade damper whose blades are rotated to 15% open will provide airflow much closer to 15% than will an opposed blade damper. *(See the A 5.2 3V curve above.)* The only drawback with a parallel blade damper, is that airflow will be directed downwards or upwards, depending on which way the blades open.

You could use an opposed blade damper, but it will need to be opened to somewhere near 45% in order to achieve the desired 15% airflow. *(See the A 5.2 3V curve above.)* Most programs prefer to work with linear curves rather than sloped curves, like the ones shown in the opposed blade graph.

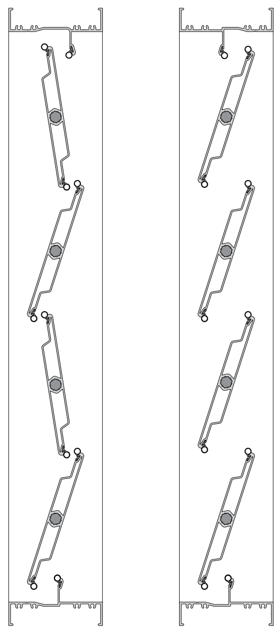
The reason that the flow characteristics are more curved for opposed blade dampers and more linear for parallel blade dampers is demonstrated clearly in the illustrations and tables shown below.

As opposed blades open, the free area created between the blades increases very slowly at lower percentages and then catches up quickly beyond 70% open. In contrast, the progression is much more consistent for parallel blade dampers.

Parallel blades are a good choice when trying to match a linear application, especially at flows between 0 and 75%. However, adjusting parallel blades and controlling flows over 75% can be more complex.

Opposed blade dampers are more difficult to adjust for controlling flows under 75% and much better for flows above 75%. Therefore, it is important to consider where your system will run most of the time, when selecting the best blade rotation for your application.

18° (20%) OPEN



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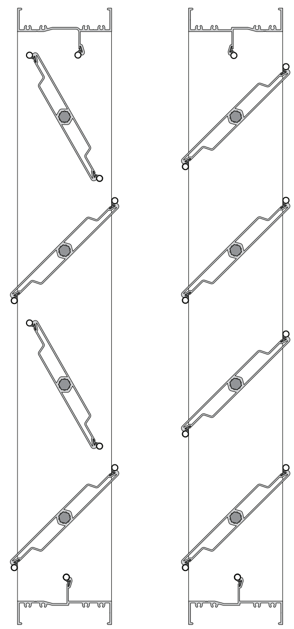
45° (50%) OPEN



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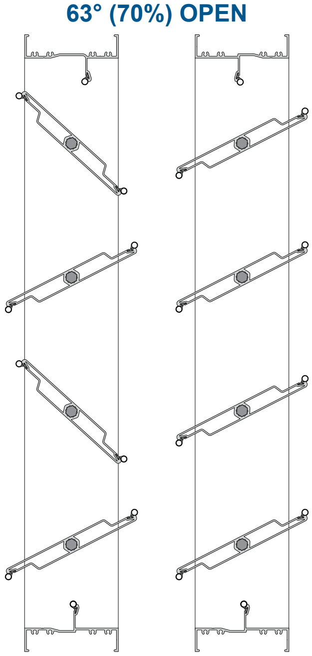
FREE AREA | SERIES 1000 – 24" X 24" ID – FLANGED TO DUCT

OPPOSED BLADE DAMPERS			
% DAMPER OPEN	DEGREES BLADE ROTATION	FT²	PERCENTAGE
10	9°	0.13	3.3%
20	18°	0.26	6.5%
30	27°	0.35	8.9%
40	36°	0.50	12.5%
50	45°	0.74	18.5%
60	54°	1.08	27.0%
70	63°	1.51	37.7%
80	72°	2.00	50.0%
90	81°	2.57	64.2%
100	90°	3.11	77.9%

63° (70%) OPEN



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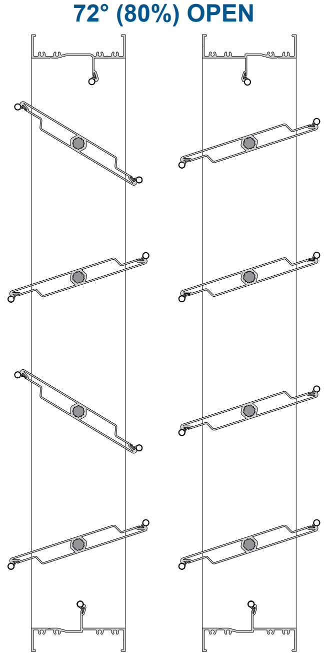
72° (80%) OPEN



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FREE AREA | SERIES 1000 – 24" X 24" ID – FLANGED TO DUCT

PARALLEL BLADE DAMPERS			
% DAMPER OPEN	DEGREES BLADE ROTATION	FT²	PERCENTAGE
10	9°	0.50	12.6%
20	18°	0.88	22.0%
30	27°	1.28	32.0%
40	36°	1.72	42.9%
50	45°	2.15	53.7%
60	54°	2.44	61.0%
70	63°	2.73	68.3%
80	72°	2.94	73.6%
90	81°	3.07	76.8%
100	90°	3.11	77.8%

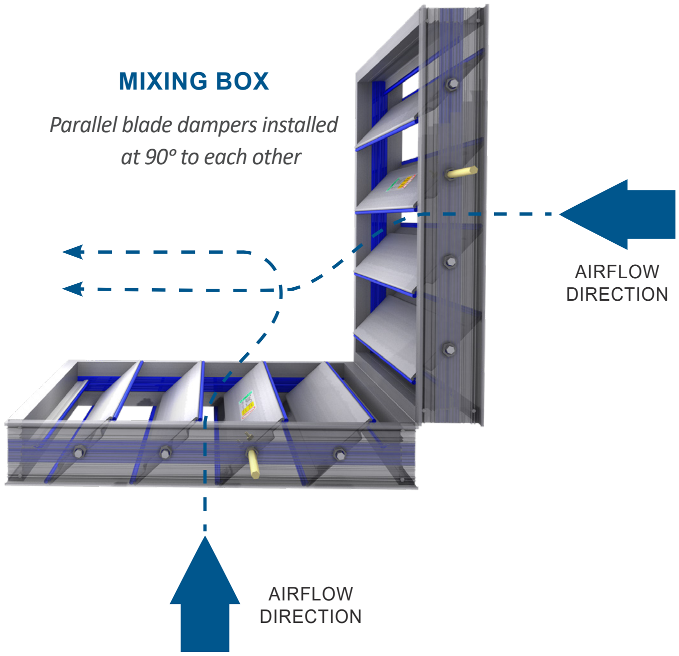
Airflow Direction:

Sometimes, dampers are used to control airflow direction. This is typically a requirement when air must be redirected upon entering an elbow or mixing box. In almost all cases, parallel blade dampers are the best choice for these applications.

MIXING BOX: *(i.e. supply and return applications in AHU's)* Outside or supply air is blended with the conditioned inside air to refresh the air being supplied back into the building. The outside air is normally much warmer or cooler than the return air from the building. If the two air sources are not blended well, the temperature difference will cause stratification of the airflow. Using parallel blade dampers that are installed perpendicular to each other, with the blades opening toward each other, forces the air from the two sources into each other. This blends the temperatures so that stratification is prevented. *(See photo at right.)*

MIXING BOX

Parallel blade dampers installed at 90° to each other

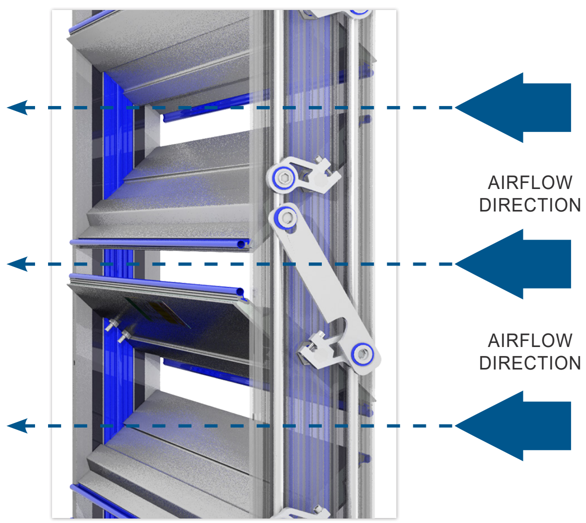


UPSTREAM OF ELBOW: When a parallel damper is installed immediately upstream of an elbow, the actuator will be positioned so that the blades are open at 45° to 60°. Each blade rotates in the same direction, allowing a greater volume of airflow to be redirected into the elbow, following the angle of the blades.

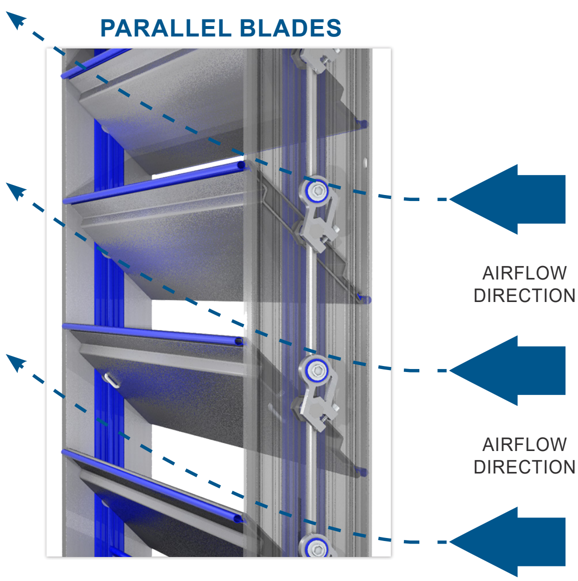
Opposed blade dampers are a less suitable choice for this type of application, because the blades cannot be set to direct airflow at an optimal angle. Regardless of the blade angle, air will travel in a linear direction as it passes through the blades and continues downstream towards the elbow. Opposed blades also condense air and reduce the amount of airflow.

DAMPER INSTALLED UPSTREAM OF AN ELBOW

OPPOSED BLADES



PARALLEL BLADES



Conclusion

If there is one lesson to be gleaned from this white paper, it should be this:

Your choice of blade operation can have a significant impact on how effectively and efficiently your system will function.

There are cases where the parallel blade damper will work best and cases where an opposed blade damper will work best. There are also cases where one will work as well as the other.

Parallel blades change the airflow's direction from its original path. Thus, parallel blade dampers are the best choice when you need to redirect the airflow, such as in a mixing box or directly upstream of an elbow. They also should be used when the controls are set up for a linear application, but should not be used in a curved application.

If air leakage is a concern, verify the manufacturer's leakage data to determine if leakage rates are different for their parallel and opposed blade dampers. Although leakage rates are the same for TAMCO parallel and opposed blade dampers, they do differ for some manufacturers' brands.

Opposed blade dampers function at peak when they are open between 45 and 90 degrees. Unlike parallel blade dampers, opposed blades compress air as it travels through the blades and continues downstream in the same direction. If linear airflow is required and the damper operates at over 50% open, then opposed blades are the most suitable choice.

Opposed blade dampers require a control signal that works off a curved line to produce predictable airflows. If torque requirements are an important consideration, one should note that opposed blade dampers generally require less torque to operate, possibly up to 35 percent less.

Making the right selection between parallel blade or opposed blade operation will result in more precise airflow control and improved air supply. Taking into consideration current rising energy costs, selecting the optimal blade operation is more important than ever, as it will pay dividends in energy and cost savings.