TECH TIP # 48

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

Understanding Multi-Leaf Dampers

Air valves or dampers are common items in an air conditioning contractor's daily life. Scores of dampers may be fabricated and installed in a single system.

But very often it's the familiar things about us that we take for granted; that we know least about; or many times forget about.

Because the job performed by a damper in a duct is so essential to the success of the air conditioning system, damper characteristics should be thoroughly familiar to us all.

Varied Types for Varied Jobs

Dampers regulate air flow. Motorized dampers are used to mix in fixed proportions of outdoor air and recirculated air, or blend the hot and cold decks of a dual-duct system. More simply, manual dampers may be used to balance air quantities through several runs of duct to compensate for variations in design. These are but a few examples.

In small systems, a simple, single-leaf damper is often used. Frequently, in those instances, pressure and flow characteristics are relatively unimportant. To regulate air volume in large ducts and in situations where space, minimum turbulence or close control are important, multiple-leaf dampers are selected.

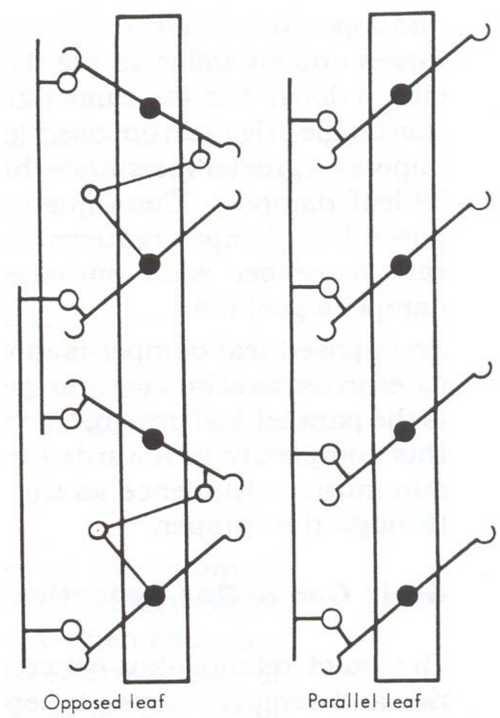

Figure 1. Multiple-leaf dampers are of two types - opposed and parallel blades. Each has specific flow characteristics.

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Figure 1 illustrates the two classes of multiple-leaf dampers - on right the parallel-leaf, the opposed-leaf design. In a few moments we'll see that each has distinctly different flow characteristics.

Pressure Loss is Key to Flow Control

A damper controls the air flow rate by adding resistance to the duct system. Wide open, both parallel and opposed-leaf dampers impose the same resistance. The pressure loss, or the added resistance that the fan must overcome by the installation of a damper, is approximately equal to 0.5 times the velocity pressure inside the duct just ahead of the damper. That is:

$$PL = 0.5\ (V/4005)^2 \text{ where V is the duct velocity in fpm.}$$

This relationship applies when the damper frame is the same size as the duct. Thus, a wide open multiple-leaf damper placed in an air stream moving at 1500 fpm would impose a resistance of $0.5\ (1500/4005)^2$ or 0.07 in. WG.

While the pressure loss for both parallel and opposed leaf dampers starts out equal, losses quickly differ as the dampers are closed down. For the same damper position (angle of leaf) an opposed leaf damper imposes a greater resistance than a parallel leaf damper. Consequently, an opposed-leaf damper reduces the air flow rate more per each movement of the damper's position.

An opposed-leaf damper is more complicated in terms of linkage arrangement than the parallel-leaf design. But the cost of this complexity is rewarded in terms of minimizing turbulence as the air moves through the damper.

Goal: One to One Reduction

The exact relationship between air flow rate and damper position is dependent on the ratio of the initial resistance of the damper (wide open position) divided by the resistance imposed by the duct system. Generally as the value of this ratio increases damper resistance becomes a greater percentage of the total) smaller damper movements are needed to affect the air flow rate.

For example: Figure 2 shows two curves relating to damper position (horizontal scale) and air flow rate (vertical scale).

Curve 1 represents typical flow characteristics for a parallel-leaf damper when the ratio of damper resistance to system resistance is small -- about 1 to 2 percent. Note that the damper must be closed down about 30 degrees (from the 90 degree wide open position to the 60 degree setting) before initiating any significant effect on the air flow rate. In other words, more than a third of the effective damper movement is useless. The situation might be compared to the "free pedal travel" common in automobile brakes. The first three quarters of an inch of pedal movement produces no braking effect at all.

Curve 2, on the other hand, shows a nearly linear relationship between air flow and damper movement. A 30 degree closing in this case (90 degrees to 60 degrees) would reduce the air flow rate by nearly 30 percent (70 percent verses 100 percent of total flow.)

For parallel-leaf dampers this type of characteristic curve occurs when the initial (wide open) damper resistance is between 20 and 30 percent of the toal duct system resistance.

The flow vs. damper setting curves for opposed-leaf dampers can be achieved when the damper's initial resistance is from 2 to 5 percent of the total system loss. Thus, we note that for the same damper to system resistance ratio, opposed-leaf dampers provide better control characteristics.

Damper Teams need Linear Control

Flow problems are compounded when two dampers are linked mechanically together in such a way that when one damper is open, the other is closed. Such an arrangement is often used in return air/fresh air intake connections, and face and bypass coil designs. If the dampers have non-linear characteristics similar to curve 1 in Figure 2, then the intended proportioning of the two air streams, say return air and outdoor air, may not be realized. It would be impossible, for instance, to maintain constant air flow in a system with equal sized dampers having flow control characteristics of curve 1.

The solution is to design a system that provides linear flow control. And as we have indicated, this occurs for parallel-leaf dampers when the damper itself represents 20 to 30 percent of the system's resistance. For opposed-leaf dampers, the resistance must range from 2 to 5 percent. Under these circumstances a contractor can be confident that damper position has a meaningful and predictable effect of system air flow rates.

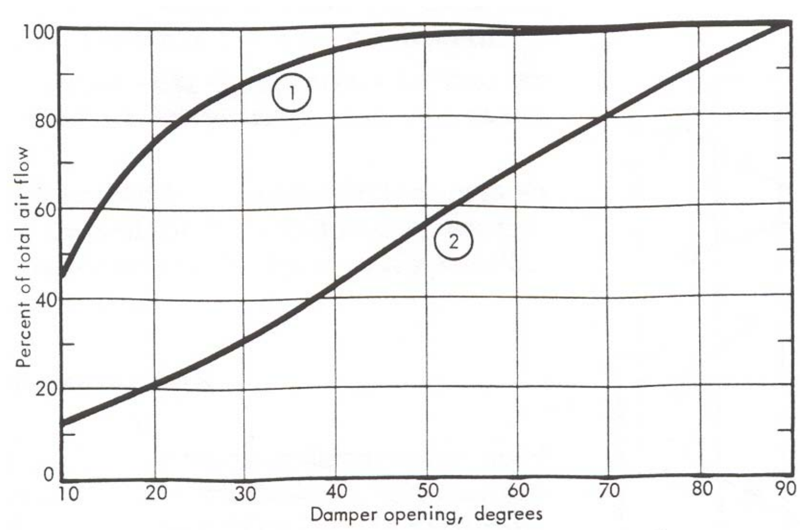

Figure 2. How well damper controls air flow depends on the ratio of damper's resistance (in wide open position) to that of the duct system. Parallel-leaf damper has characteristics of curve 1 when damper's resistance is 1 to 2 percent of total system loss. Preferred traits of curve 2 are obtained when damper represents 25 to 30 percent of total resistance. For opposed-leaf damper, best performance occurs when resistance is from 2 to 5 percent of total.