Comparison of Inlet and Outlet Dampers

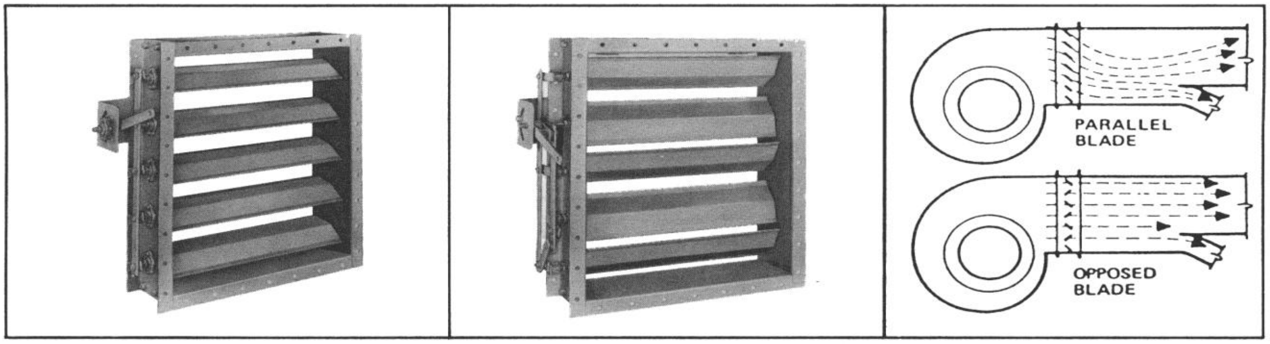


Fig. 3. Above left: Parallel blade outlet damper. This design is particularly effective on continuous process systems where sensitive control of air volume between wide open and 70 or 80 percent open is desired.

Fig. 4. Above center: Opposed blade outlet damper. Units of this type are often used where a straight line relationship between fan volume and control arm swing is desired. Alternate blades turn in opposite directions; resulting change in airflow volume is almost exactly proportional to amount of control arm swing.

Fig. 5. Above right: Airflow pattern through the two basic types of outlet dampers. Opposed blade version is usually selected when even distribution of airflow is required downstream.

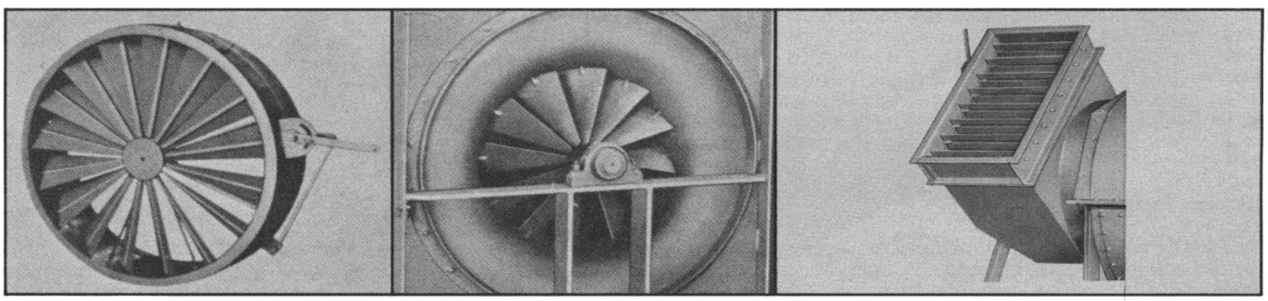


Fig. 6. Above left: External inlet damper. Units of this type are a complete assembly, supplied separately and mounted externally to structure. Damper vanes are connected to central hub through pivot bearings.

Fig. 7. Above center: Internal inlet dampers are integrated into the inlet cone providing considerable space savings and simplicity of installation.

Fig. 8. Above right: Photo of inlet box and mounted inlet box damper - angle of blades will create a vortex at the fan wheel to control flow.

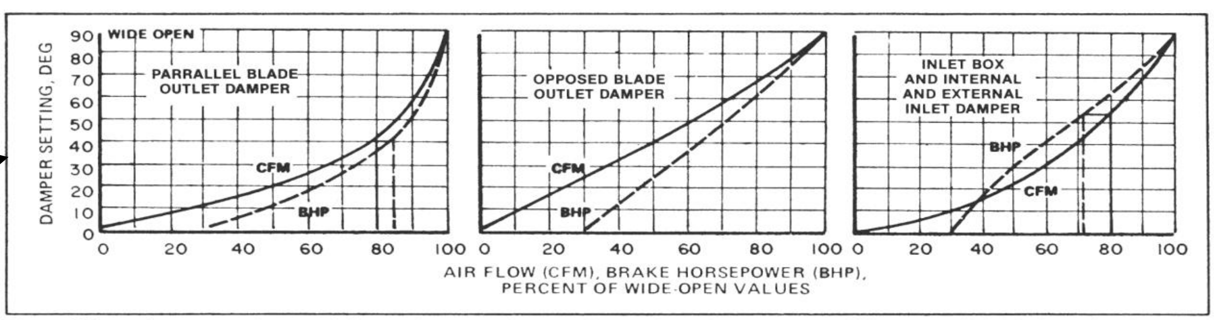


Fig. 9. Effect of vane setting on airflow volume and power for various damper types. When parallel blade outlet damper is set for 80 percent of wide open capacity, the damper setting is 40 degrees, and the fan operates at 85 percent of wide open horsepower. With an inlet damper, however, operation of 80 percent of wide open requires a 53 degree damper setting and 72 percent of the horsepower. Note: These curves are representative, not precise. See text.

These three graphs can be useful in estimating airflow

Fig. 10 COMPARISON OF INLET AND OUTLET DAMPERS				
	Parallel Blade Outlet Damper	**Opposed Blade Outlet Damper**	**External and Internal Inlet Dampers**	**Inlet Box Damper**
1. Cost	Least costly.	1.1 to 1.2 times as much as parallel blade	Internal - 1.5 to 2.5 times as much as parallel blade. External - 3 to 4 times as much as parallel blade.	1.3 to 1.4 times as much as parallel blade; combined with inlet box 3 to 4 times as much as parallel blade.
2. Control	Best for full open or closed requirements or for fine control between 80% to 100% of full flow.	Best for systems where air volume is changed over a wide range and a straight line relationship of volume to control arm swing is desired.	Same as opposed blade outlet damper.	Used on fan inlet box. Can be used with some particulate in airsteam.
3. Horsepower savings	**Depends upon characteristic BHP curve: Backwardly inclined - same, more, or less than wide open FC and Radial - less than wide open**		Power Consumption at reduced air volumes is less than with outlet dampers.	Same as inlet damper.
4. Air flow after fan	Throws air to one side.	Distributes air evenly.	No effect.	No effect.

Combined Inlet and Outlet Dampers

Occasionally it is desirable to save more power at reduced capacity while maintaining very sensitive control. In this case, the fan may be equipped with both inlet and parallel blade outlet dampers. With the outlet damper set at wide open, the inlet damper is set to give just slightly more air than needed. Exact air delivery is obtained by adjusting the outlet damper. Because of the great movement of the outlet damper vanes required to achieve a slight change in air delivery, this combination gives the most sensitive control.

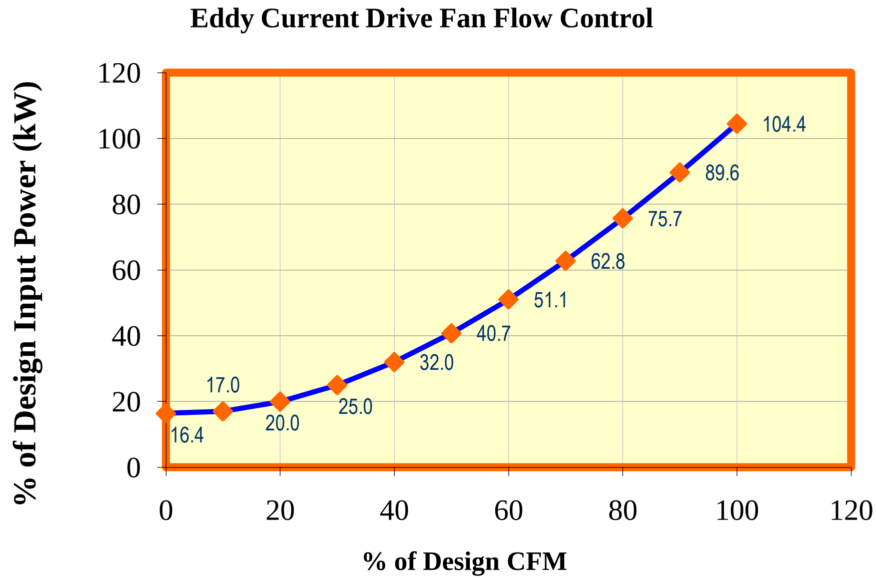
Performance Comparison

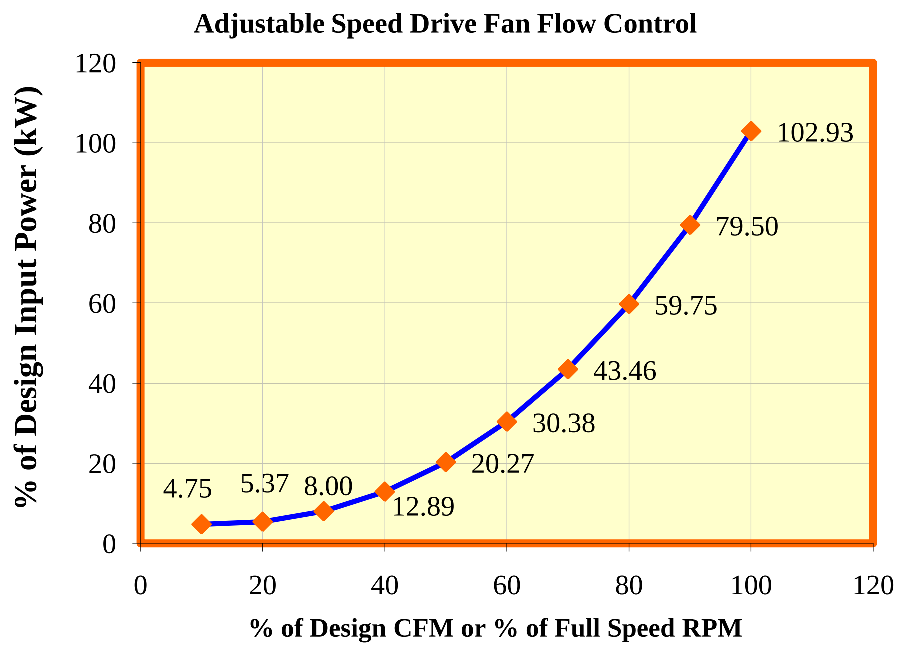
Figure 9 on page 3, shows the effects of damper settings on airflow and brake horsepower for parallel and opposed blade outlet dampers, and inlet box and inlet dampers. These plots represent generalizations of damper effect on fan performance. They should be used to compare one type to another. For more accurate dampered effect data contact the fan manufacturer.

Summary

Each system has its own requirements with respect to the control of air volume. Today system designers are not only aware of first cost considerations but, more importantly, of the long term savings that can be obtained by a properly engineered system. Obviously each system imposes limits on which dampers can be selected with respect to fumes, control sensitivity and temperature. No one system is best for all applications. Therefore, this article offers some insight into the choices available in making the appropriate selection of dampers for most applications. The table, **Figure 10**, acts as a partial check list in helping the designer to recognize some of the factors to be considered in damper selection.

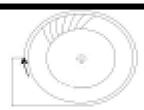
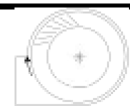
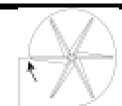
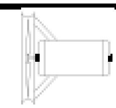
Fan Drives Power Graphs





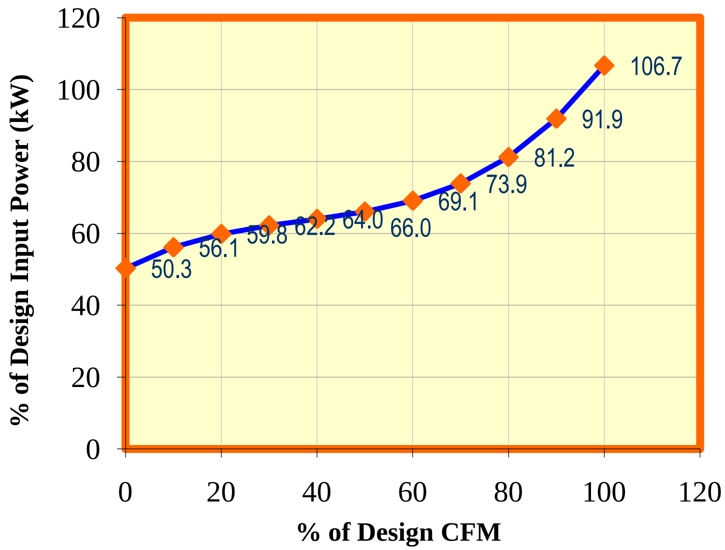
The power curves above are used in the energy savings analysis. Curves developed from data obtained by measuring the operating characteristics of various fan systems and from information provided in "Flow Control", a Westinghouse publication, Bulletin B-851, F/86/Rev-CMS 8121. Curves are representative, not precise,

Common Fan Types

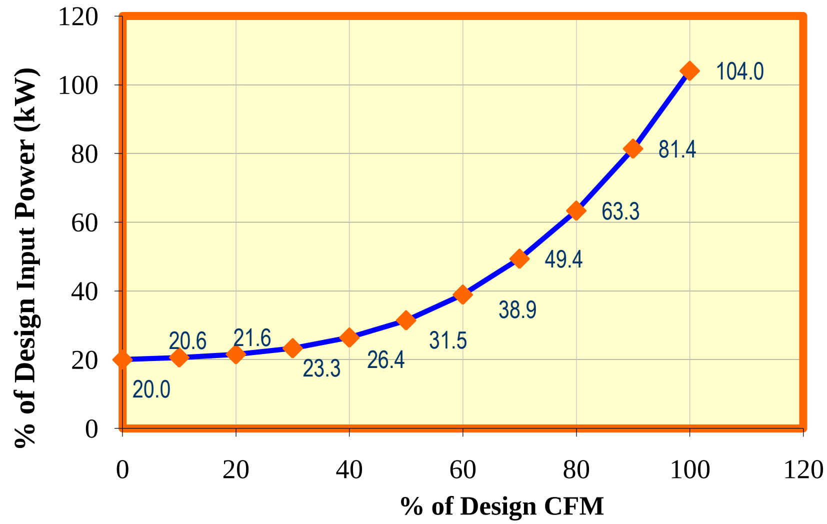
	(FC) Forward-Curved Fans	(BI) Backward-Inclined Fans	Radial-Blade Fans	Axial Fans
				
Descriptions and Fan Efficiencies	The fan blades curve in the direction of rotation. These fans are typically not as large as other fan types and structurally are not very rugged. Fan efficiencies are in the range of 55 to 65%.	The fan blades tilt back, away from the direction of rotation. The main difference between fans in this category is the shape and construction of the blades. The Backward-Inclined Flat blades tend to be more rugged and allow some particulate to pass through but these blades are not very aerodynamic and therefore are the least efficient. The Backward-Inclined Curved blades are more efficient but their orientation with the air stream can allow moisture and particulate to collect on the blades which reduces fan performance and may cause excessive vibrations. The efficiency ranges from 75 to 85%. The Backward-Inclined Airfoil blade resembles the wing of an aircraft and is the most efficient fan type with efficiencies over 90%.	These fans are typically the most rugged of all types and can range from Paddle-Wheel design to Flat Blades with corrosion resistance coatings. These fans usually operate at lower volumes but higher pressures than other fan types. The wide openings between the blades allow larger material to pass through and also minimizes vibrations when operating during conditions when the flow and pressure drops. The construction of these fans allows them to be modified to meet specific applications and to be repaired at minimum costs. Typical ranges of fan efficiencies for Flat Blades is 55 to 65% and 60 to 75% for the Radial Tip.	This fan group includes Propeller, Tubeaxial, and Vaneaxial fans. The fan blades are installed perpendicular to the air stream. The majority of these fans can be operated in reverse which allow them to supply or exhaust the air. Propeller fans generate high airflows but minimum pressure and are the least expensive and least efficient. To increase the pressure and efficiency these fans are placed inside a hollow tube to form the Tubeaxial fan. To further increase the efficiency and develop a more unified air stream, outlet vanes are installed to form the Vaneaxial fan.
Performance Characteristics	The typical performance curve for a Forward Curved fan contains a dip in the static pressure curve to the left of the point of maximum static pressure. This region of the performance curve indicates that the characteristics of the air flow through the fan was not consistent. As the flow increases, the static pressure increases and decreases within this region. It is not recommended to operate the fan within this unstable region of the fan curve due to the unpredictable flow characteristics. This area is sometimes referred to as the "stall" region.	The fan performance curve for Backward Inclined fans is similar to the forward curve but typically has a smaller dip in the static pressure curve. The major difference of the backward inclined fans is the characteristics of the BHP curve. The horsepower curve does not increase to a maximum amount at maximum flow rate but instead will reach a peak and then drop off as the flow rate continues to increase to it's maximum amount. This characteristic allows the designer to select a motor size for the worst case(design) conditions and if any errors or changes occur that would increase the flow requirements, the fan will not be overloaded. This is typically referred to as a "non-overloading" power curve.	The performance curve for fans with Radial Blade wheels is typically a smooth curve showing the pressure steadily dropping from a maximum at zero flow to a minimum pressure at full flow. This characteristic allows stable operation of the fan throughout a wide range of flow(cfm) by adjusting the pressure. The corresponding BHP curve increases at a linear rate as the fan flow rate increases. The Radial Tip fan performance curve is a blend of the Backward-Inclined and Radial Blade curves. The BHP curve increases to a maximum amount at maximum flow. The Radial Tip is more efficient than the Radial Blade and therefore requires less horsepower to produce the same output.	The fan performance curve for this group of fans indicates that they are capable of providing high flow rates at lower pressures than other fan types. These fans will typically have a unique BHP curve that requires maximum power at zero flow rate. The horsepower and static pressure will increase and decrease as flow increases until finally reaching a minimum value at maximum flow rate. These variations in flow and pressure result in different flow rates at the same operating pressure, causing instability and control problems. Operating within this region should be avoided.
Applications	Due to the narrow openings between fan blades, these fans are not suited for airstreams containing particulate. These fans usually operate at low volumes and low speeds such as in residential HVAC units.	As stated above, these fans are typically "non-overloading" and this characteristic makes them a popular choice for applications were the system performance is uncertain at maximum flow rates. The inside of these blades are usually hollow to reduce their weight but the build up of moisture and particulate can lead to cavities which reduces their efficiency. The narrow openings can limit the size of particulate in the air stream they can tolerate. These fans are a good choice for installations on the clean side of the process air stream for material and dust handling systems and for forced-draft fans in boilers.	These fans are the fans of choice for moving material or air in harsh operating environments. They are used to convey everything from air filled with particulate to wood chips, rock or metal scrap	Propeller fans are common on cooling towers and inexpensive exhaust systems. Tubeaxial and Vaneaxial fans are used in HVAC exhaust applications were higher pressures and flow rates are required. All of these fans produce significant airflow noise when compared to other fans.

Reference: "Improving Fan System Performance" Industrial Technologies and Best Practices Web Site at: http://www.oit.doe.gov

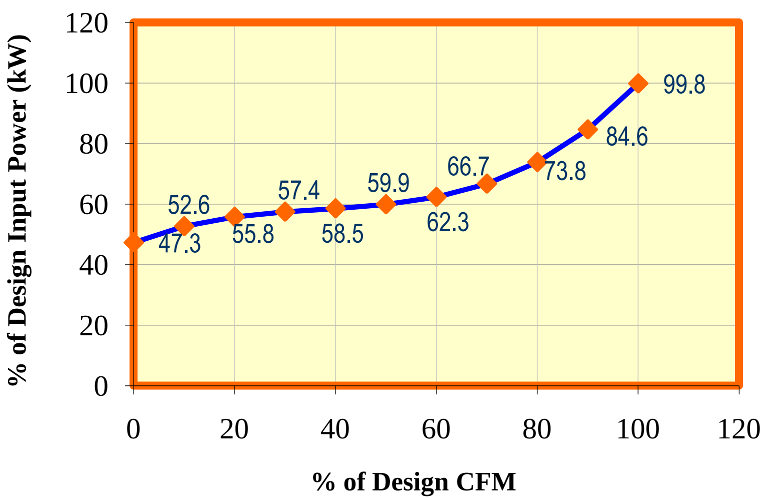
Inlet Damper Box, General Curve



Inlet Guide Vane Control, Forward Curve Fans



Inlet Guide Vane Control, BI & Airfoil Fans



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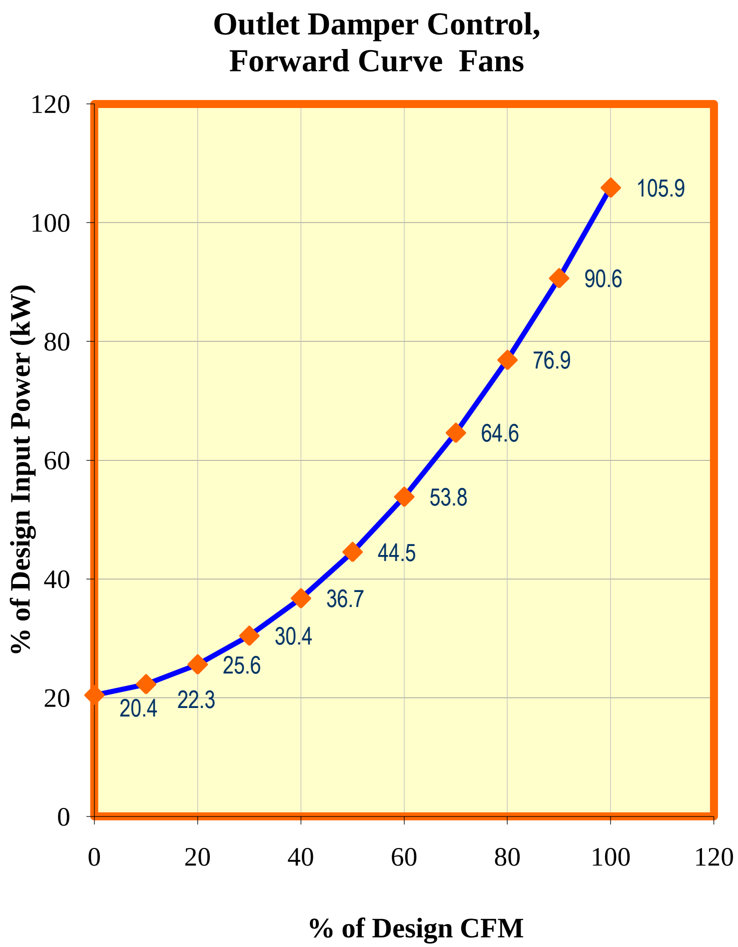

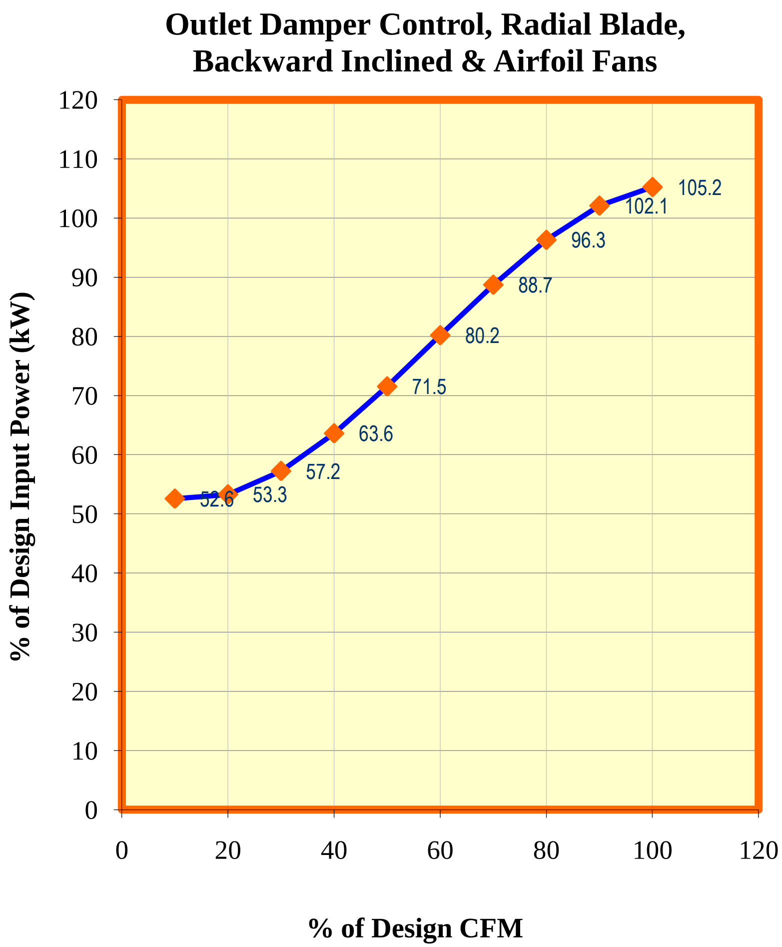

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