The Benefit of AMCA-Certified Performance When Analyzing Induced Flow Laboratory Exhaust Fan Systems

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In 2005, the Air Movement and Control Association International (AMCA) — at the request of industry consultants and laboratory end-users — initiated an AMCA standards and certification committee to quantify the air entrained and total air discharged from high plume dilution, induced flow fan blowers. This article explains how looking for AMCA certification on air movement products can help assure that they'll meet necessary efficiency and performance requirements.

Keeping air moving is critical for laboratories and other facilities to function safely and efficiently. Installing fans and exhaust systems with third-party certification ensures that units meet established industry standards. This system, installed at the Kansas Life Sciences Innovation Center, Kansas City, KS, bears the Air Movement and Control Association International (AMCA) seal.

Independent, third-party verification of ventilation system components is valuable in ensuring performance and safety. This is especially true for critical lab exhaust systems. The AMCA, a not-for-profit association of industry manufacturers, is considered the world's leading authority on the engineering of air movement and air control devices. The organization certifies induced flow fan air and sound performance based on two established testing standards:

- AMCA Standard 260-7, *Laboratory Methods of Testing Induced Flow Fans for Rating*.
- American National Standards Institute (ANSI) / AMCA Standard 300-08, *Reverberant Room Method for Sound Testing of Fans*.

The AMCA 260 and 300 certified rating seals ensure a laboratory fan system will perform as stated by the manufacturer and as required for a project.

Comparing Lab Exhaust System Efficiencies

Fan efficiencies are evaluated and compared by calculating the static efficiency of a fan at an operating point. Fan static efficiency relates the cubic feet per minute (cfm) of air moved by the fan at a given static pressure, versus the energy required to do so.

Equation 1

The calculation for fan static efficiency is:

$$Eff_S = \frac{cfm \times P_S\,(in.\,wg)}{6{,}356 \times Bhp}$$

In fan application engineering, it is generally accepted that airfoil blade housed centrifugal blowers are the most efficient fan designs available, with maximum attainable static efficiencies of approximately 80 percent. For inline mixed flow fans, the peak static efficiency is about 75 percent.

When evaluating and comparing lab exhaust fan efficiencies, other exhaust system components (such as discharge stacks and nozzles) need to be considered, regardless of whether the systems being evaluated are field-built or factory provided. Typically, all lab exhaust systems utilize a discharge stack and a high velocity discharge nozzle, which increase momentum of the exhaust air, dispersing contaminants high above the roofline. This high velocity discharge benefit is accompanied by the cost of increased horsepower.

Equation 2

The pressure loss associated with any high velocity discharge is equal to the velocity pressure at the discharge:

$$P_v = \left(\frac{\text{Velocity (ft./min.)}}{1{,}096}\right)^2 \times \text{Density (lb./ft.}^3\text{)}$$

Or at standard air:

$$P_v = \left(\frac{\text{Velocity (ft./min.)}}{4{,}005}\right)^2$$

For a field-built lab exhaust system, the stack and nozzle static pressure loss is not included in the fan manufacturer's performance data and must be added to the fan inlet static pressure in order to appropriately size the fan. For a factory-provided system (induced high plume flow fan), this loss typically is included in the manufacturer's performance data, and only the inlet static pressure is used to size the fan.

Accurate analysis comparing fan system static efficiencies requires the inclusion of the high velocity nozzle pressure loss. To calculate the static efficiency of induced flow fans, the nozzle pressure loss must be added to the inlet static pressure.

Comparing Induced Flow Fan Efficiencies

Induced flow lab exhaust fan systems can be categorized into two groups:

- Induced flow inline mixed flow fan systems. (Figure 1)
- Induced flow housed centrifugal fan systems. (Figure 2)

Figure 1

Induced Flow Inline Mixed Flow Fan Systems.

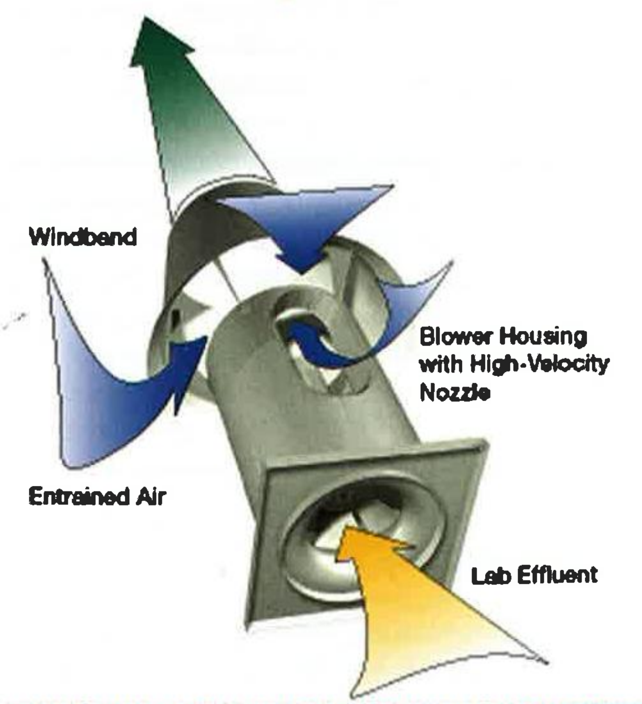
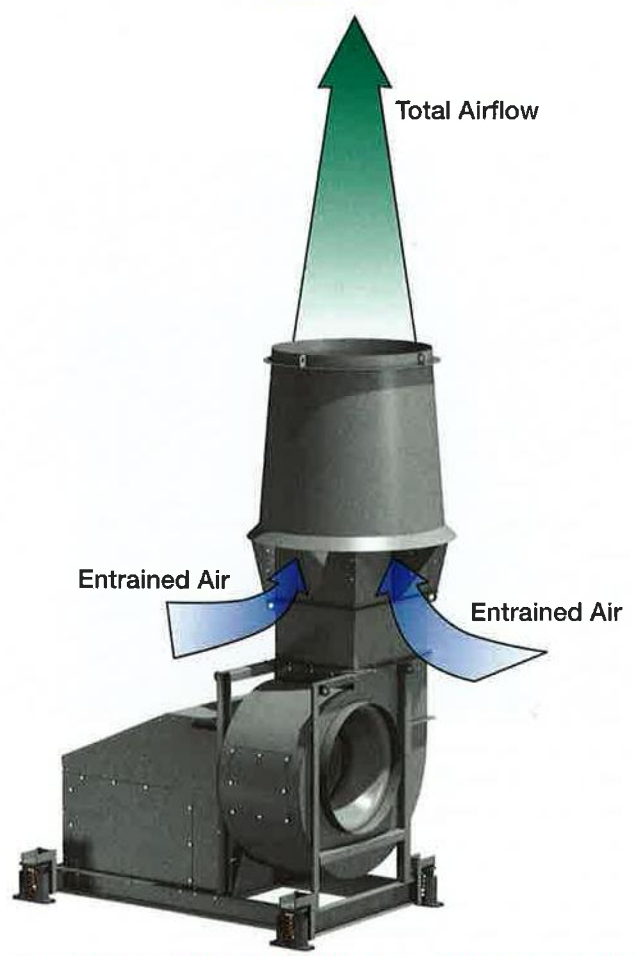


Figure 2

Induced Flow Housed Centrifugal Fan Systems.



Due to the rising concern for sustainability and energy consumption issues, evaluating several lab exhaust system fan types, and their performance with respect to fan static efficiency, is important. Comparing and evaluating systems also demonstrates the benefit of AMCA-certified performance.

For this example, three fan types are compared:

1. Centrifugal (Induced Flow)
2. Inline Mixed Flow (Induced Flow)
3. Inline Mixed Flow #2 (Induced Flow)

The following induced flow lab exhaust system performance requirements used for this analysis come from actual project documents.

Lab Exhaust Flow (cfm)	System Static Pressure (Ps) in. wg	Nozzle Velocity (ft/min)
35,524	6	6,665

In order to calculate the static efficiencies of the three fan systems, we must calculate the static pressure loss of the high velocity nozzle per Equation 2. This pressure loss is added to the system static pressure to calculate the fan static efficiency (Equation 1).

Table 1: Comparing three fans according to manufacturer-provided performance data (framed in bold).

Analyzing the Information

Table 2 provides additional information about the selected fans. Calculating the static efficiencies for each fan reveals that:

- Fans 1 and 2 have efficiencies that are commonly accepted and fall within usual application acceptance. These efficiencies fall below the maximum of 80 percent for housed airfoil centrifugal fans and 75 percent for inline mixed flow fans respectively.
- Fan 3 has a static efficiency that exceeds the possible maximum of 75 percent for inline mixed flow fans. How can this be?

Table 1

Comparing three fans according to manufacturer-provided performance data (framed in bold).

Fan	Fan Type	CFM	SP	Nozzle Velocity	Entrained Air (cfm)	Outlet Flow (cfm)	Bhp
1	Centrifugal (Induced Flow)	35,524	6	6,665	29,130	64,654	68.5
2	Inline Mixed Flow (Induced Flow)	35,524	6	6,665	39,787	75,311	81.5
3	Inline Mixed Flow #2 (Induced Flow)	35,524	6	6,665	36,945	72,469	56.6

Table 2

Fan	Fan Type	Entrained Air (cfm)	Outlet Flow (cfm)	Bhp	Static Efficiency	AMCA Certified Performance
1	Centrifugal (Induced Flow)	29,130	64,654	68.5	71.80%	Yes
2	Inline Mixed Flow (Induced Flow)	39,787	75,311	81.5	60.10%	Yes
3	Inline Mixed Flow #2 (Induced Flow)	36,945	72,469	56.6	86.50%	No