PRODUCT APPLICATION

A technical bulletin for engineers, contractors and students in the air movement and control industry

An Analysis of Induced Flow Laboratory Exhaust Fan Systems and the Benefit of AMCA 260 Certified Rating Performance

Independent third party performance verification of ventilation system components is valuable in ensuring performance and safety. This is especially true for critical lab exhaust systems. The Air Movement and Control Association International Inc. (AMCA) certifies induced flow fan air and sound performance based on two established testing standards:

- AMCA Standard 260-20, *Laboratory Methods of Testing Induced Flow Fans for Rating.*
- ANSI/AMCA Standard 300-14, *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 cfm moved by the fan at a given static pressure versus the energy required to do so.

The calculation for fan static efficiency is:

Equation 1:

$$\mathrm{Eff}_S = \frac{\text{cfm} \times P_S \text{ (in. wg)}}{6{,}356 \times \text{Bhp}}$$

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%. For inline mixed flow fans the peak static efficiency is about 75%.

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

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

Equation 2:

$$P_V = \left(\frac{\text{Velocity (ft/min)}}{1096}\right)^2 \times \text{Density (lb/ft}^3\text{)}$$

or at standard air,

$$P_V = \left(\frac{\text{Velocity (ft/min)}}{4005}\right)^2$$

For a field built-up lab exhaust system, the stack and nozzle static pressure loss is not included in the fan manufacturer's performance data. It 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 is typically 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.

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)

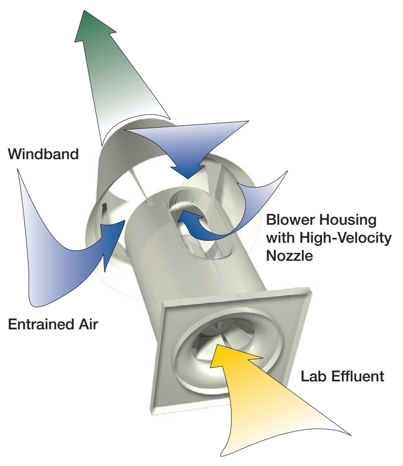

Figure 1: Induced flow inline mixed flow fan

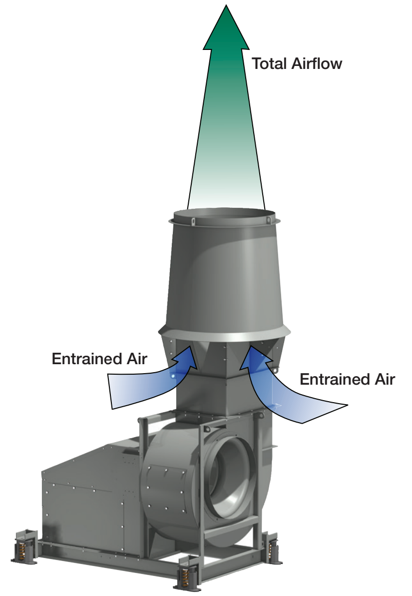

Figure 2: Induced flow housed centrifugal fan

Comparing Induced Flow Fan Efficiencies

Due to the rising concern for sustainability and energy consumption issues, it is important to evaluate several lab exhaust system fan types and their performance with respect to fan static efficiency. The following three fan examples will also demonstrate the benefit of AMCA Certified Ratings performance.

Fan types for comparison:

Fan	Fan Type
1	Centrifugal (Induced Flow)
2	Inline Mixed Flow (Induced Flow) "A"
3	Inline Mixed Flow (Induced Flow) "B"

The following induced flow lab exhaust system performance requirements used for these examples are from actual project documents, shown below.

Lab Exhaust Flow (cfm)	System Static Pressure (P_S) 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 shows the selection of fans. It includes each fan's performance, based on the manufacturer's data, framed in light blue.

Based on the manufacturer's data, Fan 3 has the high entrained flow and lowest brake horsepower.

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

Fan 1 and 2 have efficiencies that are commonly accepted and fall within usual application acceptance. These efficiencies fall below the maximum of 80% for housed airfoil centrifugal fans and 75% for inline mixed flow fans respectively.

Fan 3, however, has a static efficiency that exceeds the possible maximum of 75% for inline mixed flow fans. How can this be?

Table 1

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	Mixed Flow Induced Flow "A"	35,524	6	6,665	39,787	75,311	81.5
3	Mixed Flow Induced Flow "B"	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	71.8%	**Yes**
2	Mixed Flow Induced Flow "A"	39,787	75,311	81.5	60.1%	**Yes**
3	Mixed Flow Induced Flow "B"	36,945	72,469	56.6	86.5%	**No**

Assuming Fan 3 can exhaust the required 35,524 cfm at 6 inches static pressure from the building, the stated performance in question is the entrained airflow and nozzle velocity. Further investigation reveals Fan 1 and 2 have AMCA 260 certified rating performance. Fan 3 is not AMCA 260 performance certified and therefore has NO independent third-party performance verification. An additional indication that something is in error with this manufacturer's performance data is the very low brake horsepower of Fan 3.

This example demonstrates and reinforces the benefit of AMCA Standard 260 independent, third-party testing and certification.

Conclusion

To be assured that fan performance is factual for critical lab exhaust applications utilizing induced flow fans, be sure to specify fans and fan systems that have AMCA (third-party) certified performance ratings. The ratings are based on testing in accordance with AMCA 210 for standard fans and AMCA 260 for induced flow fans. AMCA certified ratings ensure that the product performs as tested and documented by the manufacturer.

Caution must be taken when using products with performance data that is not verified by an independent third-party (AMCA).

References:

2004 ASHRAE Handbook, HVAC Systems and Equipment, Chapter 18; American Society of Heating, Refrigeration and Air Conditioning Engineers

ANSI/AMCA Standard 210-16, ANSI/ASHRAE 51-16, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.*

AMCA Standard 260-20, *Laboratory Methods of Testing Induced Flow Fans for Rating,* Air Movement and Control Association International, Inc.

About AMCA

The Air Movement and Control Association International, Inc. (AMCA) is a not-for-profit international association of the world's manufacturers of related air system equipment — primarily, but not limited to: fans, louvers, dampers, air curtains, airflow measurement stations, acoustic attenuators, and other air system components for the industrial, commercial and residential markets.

AMCA International, backed by almost 80 years of standards development, is the world's leading authority in the development of the science and art of engineering as relates to air movement and air control devices. AMCA International publishes and distributes standards, references, and application manuals for specifiers, engineers, and others with an interest in air systems to use in the selection, evaluation, and troubleshooting of air system components.

AMCA International, with member companies and laboratories in many industrialized countries around the world, is active on the technical committees of the International Standards Organization (ISO), and participates in the development of international standards for the industry.

AMCA 260 Standard

In 2005, at the request of industry consultants and laboratory end users, AMCA initiated an AMCA standard and certification committee to quantify the air entrained and total air discharged from high plume dilution, induced flow fan blowers.

Both the Greenheck Vektor®-MD and Vektor®-CD fans have certified performance and are licensed to bear the AMCA seal.

Summary of AMCA Standards and Certification Programs

- AMCA 210 - Fan Air Performance Test Standard
- AMCA 211 - Certified Fan Air Performance Ratings Program
- AMCA 260 - Induced Flow Test Standard and Certified Fan Performance Ratings Program
- AMCA 300 - Sound Testing Standard
- AMCA 311 - Certified Sound Ratings Program

AMCA Specification & Clarification

How your specifications are written is critical to ensure you receive AMCA licensed equipment on your projects.

Incorrect: "Laboratory exhaust fan systems shall be tested in accordance with AMCA Standard 210 or 260."

This statement basically states that fans shall be tested in accordance with an AMCA Standard, but does not state that the performance be certified and the fans are AMCA Licensed.

Correct: "Laboratory exhaust fan systems shall be tested in accordance with AMCA Standard 210 or 260, and are licensed to bear the AMCA Certified Ratings Seal."

This statement states that fans shall be tested in accordance with an AMCA Standard, performance be certified and bear the AMCA Ratings Seal.

P.O. Box 410 • Schofield, WI 54476
Phone: 715.359.6171 • greenheck.com