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LABORATORY METHODS OF TESTING INDUCED FLOW FANS FOR RATING, THE DEVELOPMENT OF AMCA STANDARD 260-07

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LABORATORY METHODS OF TESTING INDUCED FLOW FANS FOR RATING

THE DEVELOPMENT OF AMCA STANDARD 260-07

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Abstract

AMCA Standard 260-07 – Laboratory Methods of Testing Induced Flow Fans for Rating is a newly created standard that establishes a uniform method of test for a category of specialized fans called induced flow fans. This test standard and the associated Certified Ratings Program (CRP) were created to satisfy the needs of professionals involved in the design of laboratory or hazardous exhaust air systems. These professionals required detailed and accurate fan performance data to use in numerical and wind tunnel air quality assessments.

Introduction

An Induced Flow Fan is defined in this Standard as a housed fan where outlet airflow is greater than its inlet airflow due to induced airflow through an outlet nozzle and a windband.

The outlet nozzle on an Induced Flow Fan is specially designed to create a high velocity jet from the inlet airflow that when combined with a windband induces ambient air to create a larger volume of diluted air that is discharged out the top of the windband.

Generally, these types of fans are installed in laboratory or hazardous exhaust air systems and are used as an alternative to a traditional centrifugal or axial fan that exhausts into a tall stack. Induced flow fans do not require a stack, but use large volumes of high velocity air to achieve an "effective stack height".

In order to accurately design systems using induced flow fans, design professionals need complete and accurate performance data. During the ASHRAE 2005 winter meeting, a technical seminar titled "Should Induced Flow Fans be Certified?" was presented. At this seminar, the principal of an

independent consulting firm specializing in wind and airflow analysis raised several issues.

A primary concern was the need for accurate values to input into numerical and wind tunnel models for air quality assessments. Specifically, the consultants needed accurate windband airflow and either windband velocity or windband diameter.

Although AMCA certified ratings and standardized test procedures already existed for inlet flow, they did not exist for airflow exiting the windband. In the absence of an industry accepted test standard, manufacturers used different methods of testing and calculating outlet airflow. This made comparing data of different manufacturers and determining the correct parameters needed for modeling difficult.

Facing these issues, several manufacturers contacted AMCA about developing a standardized test method.

Development of the Test Standard and Certified Ratings Program

Based on feedback from its members, the AMCA Board of Directors authorized the formation of a committee to develop a standardized test procedure and Certified Ratings Program for Induced Flow Fans. The committee was formed with representatives from ten different companies, most of which were already directly involved in the manufacture and/or application of Induced Flow Fans.

Below is a brief timeline of the test standard and CRP development:

Jan 2005	ASHRAE seminar discusses potential need for certification of fume exhaust fans
Feb 2005	AMCA Board of Directors discusses the need of a CRP for these fans
Apr 2005	AMCA members request the creation of CRP for "high plume dilution nozzles"
May 4, 2005	AMCA Engineering Standards Committee recommends creation of committee
May 4, 2005	AMCA Board of Directors approves formation of committee
May 10, 2005	AMCA solicits members for "Laboratory Exhaust Fan Technical Committee"
Aug 10, 2005	Initial Committee meeting 10 members and 5 guests representing 10 companies plus AMCA staff
Dec 5, 2006	Final draft of test standard and CRP completed and approved by committee
Jan 11, 2007	Draft approved by AMCA Air Movement Division Eng Standards Committee
Feb 20, 2007	Draft approved by AMCA Air Movement Division general members
Mar 1, 2007	Effective date of AMCA Standard 260-07 and associated CRP
Aug 1, 2007	AMCA Publication 111-99 revised to include accreditation of labs for 260 testing
Oct 2007	AMCA test lab completed and commissioned for Standard 260 testing

One of the first tasks of the committee was the development of a work statement. The three primary objectives were:

- Determine the performance parameters needed by designers and equipment specifiers.

- Consider, and if determined to be required, develop a method of test to determine the required performance parameters
- Develop a revision to AMCA 211 to outline a Certified Ratings Program for Laboratory Exhaust Fans and Entrainment Nozzles

While discussing what performance parameters should be included in the program, the traditional fan performance parameters were quickly agreed upon. Inlet airflow, static pressure, fan input power and impeller speed were initially defined.

The next step was to define the parameters that were specific to Induced Flow Fans. Based on feedback from the ASHRAE seminar, outlet airflow and either outlet velocity or outlet diameter seemed to be obvious required parameters. Outlet airflow was agreed upon as a required parameter.

While discussing outlet velocity and outlet diameter, the velocity profile was also discussed. The velocity profile would be useful in determining an effective area at the outlet of the windband. The committee considered developing a method to quantify the exhaust velocity profile. A 16 hole velocity measuring probe could be used to simplify the readings, but the committee was concerned that the velocity profile would change for each operating point of the fan and may not be repeatable. After further investigation, the consensus was that using an average velocity based on outlet airflow and outlet area would be sufficient. Outlet area was then added as a required parameter.

Another parameter that was discussed at great length was crosswind effects. The committee felt that this was a very important issue, but could not conceive a test that could be performed under current lab conditions that was easily reproducible and practical. However, to emphasize the potential impact of crosswinds, the following disclaimer was included in the introduction of AMCA Standard 260:

> "The test procedures defined in AMCA Standard 260 assume a still air environment. This Standard does not include testing for downdraft within the windband or testing for the effects of crosswinds. Testing to this procedure does not imply products are safe when ventilating toxic airstreams."

The issue of testing for crosswind effects was left open for future discussions.

Developing a test method

Testing for the traditional performance parameters of inlet airflow, static pressure, fan input power and impeller speed can be accomplished using methods already defined in AMCA Standard 210. One of the methods for measuring airflow and pressure utilizes a multi-nozzle inlet chamber, which

includes a variable supply fan to regulate the operating point of the test fan. This setup is referred to as "Figure 15" and is shown below.

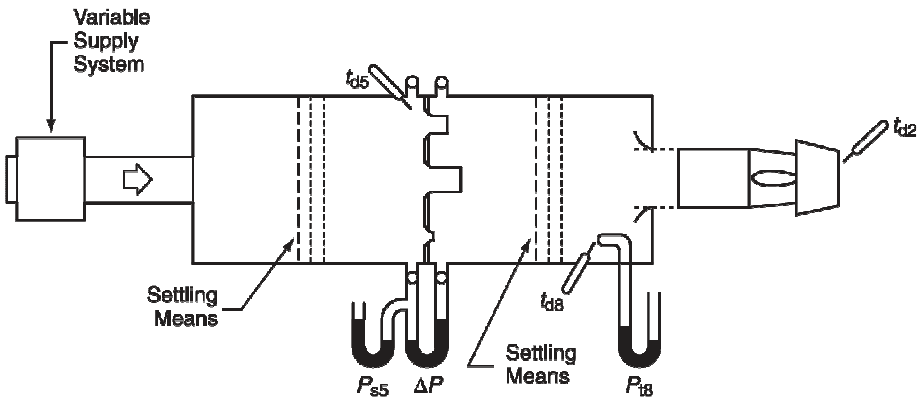


Figure 1 - AMCA Standard 210, Figure 15

The test fan's airflow is determined by measuring the pressure drop across the nozzle wall (ΔP), which correlates with the airflow. The fan's pressure characteristics are determined by reading the total pressure at the fan inlet (P_{t8}). A settling means is located upstream of the nozzle wall and total pressure tube to condition the airflow profile allowing greater accuracy of the pressure readings. Impeller speed and horsepower are typically measured using a photocell and torque cell or calibrated motor.

Defining a test method to measure outlet airflow was the next step. Several methods were discussed:

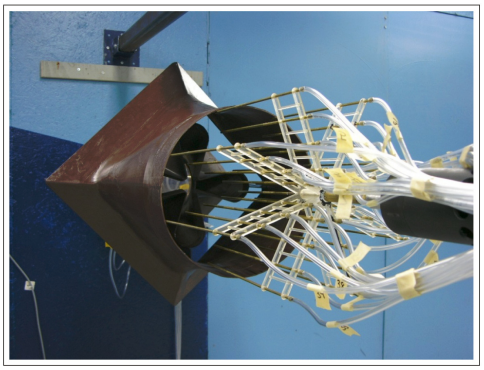
Thrust?

The option of using thrust to determine outlet airflow (and plume height) was discussed and researched extensively. Several committee members believed that this method would be preferred. Experiments were performed and it was determined that although a reasonably accurate airflow rate could be calculated from thrust, a more direct method using proven test methods would be preferred.

Induced Flow Fan mounted on plenum with side inlet

Entire system rests on a scale

Tracer gas concentrations?



This method had been used successfully by one of the committee members and was potentially a good test method, but not within the current scope of AMCA testing capabilities.

Velocity profile?

As discussed previously, due to changes in the flow pattern at different operating points, the accuracy and repeatability of this method for determining outlet flow was in question.

A new setup to directly measure airflow?

Another method was then discussed that used components of existing, proven, AMCA test setups. This option would use a standard AMCA 210 multi-nozzle test chamber (Figure 12) to measure the outlet airflow.

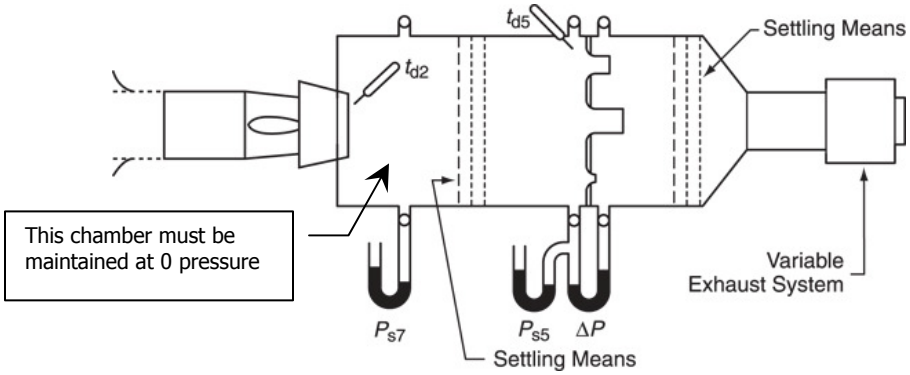


Figure 2 - AMCA Standard 210, Figure 12

In this setup, the outlet chamber pressure (P_{s7}) is always maintained at 0 pressure during the test to simulate ambient atmospheric conditions. This pressure is maintained by adjusting the variable exhaust system. As with the Figure 15 chamber above, the test fan's outlet airflow is determined by measuring the pressure drop across the nozzle wall (ΔP), which correlates with the airflow.

In order to test the outlet flow of the fan at various inlet pressures along a fan curve, a pressure control device was required on the inlet of the fan.

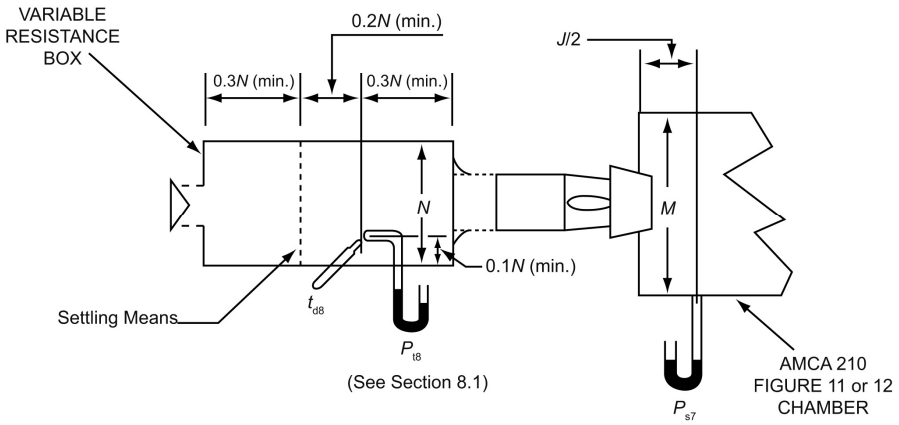


Figure 3 - AMCA Standard 260, Figure 1

This figure shows the pressure control device (variable resistance box) attached to the inlet of the fan. The various inlet pressures are obtained using dampers in the variable resistance box. This setup is defined in AMCA Standard 260 as Figure 1.

A concern was raised during discussions on this test setup, questioning the impact of discharge pressure variations on outlet flow. To accurately simulate "ambient" conditions, the pressure in the outlet chamber must be very near zero – but how near? Sensitivity testing was performed by two of the committee members to determine the impact. This testing confirmed that while outlet chamber pressure does impact outlet airflow, maintaining pressures within +/- .005 inwg of zero, will result in flow variations of less than +/- 0.5%.

Create a Certified Ratings Program

With the test procedure now defined, the committee began defining the Certified Ratings Program. Revisions would be needed to AMCA Publication 211 to include new requirements for Induced Flow Fans.

The following performance ratings were to be included in the Certified Ratings Program. These parameters must be published and verified during check tests.

Inlet air flow rate
Fan static pressure
Fan input power
Impeller speed
Inlet air density (if other than standard air)
Fan static efficiency (optional)
Outlet airflow rate
Nozzle velocity (inlet airflow rate divided by nozzle discharge area)

The figure to the right indicates the critical fan dimensions. These dimensions are used to verify that precertification units and check test units are physically in accordance with the dimensional data originally submitted, and are used to rate units based on geometric similarity.

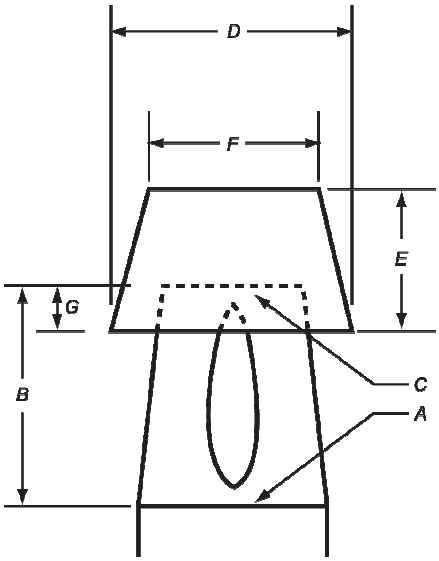


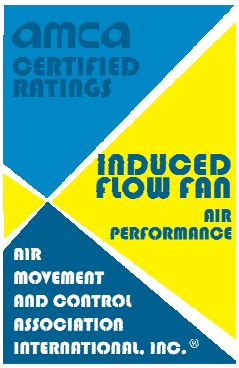
Figure 4 – AMCA Publication 211, Figure A.36

The following three statements are required to be shown adjacent to the performance ratings

"Power rating (watts, kW, or bhp) does not include transmission losses."
"Performance ratings do not include the effects of cross winds."
"Performance ratings do not include the effect of appurtenances (accessories)."

Check test tolerances for the performance ratings of inlet flow, static pressure and fan input power were defined to be identical to existing AMCA Standard 210 tolerances. Since the outlet airflow is a combination of the inlet airflow and the induced airflow, the outlet airflow tolerance was defined to be two times the inlet flow tolerance.

Two new Certified Ratings Seals were created for Induced Flow Fans.



The final step for the committee was to revise AMCA Publication 111 (Lab Accreditation Program) to include the new AMCA Standard 260 and define tolerances for lab accreditation. Again, the inlet airflow and fan input power tolerances were defined to be identical to the existing tolerances for air movement devices as described below:

Inlet airflow test results obtained in the accredited laboratory shall not differ by more than +1.25% or –2.5% along parabolic system lines from the AMCA Laboratory results except at free air where it may be +2% or –4%.

Outlet airflow test results for an induced flow fan obtained in the accredited laboratory shall not differ by more than +2% or -4% along parabolic system lines from the AMCA Laboratory results.

The tolerance of +2% or -4% for the outlet airflow test was chosen because the outlet airflow is always measured at free air.

Conclusion

Now that the new test standard, CPR and laboratory accreditation revisions are complete, manufacturers can begin the process of testing, approving and publishing certified ratings for Induced Flow Fans. In addition, design professionals should begin modifying specifications to include requirements that fans be tested in accordance with AMCA Standard 260-07 and bear the AMCA Certified Ratings Seal for Induced Flow Fan Air and Sound Performance.

Committee Members

Joe Brooks	AMCA International Inc.
Brad Cochran	CPP Inc.
Mel Cooper	M.K. Plastics Corp.
Rad Ganesh	Twin City Fan Companies Ltd.
Charlie Gans	Strobic Air Corp.
Doug Gifford Jr.	DF Fan Services Inc.
Keith Lins	M.K. Plastics Corp.
Tim Mathson	Greenheck Fan Corp.
Brian Merritt	Strobic Air Corp.
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