STANDARD

ANSI/AMCA Standard 260-20

Laboratory Methods of Testing Induced Flow Fans for Rating

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Air Movement and Control Association International

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AMCA Standard

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Laboratory Methods of Testing Induced Flow Fans for Rating

1. Purpose

The purpose of this standard is to establish a uniform laboratory method for determining an induced flow fan's aerodynamic performance in terms of airflow rate, pressure developed, power consumption, air density, speed of rotation and efficiency. This standard is an adjunct to ANSI/AMCA Standard 210 to accommodate the induced flow fans' unique characteristics.

It is not the purpose of this standard to specify the testing procedures to be used for design, production or field testing.

2. Scope

The scope of this standard is limited to induced flow fans, as defined below.

The parties to a test, for guarantee purposes, may agree on exceptions to this standard in writing prior to the test. However, only tests that do not violate any mandatory requirements of this standard shall be designated as tests conducted in accordance with this standard.

3. Normative References

The following standard contains provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below.

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

4. Units of Measurement

The International System of Units, *Le Systéme International d'Unités* (SI units), are the primary units employed in this standard, with inch-pound (I-P) units given as the secondary reference. SI units are based on the fundamental values of the International Bureau of Weights and Measures, and I-P values are based on the values of the National Institute of Standards and Technology, which, in turn, are based on the values of the International Bureau.

5. Symbols and Subscripts

All symbols and subscripts are defined in ANSI/AMCA Standard 210 with the following addition: An induced flow fan has two planes of exit. Where the main (inlet) flow exits the nozzle, the outlet plane will preserve the ANSI/AMCA Standard 210 definition of Plane 2. The plane at the end of the windband will be identified by a subscript of *9*. Thus, the average velocity at the exit of the nozzle is identified as V_2, and the average velocity at the exit of the windband is identified as V_9.

6. Definitions

All definitions are provided in ANSI/AMCA Standard 210 with the following additions:

6.1 Induced flow fan

An induced flow fan is a housed fan whose outlet airflow is greater than its inlet airflow due to induced airflow. Induced flow fans under the scope of this standard will include a nozzle and windband. All of the flow entering the inlet will exit through the nozzle. The flow exiting the windband will include the nozzle flow plus the induced flow.

6.2 Nozzle area

The nozzle area is the inside area measured in the plane(s) of the outlet opening(s) of the nozzle.

6.3 Nozzle

The converging section on the discharge of the housed fan, whose purpose is to increase the velocity of the exhaust air (see Figure 2).

6.4 Outlet airflow

The outlet airflow is the airflow at the inlet plus the induced airflow. It is the total flow exiting the windband.

6.5 Outlet area

The outlet area is the inside area measured in the plane of the outlet opening of the windband.

6.6 Windband

A component that allows for the induction of ambient air mixing with exhaust air prior to leaving the induced flow fan (see Figure 2).

7. Instruments and Methods of Measurement

All of the requirements for instruments and methods of measurements found in ANSI/AMCA Standard 210 are applicable to testing done in accordance with this standard.

7.1 Variable supply and exhaust system

A means of varying the point of operation shall be provided in a laboratory setup. Throttling devices may be used to control the point of operation of the fan. Such devices shall be located at the end of the duct or chamber and should be symmetrical around the duct or chamber axis.

8. Test Setups

The two tests described in Sections 8.1 and 8.2 are required for induced flow fans.

The air path components shall remain the same for both tests.

8.1 Inlet chamber or inlet duct setup

A full ANSI/AMCA Standard 210 test using Standard 210's Figures 13, 14, 15 or 16 shall be performed. No duct on the outlet is allowed. For this test, Plane 2 is defined as the plane at the nozzle outlet and the fan outlet area is defined as the nozzle outlet area. The results shall be presented as defined in ANSI/AMCA Standard 210. The resulting fan curve will show all performance parameters except outlet airflow as defined above.

8.2 Test for measurement of outlet airflow

The induced flow fan shall also be set up and tested in accordance with Figure 1. The outlet end of the windband is attached to an outlet chamber per Figure 11 or 12 of ANSI/AMCA Standard 210. The outlet can be attached either flush or protruding into the chamber. A variable resistance box is attached to the inlet of the induced flow fan as defined in Figure 1.

9. Observations and Conduct of Test

All testing requirements and data recording must be in accordance with ANSI/AMCA Standard 210 except as stated below.

9.1 Data recording requirements for the outlet airflow test as defined in Section 8.2

Torque or other means of determining input power is not required for this test. Chamber static pressure (P_{s7}) is maintained at zero for this test and need not be recorded. The resistance box pressure (P_{t8}) and temperature (t_{d8}) must be recorded. In lieu of a total pressure tube, a piezometer ring can be used to measure static pressure at Plane 8. If this alternate arrangement is used, and the calculated Plane 8 velocity is greater than 2 m/s (400 fpm), then the calculated Plane 8 velocity pressure (a positive value) shall be added to the measured static pressure (a negative value). Calculation of the Plane 8 velocity pressure requires the inlet flow rate as determined in the inlet chamber/inlet duct test as well as the area and density in Plane 8. The duct piezometer formulae given in ANSI/AMCA Standard 210 can be used, except Plane 8 is substituted for Plane 4.

10. Calculations

All calculation requirements found in ANSI/AMCA Standard 210 apply to this standard except as defined in the following:

10.1 Calculation requirements for the outlet airflow test as defined in Section 8.2

The equations for flow and pressure are as defined in ANSI/AMCA Standard 210, Figure 11 or 12 as appropriate. Some variables must be revised to accommodate the setup shown in Figure 1 below.

10.1.1 Inlet density (ρ)

The pressure drop through the resistance box will change the inlet density from that shown in the ANSI/AMCA Standard 210, Figure 11 or 12 calculations. The following must be used:

$$\rho = \rho_0 \left(\frac{t_{d0} + 273.15}{t_{d8} + 273.15}\right)\left(\frac{P_{s8} + p_b}{p_b}\right) \qquad \text{Eq. 9.1 SI}$$

$$\rho = \rho_0 \left(\frac{t_{d0} + 459.67}{t_{d8} + 459.67}\right)\left(\frac{P_{s8} + 13.595 \times p_b}{13.595 \times p_b}\right) \qquad \text{Eq. 9.1 I-P}$$

10.1.2 Fan static pressure

For the Figure 1 setup, the fan static pressure will be the negative of the fan inlet total pressure. Therefore:

$$P_s = -P_{t8} \qquad \text{Eq. 9.2}$$

10.2 Total efficiency calculation

$$\eta_t = \frac{Q_1 P_{v2} K_p - Q_1 P_{t1} K_p}{H} \qquad \text{Eq. 9.3 SI}$$

$$\eta_t = \frac{Q_1 P_{v2} K_p - Q_1 P_{t1} K_p}{6343.3H} \qquad \text{Eq. 9.3 I-P}$$

Where:

Q_1 is the flow through the fan inlet, m^3/s (cfm)
P_{t1} is the total pressure in fan inlet, Pa (in. wg)
P_{v2} is the velocity pressure in fan nozzle, Pa (in. wg)
H is the fan input power, W (bhp)
K_p is the compressibility factor

Note: These data are obtained from the ANSI/AMCA Standard 210 test described in Section 8.2.

10.3 Compressibility factor

The compressibility coefficient (K_p) may be determined using the following equations from ANSI/AMCA Standard 210:

$$x = \frac{P_t}{P_{t1} + p_b}$$ Eq. 9.4 SI

$$x = \frac{P_t}{P_{t1} + 13.595p_b}$$ Eq. 9.4 I-P

And:

$$z = \left(\frac{\gamma - 1}{\gamma}\right)\left(\frac{\left(\frac{H}{Q}\right)}{P_{t1} + p_b}\right)$$ Eq. 9.5 SI

$$z = \left(\frac{\gamma - 1}{\gamma}\right)\left(\frac{\left(\frac{6343.3H}{Q}\right)}{P_{t1} + 13.595p_b}\right)$$ Eq. 9.5 I-P

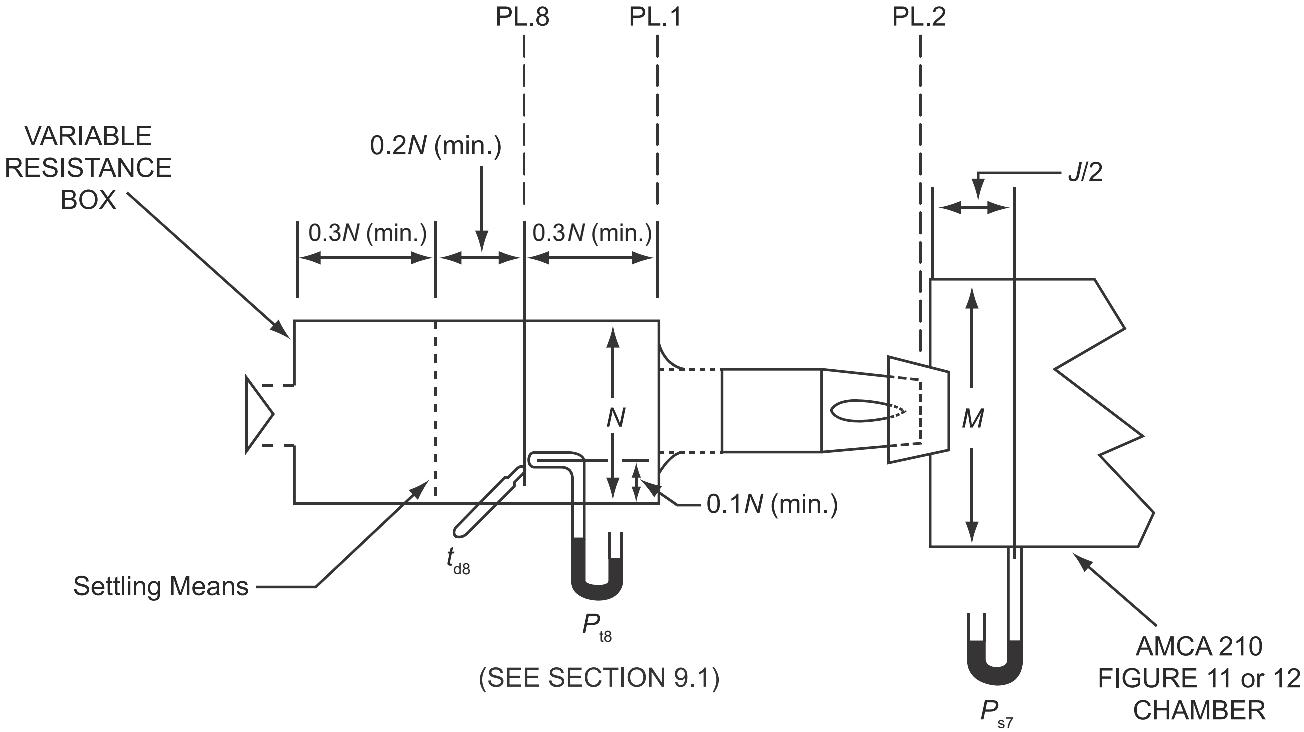
And:

$$K_p = \left(\frac{ln(1 + x)}{x}\right)\left(\frac{z}{ln(1 + z)}\right)$$ Eq. 9.6

The compressibility coefficient (K_p) may be evaluated directly. P_t, P_{t1}, p_b, H and Q are all test values. The isentropic exponent (γ) may be taken as 1.4 for air.

11. Report and Results of Test

The results of the fan tests shall be presented as plots. ANSI/AMCA Standard 210 defines typical plotting conventions. The outlet flow vs. fan static pressure may be plotted on the same graph as the inlet flow. Descriptions of the test fan, test instruments and personnel, as outlined in Section 9, must be reported. The laboratory shall be identified by name and location.



Notes:

1. The exit plane of the windband may be flush with the chamber or protrude inside. The depth of protrusion shall not be more than one-half the depth of the windband.
2. The dimension N can be either the inside square or inside round dimension of the variable resistance box. Its value shall make the area at Plane 8 at least five times the inlet area (A_1) of the fan.
3. Settling means shall be woven wire mesh or perforated sheet with 40–50% open area.
4. The dashed lines on the test fan inlet indicate an inlet bell and one equivalent duct diameter that may be used for inlet duct simulation.
5. The inlet opening of the variable resistance box must be sufficiently large to allow the test fan to operate at the airflow rate of interest.
6. The chamber pressure (P_{s7}) is maintained at zero for all determination points.
7. In lieu of a variable resistance box, any ANSI/AMCA Standard 210 inlet test method may be used for the inlet side of the ANSI/AMCA Standard 260 test (see ANSI/AMCA Standard 210, Figures 13, 14, 15 or 16).
8. Flow and Pressure Formulae

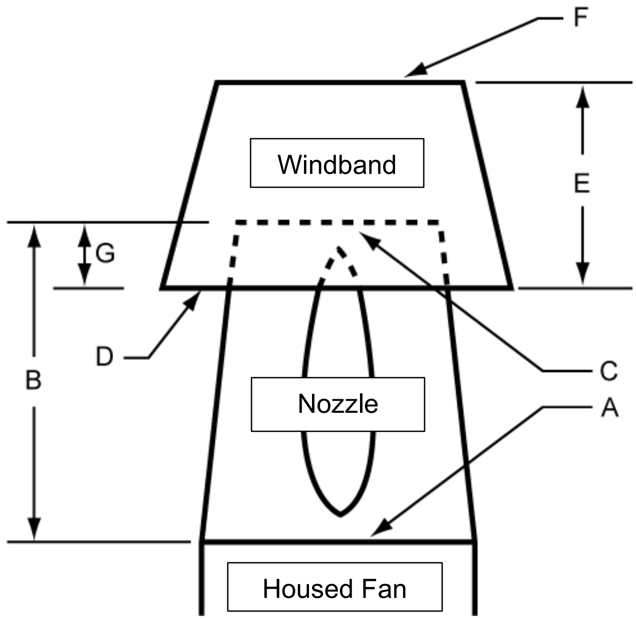
   The formulae for flow rates are given in ANSI/AMCA Standard 210, Figure 11 or 12. The inlet density given in Section 10.1.1 of this standard is substituted for the inlet density defined in ANSI/AMCA Standard 210. Formulae relating to fan outlet velocity (V_2), outlet velocity pressure (P_{v2}) and outlet total pressure (P_{t2}) can be ignored.

   $P_s = -P_{t8}$

   $P_{t1} = P_{t8}$

   See Section 9.1 to determine P_{t8} when P_{s8} is measured instead of P_{t8}.

Figure 1 — Test Setup to Determine Induced Flow Outlet Airflow



A Nozzle inlet area after blade discharge
B Nozzle height
C Nozzle discharge area
D Windband inlet diameter
E Windband height
F Windband discharge area
G Overlap between nozzle and windband

Note: This figure is used in AMCA Publication 211, Certified Ratings Program Product Rating Manual for Fan Air Performance, where it is listed as Figure A.36.

Figure 2 — Induced Flow Fan Nozzle and Windband

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