SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

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Self-Propelled Sweepers - Air Flow Performance - Part 1: Suction Air Volume Performance

RATIONALE

The document has been revised to update the referenced documents.

1. SCOPE

This SAE Standard establishes a test method and a definition for disclosing the suction air volume performance of self-propelled sweepers that solely use a pneumatic conveyance means for the collection and transfer of "sweepings" into a collection hopper.

1.1 Purpose

The purpose of the document describes a test practice for measuring the suction air movement occurring in vacuum and regenerative air street sweepers described in SAE J2130-1. The document also proposes a format for the presentation of the results. The document can be used to disclose or compare particular operating performance criteria under similar conditions.

2. REFERENCE

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publication

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J2130-1 Identification of Self-Propelled Sweepers and Cleaning Equipment Part 1 - Machines with a Gross Vehicle Mass Greater than 5000 kg

3. DEFINITIONS

3.1 SWEEPER

A self-propelled vacuum or regenerative air street sweeper that is primarily designed to sweep material from highways, parking lots, airport complexes, industrial and construction sites, and during road maintenance work. The sweeper may use broom means to dislodge and direct material into a pneumatic collection mechanism that is the sole means to convey the swept material into a collection hopper.

3.2 SUCTION/BLOWER FAN

Centrifugal fan means for developing the required air movement/pressure employed in the sweeper's pneumatic conveyance mechanism.

4. TECHNICAL REQUIREMENTS

4.1 Recommended Apparatus

Manometer - Pitot tube - Tachometer - Thermometer - Barometer - Hygrometer (see note in 4.4).

4.2 Method

The machine shall be set up in its optimum running condition according to the recommendations given in its operator's instruction manual. The hopper filter meshes shall be clean and all air ducts free from debris. Wander hoses, drain-off hoses and other apertures (other than the suction pick-up nozzle conduit), etc., shall be sealed and blanked-off. The pick-up nozzle shall be set to the correct inlet aperture setting as recommended by the manufacturer when the machine is in its normal operating condition.

It is important to measure the engine and suction/blower fan speed during the test which shall be set up to the normal operating condition as recommended in the machine's operational handbook. Suction/blower fan speeds may be determined by establishing the drive ratio of any gearbox or pulley arrangement, or preferably by a tachometer means directly measuring the fan.

The manometer and pitot tube shall be checked to ensure the pitot tube is clean and that the manometer and connecting tubes are perfectly sealed with no leakage to atmosphere. If an electronic manometer is used, first ensure that it is calibrated to zero pressure in the inert state. Two small holes shall be provided at 90 degrees to each other in the suction conveyance conduit large enough to permit the insertion of the pitot tube. These holes shall be positioned in the straightest section of the conduit to ensure minimum turbulence. There shall, in any case be no bends within at least 0.5 m either side of the measurement point. See Figure 1.

The ambient temperature shall be recorded before and after the tests in order that results may be corrected to a standard of 20 °C (68 °F). Barometric pressure shall also be recorded so that corrections may be made to a standard of 760 mm Hg or 1013 mb (norm at sea level). Corrections for temperature and barometric pressure will ensure that quantifiable comparative data is available to a common standard.

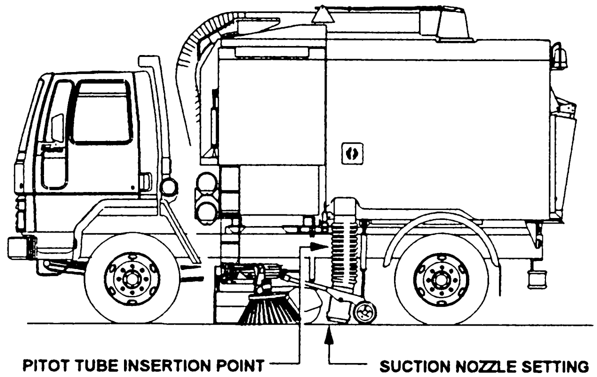
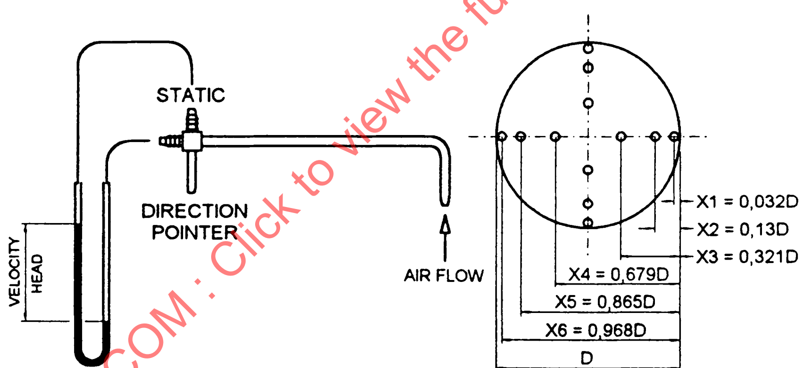


Figure 1 - Test set-up

The pitot tube shall have a calibrated scale marked with six positions, refer to Figure 2, according to the internal size of conduit fitted (refer to 'pitot tube divisions'). The pitot tube is then inserted into the air duct with the probe pointing into the air direction flow within 5 degrees of the conduit axis. Velocity head pressure readings are then read from the manometer at each of the twelve positions, six for each pass (or hole). Readings taken are the total velocity head (in millimeters water gauge), shown on the manometer. From these twelve results, the average velocity head and hence air flow velocity and volume may be calculated based on the duct's cross-sectional area.

Care must be taken while measuring the velocity head readings to ensure that the pitot tube is held parallel to the walls of the conduit. This may be checked by reference to the direction pointer on the tail of the pitot tube (this points in the same direction to the pitot probe).



D = Inside diameter of suction conveyance conduit

Figure 2 - Pitot tube positions for a six-point pass in circular ducts

The static depression shall also be measured within the duct in order to make a correction for air density by connecting the side holes in the pitot tube to the manometer, leaving the other side open to atmosphere. The total deflection (in millimeters water gauge) may then be read from the manometer. Note that in this application the reading will be a negative pressure and shall be used as such when applying the formulae for correction of duct depression.

The negative pressure (depression) may also be measured within the hopper or within the inlet eye of the blower fan for comparative information or as a gauge of air flow against hopper depression using a manometer. These measurements may be conducted by inserting a length of small diameter tubing into the hopper via the discharge door seal or by connection onto a purpose made device which seeks the pressure within the fan inlet eye. The tube is simply connected to one side of the manometer and the total deflection (in millimeters water gauge) recorded.

4.3 Results Tabulation

The test results may be typically recorded in the format shown in Figure 3, the corrected values would be derived by the calculation methods given in 4.4.

Fan Speed (rpm)	Uncorrected Pitot Velocity Head Readings (mm H_2O)													Corrected Values (20 ºC/1013mb)			
	First Pass (first hole)						Second Pass (second hole)						Fan Inlet Pressure (mm H_2O)	Average Vel. Head (mm H_2O)	Test Duct Air Vel. (m/sec)	Test Duct Air Vol. (m^3/sec)	Fan Inlet Pressure (mm H_2O)
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}					

Figure 3 - Results tabulation

4.4 Calculations

See Equations 1 to 6.

$$\text{Average velocity head (in mm } H_2O) = \sqrt{\frac{\Sigma x_n^2}{12}} \quad \text{(Eq. 1)}$$

$$\text{Correction for temperature (correct to 20 °C)} = \frac{\text{ambient temperature (°C)} + 273}{293} \quad \text{(Eq. 2)}$$

$$\begin{array}{c}\text{Correction for barometric pressure} \\ \text{(correct to 1013 mb} - \text{sea level)}\end{array} = \frac{1013}{\text{barometric pressure (mb)}} \quad \text{(Eq. 3)}$$

$$\begin{array}{c}\text{Correction for duct depression} \\ \text{(correct to std. density)}\end{array} = \frac{10363}{10363 + \text{static depression (mm } H_2O) \text{ in test duct}} \quad \text{(Eq. 4)}$$

$$\text{Air Velocity in duct (m/s)} = \begin{array}{c} 4.032 \times \sqrt{(1) \times (2) \times (3) \times (4)} \\ \text{(multiply by 196.8 to convert m/s to ft/min)}\end{array} \quad \text{(Eq. 5)}$$

$$\text{Volume of conveying air } (m^3/s) = \begin{array}{c} (5) \times \text{duct cross section } (m^2) \\ \text{(multiply by 2118.9 to convert } m^3/s \text{ to cfm)}\end{array} \quad \text{(Eq. 6)}$$

NOTE: Corrections may also be made for relative humidity conditions. Usually the results shall be specified at 50% humidity. High humidity will result in lower air volume recordings due to lower density. The effect is often small and may therefore be ignored, though in adverse conditions tests should be aborted.