Flow Rate Calculations Made Using the VELOCICALC

Application Note TSI-127

The VELOCICALC is able to calculate the flow rate based on several different methods. This Application Note is designed to help the user better understand how those calculations are made.

Calculation of Flow Rate Using Velocity and Duct Size

The VELOCICALC can calculate flow rate from velocity and duct size. This type of flow rate calculation applies to any measurement that occurs in a duct or pipe. Velocity is measured by the VELOCICALC using the hot wire sensor in the detachable probe or by a pitot tube that is attached to the pressure ports. The hotwire probe will be utilized for the measurement if it is plugged in. The instrument automatically selects the flow mode based on the type of probes attached. The size of the duct or pipe (area is calculated by the instrument) must be entered into the instrument. For a circular pipe or duct, the diameter must be entered (either cm or inches) and for a rectangular duct, both the x and y dimensions need to be entered. The equations the VELOCICALC uses for this flow rate calculation are as follows:

$$\text{Circular Area} = \text{A} = \frac{\pi(d)^2}{4}$$

$$\text{Rectangular Area} = \text{A} = (x)(y)$$

$$\text{Flowrate} = (v)(A)$$

where:

A = area
d = diameter of duct
x = horizontal dimension of duct
y = vertical dimension of duct
v = velocity

Example

You are making a flow measurement in a duct that is 1.5 feet tall and 2 feet wide. Assume that the velocity in the duct is 2500 ft/min.

To make this measurement, select Flow Setup from the main menu. Enter the shape of the duct (rectangular) and the dimensions of the duct (x size = 1.5 ft or 18 inches, y size = 2 ft or 24 inches. The instrument automatically calculates the flow rate as follows:

Rectangular Area = (1.5 ft)(2 ft) = 3 ft^2

Flow Rate = (2500 ft / min)(3 ft^2) = 7500 ft^3 / min

Calculation of Flow Rate Using Horns and Cones

To use the VELOCICALC to measure flow rate from horns or air cones. The models are AM 300, AM 600, AM 900, and AM 1200 and are manufactured under the Alnor brand. The device can also measure flow rate based on Air Cones that utilize the rotating vane head instead of the thermal probe.

When measuring flow rate using the horn method, the VELOCICALC measures the velocity and multiplies the reading by a factor that is preprogrammed into the meter. These factors are approximations of a curve and will introduce some error. The typical error is between 3–6% when using the VELOCICALC and the horns properly. This amount of error is an acceptable limit according to standard practices. The amount of error can easily be greater if the VELOCICALC probe is not properly placed in the horn.

Calculation of Flow Rate Using Differential Pressure and a K Factor

The VELOCICALC models listed above can calculate flow rate from the square root of differential pressure and a K factor. This type of flow rate calculation applies to measurements made on diffusers or flow stations with pressure taps designed for this purpose. Differential pressure is measured by the VELOCICALC using the pressure ports. The K factor must be entered into the instrument. The equations for this flow rate calculation is as follows:

$$\text{Flowrate} = \left(\sqrt{p}\right)\left(K_f\right)$$

where:

p = differential pressure

K_f = K factor

The source of the K factor for this type of measurement is the manufacturer of the diffuser or flow station. These manufacturers specify the K factor that must be used when making flow measurements using the pressure taps. Several K factors are usually supplied, depending on the pressure and flow rate measurement units that are being used.

NOTE: TSI Incorporated does not provide K factors for this measurement. The K factors must come from the manufacturers of the diffusers or flow stations through which the flow is being measured.

Example

You are making a flow measurement using a diffuser with pressure taps. The manufacturer of the diffuser specified the K factors listed in the table below.

Manufacturer-Supplied K Factors

K factor	Pressure Units	Flow Units
112.3	inches H_2O	ft^3/min
3.36	Pa	l/s
139.5	mm Hg	m^3/hr

To make this measurement, select Press/Kfact in the flow setup screen. Enter the flow rate mode (select the K_f symbol on the display) and then the K factor (112.3 or 3.36 or 139.5, depending on the pressure and flow rate units). The instrument automatically calculates the flow rate.

If the differential pressure measurement was 0.876 inches H_2O and the K factor entered was 112.3, the flow rate displayed by the instrument would be:

$$\text{Flowrate} = \left(\sqrt{0.876}\right)(112.3) = 105.1 \text{ ft}^3 / \text{min}$$

If the differential pressure measurement was 218 Pa (0.218 kPa) and the K factor entered was 3.36, the flow rate displayed by the instrument would be:

$$\text{Flowrate} = \left(\sqrt{218}\right)(3.36) = 49.6 \text{ l} / \text{s}$$

If the differential pressure measurement was 1.64 mm Hg and the K factor entered was 139.5, the flow rate displayed by the instrument would be:

$$\text{Flowrate} = \left(\sqrt{1.64}\right)(139.5) = 178.6 \text{ m}^3 / \text{hr}$$

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 Printed in U.S.A.