USING K-FACTORS WITH THE ACCUBALANCE® AIR CAPTURE HOOD MODEL 8375

APPLICATION NOTE TSI-137

Capture Hoods and Correction Factors (K-Factors)

In an ideal world, all capture hoods would provide accurate readings in all flow conditions. This would be true regardless of diffuser size, shape, throw pattern or delivery duct parameters such as shape, size, construction material and proximity of dampers or elbows. In the real world; however, all of these variables can affect the performance of a capture hood. To obtain the most reliable measurements with a capture hood, therefore, it is necessary to use correction factors, or K-Factors, to account for these varying flow effects.

The need for K-Factors has been recognized by the most respected organizations in the Heating Ventilating and Air-Conditioning profession, who recommend[1-5] the use of correction factors when using any capture hood. ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.) recommends[1] that, "All flow measuring instruments should be field verified by running pitot-tube traverses to establish correction and/or density factors." ASHRAE also recommends[2 & 3] comparing duct traverses to capture hood readings for performance checks in the field. Similarly, AABC (Associated Air Balance Council) recommends[5], "take a traverse of the duct and determine correction factors as necessary."

The Importance of K-Factors

If measurement accuracy is important, then the use of K-Factors is imperative. As stated earlier, it is well known that many factors affect readings taken with capture hoods. The uncertainties introduced by the wide variety of possible flow conditions make K-Factors vital in achieving accurate capture hood measurements.

K-Factors also become extremely important when comparing the performance of two different capture hoods. It is generally accepted that the best accuracy that any capture hood can offer is 5% of the reading. Ideally then, when comparing two different capture hoods that have the best possible accuracy of 5%, there could be up to a 10% difference in readings between the two instruments. In the non-ideal flow conditions encountered in the real world, this level of agreement between different capture hoods can only be expected *after* an appropriate K-Factor has been applied to each hood. In fact, any comparison between different capture hoods is meaningless without the inclusion of the appropriate K-Factor for each hood.

Determining and Using K-Factors

The K-Factor for a capture hood is defined as the ratio of the “true flow” to the “measured flow.”

K-Factor = True Flow/Measured Flow

The best way to determine the “true flow” is to perform an accurate duct traverse with a pitot tube or thermal anemometer in the duct upstream of the diffuser (make sure the duct only serves one diffuser). TSI maintains that the accurate methods for traversing ducts are the Log-linear method for round ducts and the Log Tchebycheff method for rectangular ducts[6]. The “measured flow” is the capture hood reading at the diffuser.

Determining K-Factors: An Example

Suppose you complete a velocity traverse of a 10” (25 cm) round duct leading to a particular diffuser and obtain the following numbers:

Position of measurement relative to inner duct wall	Velocity measurements: Traverse #1	Traverse #2	Traverse #3
inches (cm)	ft/min (m/min)	ft/min (m/min)	ft/min (m/min)
0.2 (0.51)	575 (173)	725 (218)	535 (161)
0.8 (2.03)	590 (177)	730 (219)	575 (173)
1.5 (3.81)	595 (179)	790 (237)	625 (188)
2.2 (5.59)	605 (182)	770 (231)	640 (192)
3.6 (9.14)	665 (200)	785 (236)	685 (206)
6.4 (16.3)	795 (239)	815 (245)	790 (237)
7.8 (19.8)	790 (237)	790 (237)	775 (233)
8.5 (21.6)	750 (225)	760 (228)	740 (222)
9.2 (23.4)	710 (213)	745 (224)	670 (201)
9.8 (24.9)	680 (204)	685 (206)	655 (197)
Total:	6755/10 (2029/10)	7595/10 (2281/10)	6690/10 (2010/10)
Average (Total/10):	676 ft/min (203 m/min)	760 ft/min (228 m/min)	669 ft/min (201 m/min)

Average air velocity = (676+760+669)/3 = 702 ft/min
(203+228+201)/3 = 211 m/min

To calculate the flow in the duct, it is necessary to multiply the average air velocity by the duct cross-sectional area as follows:

Average Velocity (ft/min or m/min) x duct cross sectional area (ft^2 or m^2)
= Flow (ft^3/min or m^3/min)
Average Velocity (ft/min or m/min) x πr (ft^2or m^3) = Flow (ft^3/min or m^3)
Average Velocity (ft/min) x π $[(5”/12”)\ ft]^2$ = Flow (ft^3 /min)
Average Velocity (ft/min) x π $[0.417\ ft]^2$ = Flow (ft^3 /min)
702 ft/min x 3.14 $[.417\ ft]^2$ = Flow (ft^3 /min)
702 ft/min x 0.546 ft^2 = 383 ft^3 /min

Average Velocity (m/min) x π $[(12.5cm/100cm)\ m]^2$ = Flow (m^3 /min)
211 m/min x 3.14 $[.125\ m]^2$ = Flow (m^3 /min)
211 m/min x 0.049 = 10.4 m^3 /min

Continuing our example, assume that the AccuBalance air capture hood 8375 reading at the diffuser is 10 m^3/min. Then, recalling that:

K-Factor = True Flow/Measured Flow

Then:

$$\text{K-Factor} = (10.4\ m^3/\text{min})/(10\ m^3/\text{min}) = 1.04$$

From this equation, you can see that the product of the AccuBalance air capture hood 8375 reading ("Measured Flow") and the K-Factor is the "True Flow":

Measured Flow x K-Factor = True Flow

From our example:

$$10\ m^3/\ \text{min} \times 1.04 = 10.4\ m^3/\text{min}$$

Now we could use this K-Factor whenever we use a AccuBalance air capture hood 8375 to measure flow where the duct/diffuser combination and other factors are the same.

For example, suppose we use the AccuBalance air capture hood 8375 to measure flow in a similar duct/diffuser combination and get a reading of 10.2 m^3/min. Because we have already done a duct traverse and K-Factor determination for that duct/diffuser combination, we simply multiply this reading by the same K-Factor to get the true flow. So, 10.2 m^3/min x 1.04 gives us our true flow of 10.70 m^3/min. The true flow of 10.70 m^3/min would be the value to record in a "Balance Report" or other documentation.

Pre-determined K-Factor

Oftentimes it is not possible to do a duct traverse due to lack of access to the duct or lack of straight duct between elbows, take-offs or other air disturbances. In such cases, you may choose to use a pre-determined K-Factor or a K-Factor based on your previous experience with similar duct/diffuser combinations. In fact, you may find it helpful to keep a record of duct/diffuser combinations and their K-Factors as you measure them in the field. You could then refer to this record and choose an appropriate K-Factor whenever you encounter a duct which cannot be traversed.

References

[1]ASHRAE, *1999 ASHRAE Handbook, HVAC Applications, I-P Edition*, Chapter 36.2.
[2]ASHRAE Standard 111-1988, *Practice For Measurement, Testing, Adjusting, And Balancing of Building Heating, Ventilation, Air-Conditioning And Refrigeration Systems*. Section 8.6.5
[3]ASHRAE, *1997 ASHRAE Handbook, Fundamentals, I-P Edition,* Chapter 14.21.
[4]Associated Air Balance Council, *National Standards*, Chapter 8, p. 30.
[5]Associated Air Balance Council, *Technician Training Manual*, Chapter 4, p. 60.
[6]TSI Application Note, *Traversing a Duct to Determine Average Air Velocity*, TI-106.
[7]TSI Application Note, *Experimental Determination of Correction Factors for Use with Capture Hoods,* TI-128.

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