DIFFERENCES IN MASS MEASUREMENT READINGS WHEN COMPARING PHOTOMETRIC BASED INSTRUMENTS

APPLICATION NOTE EXPMN-019 (A4)

Introduction

When comparing the readings of two or more photometric based instruments, which are all theoretically sampling the same aerosol, one may notice that the mass concentration reading of one of the instruments is significantly different than that of the other(s). For this paper a significant difference is defined as being greater than ±50%.

Upon seeing this type of difference, an assumption might be made that a failure has occurred in one of the instruments. To rule out instrumentation failures, TSI recommends comparing the readings from two or more instruments within the same product family, because these instruments share the same optics and will provide similar results. For example, comparing mass concentration readings between multiple SidePak™ AM520 Personal Aerosol Monitors that are sampling from the same aerosol.

Further Background and Reasoning

Gravimetric mass sampling is generally considered to be the reference for mass measurements throughout the world. Photometers are precise real-time instruments that estimate the mass concentration of aerosols and are not considered to be "reference" instruments. Photometers are very dependent on a variety of parameters, including aerosol size, refraction, flow rate through the instrument, internal optics, etc. Every make and model of photometer is different. TSI Dust Monitors (i.e., DustTrak™ Monitors and SidePak Monitor Models AM520 and AM510) are calibrated back to a "standard" aerosol—Arizona Road Dust 1 (ARD1). Any aerosol other than ARD1 will have different responses. For these reasons, DustTrak Monitors and SidePak AM520 and AM510 Personal Exposure Monitors will most likely read differently when measuring any other aerosol, other than ARD1.

These products were designed to be mainly used in two ways.

1. First, to directly measure mass concentrations of an aerosol. To accomplish this, it is recommended that a study be performed to calculate a Custom Calibration Factor (CCF) for a specific area and aerosol. After calculating, the CCF can be entered into the instrument and be applied when taking measurements and estimating the mass of the aerosol. Refer to the manuals for each of the TSI instruments listed above for a step-by-step process of creating and adding CCFs to the mass measurements.

2. Second, as a comparative measurement. To do this, baseline measurements are taken of an aerosol in an area. After a baseline reading is established, and action is taken (i.e., increased ventilation or filtration) a subsequent measurement is then taken to determine the change or improvement in mass measurements being measured in that area. This process is repeated until a satisfactory improvement in the mass concentration has been achieved. It is important to note that mass measurements using TSI instruments cannot be considered as "reference data"—i.e.: that one type of TSI instrument cannot serve as a reference for another TSI instrument.

An Option for Getting Instruments to Match

If users have been using certain instrument(s) as a standard (not a reference) for a specific application, and it is preferred a new product match the current product, a Custom Calibration Factor (CCF) must be entered into the new instrument to calibrate it with the existing instrument.

A CCF can be created by either:

a) Conducting gravimetric analysis for the new instrument, assuming the existing instrument was calibrated to a gravimetric sample previously, or

b) Taking measurements with both instruments over a 30–60 minute period and comparing the data to develop a new CCF for the new instrument based on the variance of the readings.

Option (b) does not provide a better understanding of the specific aerosol but can be a quick method to simply get the two instruments to match.

Updating the Custom Calibration Factor for the SidePak AM520 Monitor

As an example, the following describes the procedure for adjusting the CCF for the SidePak AM520 Monitor. Refer to the Calibration section of the SidePak AM520 Monitor User Guide which was provided new with the instrument. Within the Calibration section, find the User Cal heading.

Procedure for selecting the calibration factor through the SidePak AM520 Monitor user interface:

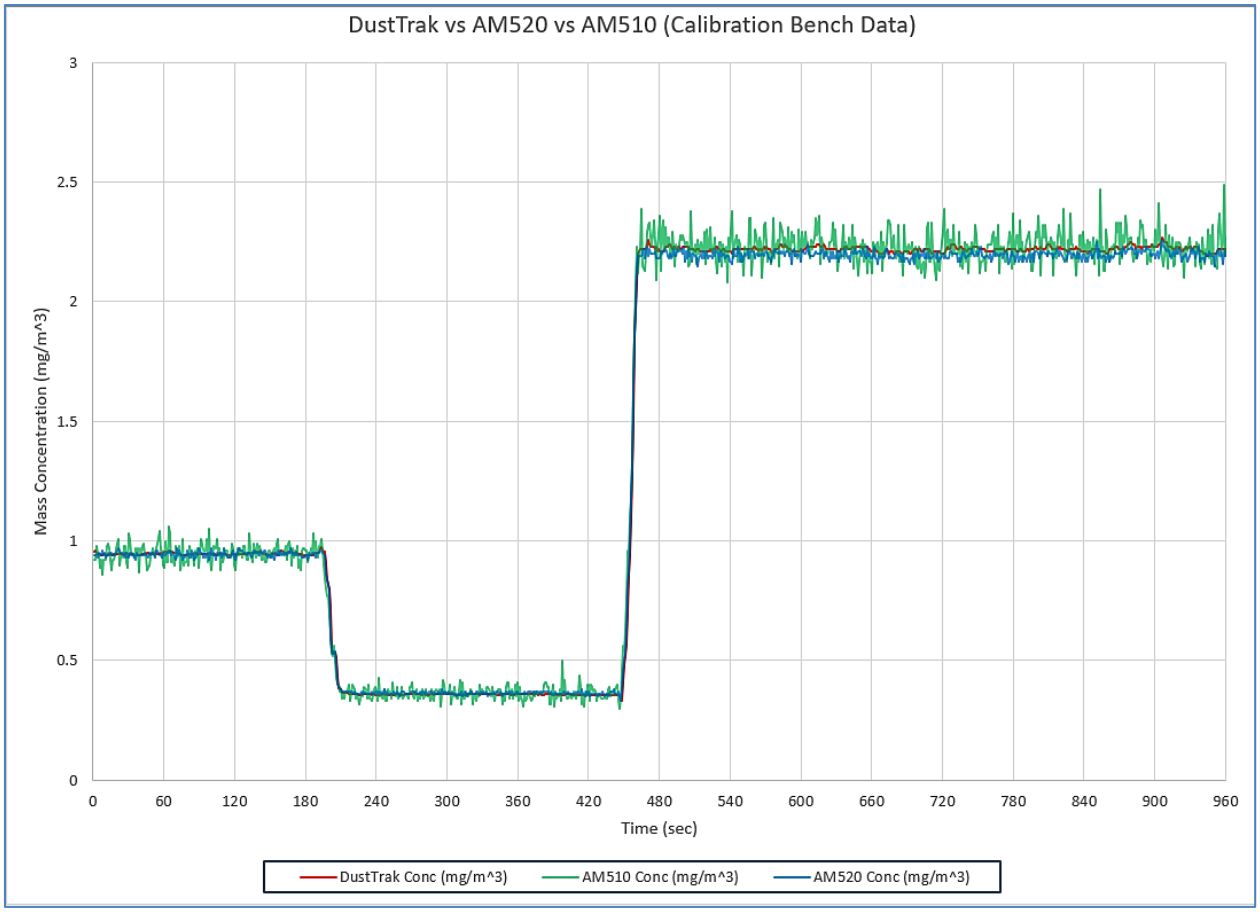
1. Under **MAIN MENU**, use the ▲ ▼ keys to scroll to **CALIBRATIONS** and press ↵.
2. Under **CALIBRATION** menu, use the ▲ ▼ keys to select **USER CAL** and press ↵.
3. Under **USER CAL**, use the ▲ ▼ keys to select the calibration you want and then press ↵ to confirm the setting.
   - User Cal 1 (Factory) is set to 1.00 by TSI and cannot be adjusted.
   - User Cal 2 (Ambient) is set to 0.38 by TSI and cannot be adjusted.
   - User Cal 3 to 7 default to 1.00 and can be adjusted from 0.10 to 10.00 through TrakPro™ Data Analysis Software.
   - User Cal 3 to 7 can be changed in the field through the AM520/AM520i menu, after pressing ↵ to select the desired factor, adjust the value of the cal factor using the ▲ ▼ keys. Press the ↵ key again to accept the changes and return to the **CALIBRATION** Menu.

Comparing Instruments

Once the Custom Calibration Factor has been developed using one of the options above and applied to the corresponding instrument(s), the instruments can now be accurately compared.

To show this, TSI created Custom Calibration Factors for the SidePak AM520 monitor and its predecessor the SidePak AM510 monitor to match a DustTrak II instrument and compared them side-by-side in a controlled environment.

The graph below shows the response correlation from each instrument measuring the same aerosol, during the same period of time.



As the graph above shows, each instrument will have a unique response signature to the same aerosol, with the SidePak AM510 showing the most variability. However, the correlation of all three instruments are very similar with the DustTrak II monitor and SidePak AM520 being very closely aligned.

This shows that three different instruments with different optical photometers can be reliably calibrated to the same aerosol.

Conclusion

It is not uncommon for photometric based instruments to provide different results, when sampling the same aerosol. Photometer measurements are very dependent on a variety of parameters, including aerosol size, refraction, flow rate through the instrument, internal optics and others. It is important to keep in mind that these variables can be especially acute when comparing instruments that are not in the same product family and when the instruments do not share the same manufacturer. However, this can also occur within a manufacture's own product lines where technical variants are common in different product generations, product lines and measurement technologies.

If you believe an error has occurred with use of a TSI instrument, please contact a TSI Technical Service Representative at 1-800-680-1220 or by filling out the required information at http://www.tsi.com/Support/.

EXPMN-019 Rev. B (10/7/2019) A4 Printed in U.S.A.