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Application Note

A Reference Device for Low-cost Particulate Sensors

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Low-cost Particulate Sensors

Over the past several years, low-cost sensors have become more widely used among public consumers, universities, and community assessment and advocacy groups, for localized ('microscale') assessment of ambient air quality. In addition, state and local agencies have adopted this technology to supplement regulatory air quality networks.

These government agencies, including the US EPA, have regulations in place to control emissions of certain air quality pollutants, and develop test criteria for instruments that are used for official air quality monitoring assessments in regulated applications. These instruments are typically very sophisticated, expensive, and require well-trained operators to ensure the data integrity and quality.

Particulate matter is of large concern due to its consequential human health implications from exposure, even at low concentrations for sensitive groups (including the elderly and children). $PM_{2.5}$ is a criteria pollutant as defined by the US EPA[1] and other regulatory agencies around the world and is most harmful due to its very small size (< 2.5 µm) which gives the ability to penetrate deeply into the lungs[1]. Low-cost sensors can help to provide supplementary, real-time information to the public regarding potential exposure risk during high pollution events.

Figure 1. Low-cost particulate sensors being tested alongside a US EPA-approved continuous, real-time ambient particulate monitor. Courtesy: Air Resource Specialists and Colorado State University

Low-cost particulate sensors use well-known conventional, monochromatic light scattering technology to measure ambient particulate matter pollution levels. The advantages to this approach are very fast response time (seconds to minutes), measurement sensitivity, and little required maintenance. They are also typically very small, inexpensive, handheld devices that can be easily deployed in a variety of environments requiring little operating power. The primary disadvantages, however, are their lack of measurement accuracy, interferences, and drift. A good reference or calibration method is required to maintain the integrity and overall beneficial use of these low-cost sensors.

[1] US Environmental Protection Agency. (2020, October 1). *Particulate Matter (PM) Basics.* US EPA. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.

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Model T640 Real-time Particulate Monitor

Traditional, 'continuous' instruments used by regulatory ambient air quality monitoring agencies to measure ambient airborne particulate matter typically use Beta-attenuation and/or Tapered Element Oscillating Microbalance (TEOM) technologies which have been available for decades. These conventional instruments will typically produce and report 1-hr mass concentration data used for public reporting and/or forecasting of air quality. More recent developments involve very sophisticated light scattering technology that produces very accurate particulate matter mass measurements sufficient to meet the regulatory approval requirements and matches the fast time resolution and measurement sensitivity of low-cost sensors.

Figure 2. Photo of TAPI T640 (with 640x option) instrument with US EPA approval for PM_{10}, $PM_{2.5}$, and PM_C together in a single instrument powered by solar panels. Courtesy: Thomson Environmental Systems Pty Ltd.

The Model T640 ambient particulate monitor uses a broadband (or polychromatic) light-scattering technique that yields extremely high-resolution particle size distribution and number count data, and then converts it into sensitive, high precision, and short-time resolution (down to 10s) particulate matter mass concentration data.

The Model T640 is a US EPA approved Federal Equivalent Method (FEM) for $PM_{2.5}$ and is also approved for PM_{10}, $PM_{2.5}$, and PM_C with the 640x option. Additionally, the instrument has an option to provide Total PM and PM_1 mass concentration measurements, simultaneously and in addition to the standard PM_{10} and $PM_{2.5}$ mass concentration measurements. The Total PM and PM_1 mass conversion algorithms use the same density factors by particle size bin that were derived for the PM_{10} and $PM_{2.5}$ FEM measurement algorithms which provides confidence into the accuracy of these additional mass measurements.

Flexible and Easy to Set Up

The Model T640 is simple to setup, operate, and maintain. The instrument is lightweight and uses very little power, providing flexibility for installation in a wide variety of locations. Instruments can be typically operated for months at a time without the need for any operator intervention.

For further information about this solution, please contact your local Teledyne API Regional Sales Manager or TAPI Sales at: api-sales@teledyne.com. You can also visit our website at www.teledyne-api.com for more information about our products.

[1] US Environmental Protection Agency. (2020, October 1). *Particulate Matter (PM) Basics.* US EPA. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.