SP4 EVALUATION OF LASER BASED PARTICLE SENSORS

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The World Health Organization estimated that in 2012 around 7 million people died as a result of air pollution exposure. Recently the public has become more aware of the environmental and health costs of air pollution. In response, companies have been rushing to produce cheap air monitoring sensors for all applications. Currently only particle sensors based on laser light scattering can be produced cheaply. However, their measurements are questionable as few of these devices have been scientifically analyzed. The public lack the technical means of checking these themselves, so must take the quality of the measurements on trust from the supplier. Accuracy is especially important when these sensors are used in air filtration units to provide protection against pollutants. Manufacturers of filtration units often advertise efficiency based on the air that passes through the filter rather than the air in the room where the filter sits and often do not report the sensors used to measure the effect of the filter. Where decisions are made based on the effectiveness of air filtration units, it is important to validate the sensors in settings comparable to the field.

In our evaluation, we tested several laser based particle sensors with costs ranging from tens to thousands of dollars. Measurements were compared against the Aerodynamic Particle Sizer (APS) 3321, a "gold standard" advanced instrument for particle counting. Two particle sources, ISO road test dust and sodium chloride was used. Sensors were placed in a custom built test chamber, while the APS sampled air with a tube feedthrough. Particles were introduced into the chamber until the concentration reached 1500 ug/m^3, and measurements began when the concentration fell below 1000 ug/m^3, which is typical of highly polluted cities. Particles were reintroduced when the concentration fell below 10 ug/m^3, and this was repeated two times.

Sensor readings were plotted against APS and strong positive correlations (R^2 > 0.78) were observed. Counting efficiency typically decreased at higher concentrations. This is likely due to particles blocking the laser from reaching those behind it, causing them to not be counted. For all sensors, different readings for the same concentration was obtained depending on the particle source. Particle counts were also always underestimated. Mass based concentration readings were over and under estimated. Laser based sensors count particles based on the light scattered, and perform calculations based on a pre-set refractive index. Mass concentration reported is based on a pre-defined density. Since ISO road test dust and sodium chloride particles have different refractive indices and densities, different readings result for the same concentrations.

Although particle counts were under-reported, and readings different based on particle material, effective use in air filtration units is possible. The tested sensors were found to be strongly correlated with APS and have high repeatability, which demonstrates their potential effectiveness.

As long as the sensors are calibrated in the field using an advanced instrument, accurate readings will be obtained. In an indoor environment, the particle source does not significantly change and this ensures repeatability over long periods of time.