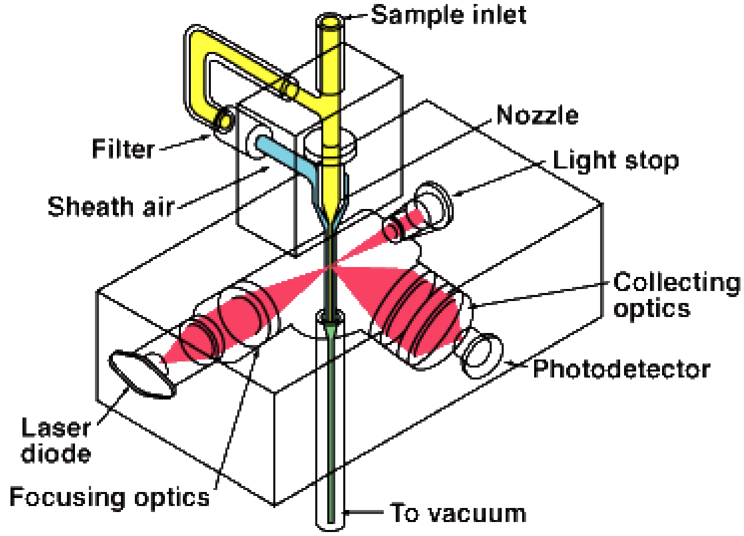
DUSTTRAK™ AEROSOL MONITOR THEORY OF OPERATION

APPLICATION NOTE ITI-036



The Model 8520 DustTrak™ Aerosol Monitor uses light scattering technology to determine mass concentration in real-time. An aerosol sample is drawn into the sensing chamber in a continuous stream. One section of the aerosol stream is illuminated with a small beam of laser light. Particles in the aerosol stream scatter light in all directions. A lens at 90° to both the aerosol stream and laser beam collects some of the scattered light and focuses it onto a photodetector. The detection circuitry converts the light into a voltage. This voltage is proportional to the amount of light scattered which is, in-turn, proportional to the mass concentration of the aerosol. The voltage is read by the processor and multiplied by an internal calibration constant to yield mass concentration. The internal calibration constant is determined from the ratio of the voltage response of the DustTrak™ monitor to the known mass concentration of the test aerosol.

Light scattering-type aerosol monitors respond linearly to the aerosol mass concentration. That is, for a monodisperse aerosol, one particle scatters a fixed amount of light; two particles scatter twice as much light; and 10 particles scatter 10 times as much light. The scattered light is dependent upon particle size. This dependence is most dramatic for particles with diameters (D) less than one third the wavelength of the laser (~ 0.25 µm). For these small particles, the scattered light decreases as a function of the sixth power of the diameter (D^6). The laser diode used by the DustTrak™ monitor has a wavelength of 780 nanometers (nm) which limits the smallest detectable particle to about 0.1 µm. The scattered light is also dependent upon the index of refraction and light absorbing characteristics of the particles. Light scattering from particles can be modeled using a complex set of equations using Mie light scattering theory. The light scattering dependence on particle size is characteristic of all aerosol monitors of this type. The effect of particle size dependence on the mass concentration computed by the DustTrak™ monitor is greatest for monodisperse aerosols. If you need very accurate mass concentration readings and use the DustTrak™ monitor in an environment where a specific aerosol type predominates, you can recalibrate the unit for that aerosol.

The DUSTTRAK™ monitor is calibrated against a gravimetric reference using the respirable fraction of standard ISO 12103-1, A1 test dust (Arizona Test Dust). This test dust has a wide size distribution covering the entire size range of the DUSTTRAK™ monitor and is representative of a wide variety of ambient aerosols. The wide range of particle sizes averages the effect of particle size dependence on the measured signal.The sensing volume of the DUSTTRAK™ monitor is constant and is defined by the intersection of the aerosol stream and the laser beam. Mass is determined from the intensity of light scattered by the aerosol within the fixed sensing volume. Since the sensing volume is known, the information can be easily converted by the DUSTTRAK™ microprocessor to units of mass per unit volume (mg/m^3).

The optics inside the DUSTTRAK™ monitor are kept clean by surrounding the aerosol stream in a sheath of clean filtered air. This sheath air confines the aerosol to a narrow stream and prevents particles from circulating around the optics chamber and collecting on the optics. Besides keeping the optics clean, this allows the DUSTTRAK™ monitor to respond quickly to sudden changes in concentration.

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