17.3: Particle Size Measurement by Light Scattering

There are several techniques for measuring the Particle Size Distribution (PSD) of a powder, but the most popular is based on the way that particles scatter light, which depends on their size. Such scattering is very commonplace. A light beam passing through a column of smoke is reduced in intensity, but little of this reduction is due to actual absorption of light by the particles and, if the column were to be viewed from the side in a darkened room, it would be clear that most of the "lost" light is being scattered sideways. This is mainly Fraunhofer scattering, similar to that emerging from a narrow slit. The corresponding equation is provided here.

Measurement of the intensity of light scattered from a dispersion of particles, as a function of scattering angle, thus allows the particle size distribution (PSD) to be deduced. Particles are normally dispersed in a liquid, which may need to be continuously stirred, and laser light is used, giving high incident intensities at a fixed wavelength. Software is supplied that allows the PSD to be automatically produced after a short time (~1 minute) of measurement.

The range of particle size for which this technique is reliable is from around 1 μm up to ~100 μm, which is satisfactory for many powders. The presence of smaller particles can be analysed via the effect that Brownian motion has on them, creating small fluctuations in the intensity of light scattered through large angles. These fluctuations can be detected, allowing measurement of particles down to about 0.1 μm, although specialised experimental set-ups are required for this.

The image below shows a set-up for measurement of PSD via scattering of laser light (www.lsinstruments.ch/technolo...ht_scattering/)
The two videos below were obtained using a set-up similar to that shown above, with the two powders used in the previous page suspended in rapeseed oil. (As indicated there, these particles remain in suspension for extended periods.) The first shows the outcome with the coarser particles. It can be seen that most of the scattered light is being diffracted through an angle of about 0.2-1°, which is broadly consistent with the Fraunhofer equation (see above). The stochastic nature of the scattering events is apparent in this video.

https://www.doitpoms.ac.uk/tlplib/po...00mscLaser.mp4

Laser Scattering with 200 μm particles in suspension

The corresponding video for the 30 μm powder particles can be seen below. It can be seen that the average scattering angle is now somewhat larger - up to about 2°, again in approximate agreement with the Fraunhofer equation. Also, while there are again random fluctuations as the individual particles tumble through the laser beam, the fact that they are finer, and there are more of them, leads to a slightly more uniform and constant image than with the coarser particles.

https://www.doitpoms.ac.uk/tlplib/po...30mscLaser.mp4

Laser Scattering with 30 μm particles in suspension