UNDERSTANDING LIGHT TRANSMITTANCE VALUES TO OPTIMIZE SAMPLE CONCENTRATION

The amount of light transmitted through the cell serves as a measure of particle concentration. Understanding how different materials interact with the incident light and affect the T% is important to proper method development.

Background

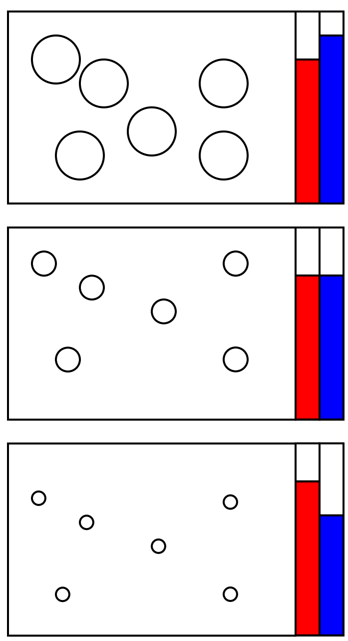
Particle size analyzers using static light scattering have an optimum sample concentration range in order to produce the best results. Horiba's LA-series instruments use the amount of light transmitted through the cell (T%) to measure sample concentration.

The T% value is simply the amount of light that is transmitted directly through the cell relative to the 100% value set in the Blank measurement. The greater the amount of particles in the cell, the lower the T% value will be.

The goal is to find a concentration that provides a sufficiently strong signal to the particle detectors, while avoiding multiple scattering from too-high a concentration. This has been empirically determined to be 70-95% transmission for the Horiba optical systems for a wide range of materials. The requirements of a particular sample need to be evaluated to determine the most appropriate conditions for measurement.

Size vs. Wavelength Effects

For particles larger than about one micron, increasing sample concentration will reduce the T% by a corresponding amount. As the particles approach and get smaller than the wavelength of the incident light, some of that light "misses" the particles leading to a discontinuity in the concentration vs. transmittance relationship. This light reaches the transmittance detector, yielding a higher T% value than would otherwise be the case.



Effect of Size on T% Values for Otherwise Equivalent Particles

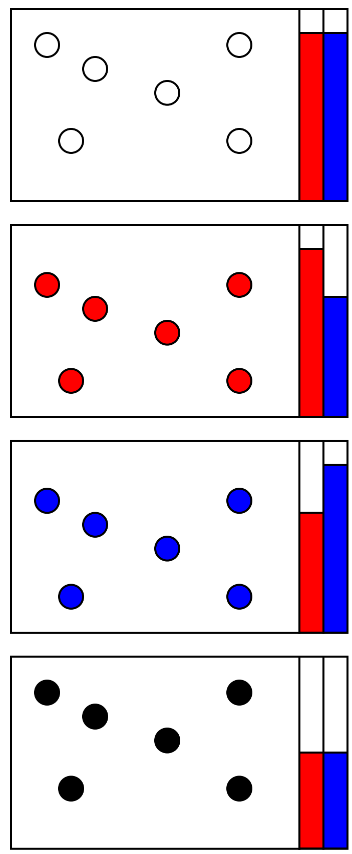
The LA-900-series instruments use two light sources – a 633nm wavelength helium-neon laser and a tungsten-halogen lamp with an optical filter producing 405nm wavelength light. This shorter wavelength light will be less likely to bypass the smaller particles, so for the sub-micron particles, the blue light will tend to be preferentially blocked by the particles, leading to a lower T% reading than for the laser. The smaller the particles, the more pronounced this effect will be.

T% values for Polystyrene Latex samples of different sizes		
Particle size	Laser T%	Lamp T%
10 micron	78.4	84.6
1 micron	93.7	91.4
500 nm	92.5	79.8
100 nm	96.7	81.3

<u>Effect of Particle Color</u>
The second factor which can show differences between the two T% readings is the color of the particles. White or black particles will absorb light of all wavelengths equally, but a colored material will preferentially absorb light of a complementary wavelength.

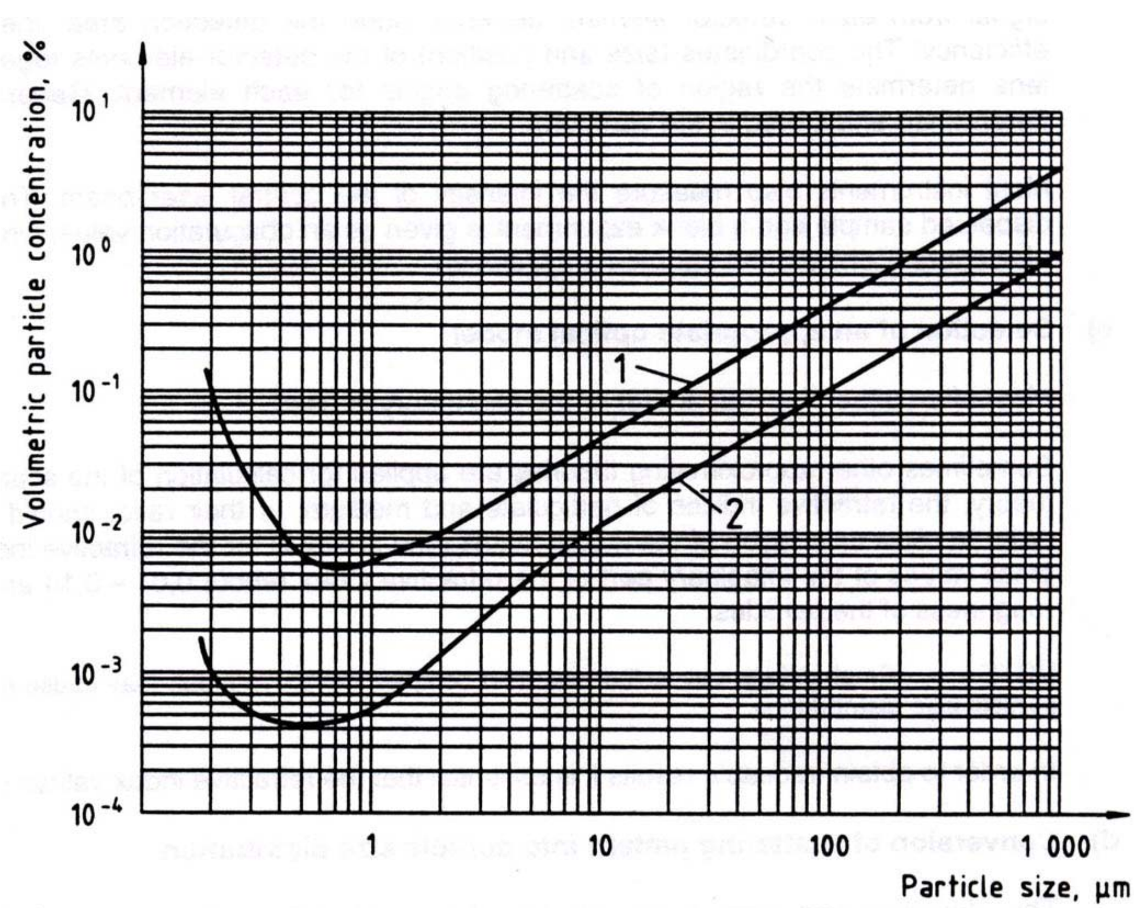
Samples that appear yellow or red will preferentially absorb the blue light, yielding a significantly lower blue T% than might otherwise be expected. A blue or green colored sample will preferentially absorb of the red light, yielding a significantly lower red T% than might otherwise be expected.

Particles which absorb all wavelengths equally, such as metals or carbon black, will have a different concentration vs. transmittance curve. For a given amount of sample and particle size, the T% will be lower. For a given T% reading, there will actually be less sample in the system. This might lead to a weaker signal on the particle detectors than desired. In order to still get a good signal to the detectors, it is better to run at a lower T% value than we would for an equivalent size and concentration of material that transmits light through the particle (translucent or transparent).



Effect of Particle Color on T% Values for Otherwise Equivalent Particles

Size vs. Statistics
Although not subject to light scattering effects, particles in the hundreds of microns tend to require a higher total concentration than smaller particles simply because of the small total numbers of these large particles. This small number of particles leads to inconsistency of the particle flow through the cell, thus the detector signal fluctuates significantly. For materials with a portion of the sample over several hundred microns, it has been found preferable to run sample concentrations that result in a T% at the lower end of the standard range.



Typical upper (1) and lower (2) particle concentration limits for a laser diffraction instrument. This range will depend on particulate material, distribution width, and other variables

For further information on this document or our products, please contact:
Horiba Instruments, Inc.
17671 Armstrong Ave.
Irvine, CA 92614 USA
(949) 250-4811
www.horiba.com