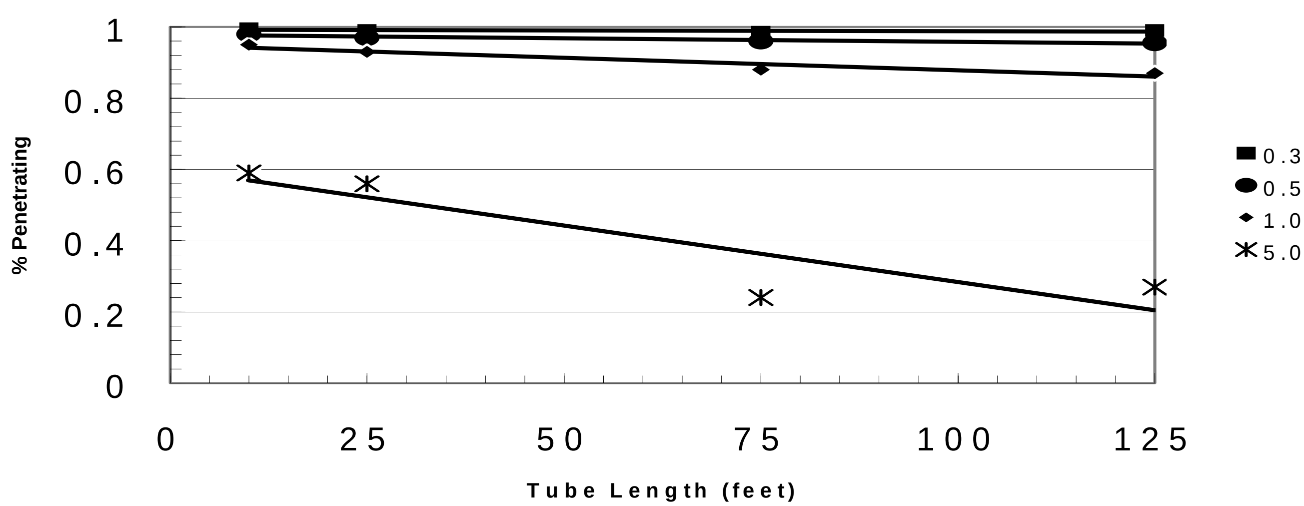
Sampling 5.0 Micron Particles

Summary
As the foremost worldwide experts in aerosol particle counting, Particle Measuring Systems recommends strongly *against* using a 0.1 CFM unit to sample and monitor 5.0 µm particles. Instead, a 1.0 CFM flow is required to provide adequate sample to ensure the detection of undesired 5.0 µm particles.

Particle Loss in Transport
In training several thousand students at the Particle Measuring Systems' Particle College, instructors have consistently stressed the difficulties of sampling large particles; the inertia in such particles is so great that they cannot effectively travel through the sample tubing without bumping into and adhering to the tubing walls. Thus, they will present to the particle counter, not when they first appear, but only when something bumps against the tubing, jarring them loose.

The well-documented exception occurs when the sample tubing is evacuated at an unusually high flow rate (e.g., 2.0 to 3.0 CFM). Such rates normally are seen only in manifold systems. These systems can transport large particles for longer distances, but cannot provide continuous monitoring of the sampling probe of interest. Even with the use of such high flows, the 5.0+ µm particles suffer such high fallout rates that a maximum of 20% can traverse 125' of tubing (see Figure 2) – and this *only if the tubing is absolutely straight*, with none of the normal bends.

Figure 2. Particle Loss Rates in Bev-a-line XX tubing, 3/8 I.D., using PMS 3 CFM Aerosol Manifold Flow Rate



Design Recommendations

As a result, Particle Measuring Systems' research shows that the most reliable way to count large particles is to design the system as follows:

1) Sample the maximum quantity of air, thereby maximizing the chances of a 5.0 µm particle being present. This is best done by increasing the flow rate to 1.0 CFM, which provides 10 times the sample to analyze as a 0.1 CFM flow.

2) Minimize the sample tubing, thereby minimizing large particle fallout.

> a) NO Tubing: Given laminar flow, the particles sampled will be those present in the cylinder of sample air that enters the sample inlet of the particle counter. When isokinetic sampling at a constant vertical flow rate, the area of the base of the cylinder will be directly proportional to the sample flow rate.
>
> > For example: For a vertical flow rate of 90 ft/min, the inlet area of an isokinetic probe will be:
> >
> > > For 1.0 CFM probe: 18.00 mm radius => area of 1032 mm^2.
> > >
> > > For 0.1 CFM probe: 5.75 mm radius => area of 103 mm^2.
>
> Thus, with 1.0 CFM, the area for catching large particles is ten times as large.
>
> b) Minimal Tubing: If tubing cannot be totally eliminated, then the higher the sample velocity through the tubing, the fewer large particles will be lost. In comparison:
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> > At 1.0 CFM, the sample velocity is approximately 3,350 ft./min.
> >
> > At 0.1 CFM, the sample velocity is only 1,100 ft./min. and will lose a much higher percentage of the 5.0 µm particles.

Conclusion

In using Particle Measuring Systems' particle counters to monitor 5.0 µm particles, be sure to counsel our customers to use a 1.0 CFM instead of a 0.1 CFM particle counter.

William W. Belew
Product Line Manager, Aerosols
Particle Measuring Systems
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