Technical Note

Performance of the VersaTrap Spore Trap Cassette
Cat. No. 225-9820 and 225-9821

Spore Trap Principle of Operation
A spore trap cassette, such as VersaTrap®, is an inertial impactor—a sampler that collects particles based on their inertia. As shown in Figure 1, the particle-laden air enters the sampler through the inlet nozzle. While the airstream is reflected and flows around the collection plate, particles with sufficient inertia deviate from the airstream lines and are collected onto the collection plate. Smaller particles, with less inertia, follow the airstream lines and leave the sampler through the outlet.

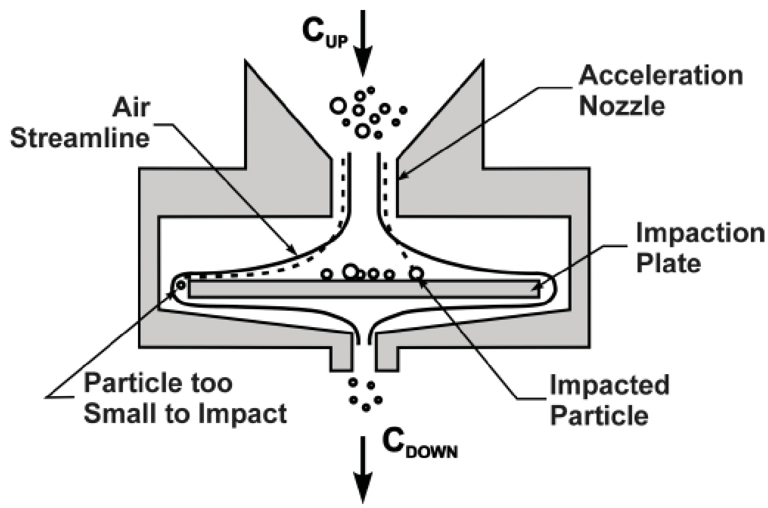

Figure 1. Schematic of an inertial impactor

Collection Efficiency of Inertial Impactors
The size of particles collected depends on their velocity which is equal to the airjet velocity at the sampler's inlet slit. With the increase of velocity, particles will gain more inertia. This is desirable as smaller particles may gain enough inertia to be collected on the collection substrate, however, the gain of additional inertia may also cause larger particles to bounce. To prevent particle bounce and increase overall collection efficiency of an inertial impactor, the collection plate is covered with a specially formulated sticky substrate.

Performance of an inertial impactor is defined using the 50% cut-off size (d_{50}) which is the measure of the particle size at which 50% of the particles are collected and 50% pass through the sampler. Ideally, all particles smaller than the 50% cut-off size will pass through the impactor and all larger ones will be collected on the collection substrate. In reality, the collection efficiency curve is S-shaped. The 50% cut-off size can be found from the impactor's collection efficiency curve which is determined by measuring the concentration and size of particles upstream (C_{Up}) and downstream (C_{Down}) of the sampler.

VersaTrap Collection Efficiency
The VersaTrap spore trap cassette underwent recent studies to determine its characteristics at flow rates ranging from 5 to 30 L/min. Using experimental** data, the collection efficiency curves corresponding to six different sampling flow rates were plotted and 50% cut-off sizes and sharpness of collection efficiency curves of the VersaTrap cassette were determined (Figure 2.).

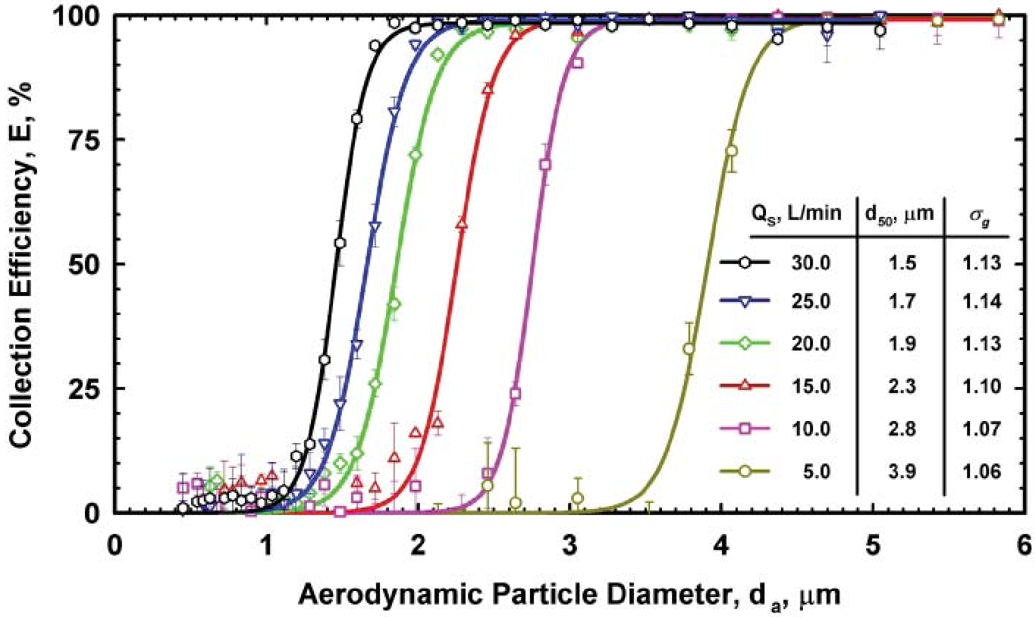

Figure 2. Performance of VersaTrap spore trap measured at six different sampling flow rates.

Explanation of Graph in Figure 2

In Figure 2, each curve represents the collection efficiency of the VersaTrap cassette when operated at different flow rates. Each point is the average of three measurements and error bars indicate standard deviation. The table inside the graph provides the 50% cut-off size and geometric standard deviation (σ_g, efficiency curve sharpness)*** measured for each flow rate.

Discussion of Data

The data presented in Figure 2 show collection efficiency that increases sharply from 0 to 100% near the 50% cut-off size at each flow rate tested. Larger particles were collected with close to 100% efficiency for flows from 5 to 20 L/min. Minimal particle bounce (less than 10%) was observed for 4.0 to 6.0 µm particles at flows from 25 to 30 L/min. There was no bounce of larger particles observed at flow rates 20 L/min and below. Figure 3 depicts the performance of the VersaTrap at 15 L/min, the recommended flow rate for use with spore traps.

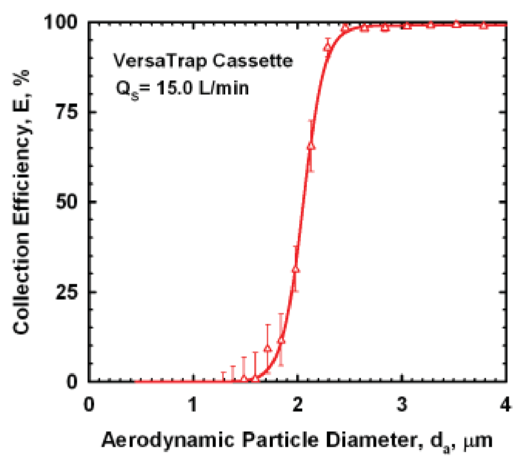

Figure 3. VersaTrap performance at 15L/min.

Conclusion

Based on the above study, it is concluded that the VersaTrap spore trap cassette provides sharp collection efficiency at any sampling flow rate between 5 and 30 L/min providing the user with the option of targeting specific size particles. The VersaTrap cassette started to demonstrate bounce of larger particles at a sampling flow rate of 25 L/min. The observed particle bounce was minimal and less than 10% even at 30 L/min. VersaTrap provides a 2.3 µm 50% cut-point at 15 L/min.

** *The data was acquired by using an Aerodynamic Particle Sizer APS 3320 to measure aerosol concentration upstream and downstream of a VersaTrap cassette. Potassium sodium tartrate was used to generate the solid spherical test aerosol particles.*

*** *The sharpness of the collection efficiency curve of the impactor is determined using a geometric standard deviation,* $\sigma_g = \sqrt{d_{84.1}/d_{15.9}}$, *where* $d_{84.1}$ *and* $d_{15.9}$ *are the aerodynamic particle sizes for which collection efficiency is 84.1% and 15.9% respectively. The closer the* σ_g *is to 1.0, the sharper the efficiency curve (**an ideal impactor*** σ_g ***is 1.0,** i.e. the collection efficiency curve is completely vertical).*