



Understanding Sampler Performance Measures

In order to understand the level of performance of a concentrating air sampler, it is important to understand the differences between the various measures commonly used to describe the overall concentrating performance.

Normally the measures are based on ratios of the sample concentration, C_s at some time during the sampling period and the ambient air particulate concentration, C_a , and can be derived from the following equation. The formula below shows the relationship of sample concentration versus air concentration for a concentrating liquid based air sampler assuming no loss of material over time.

$$C_s = \frac{F \cdot n}{v} \cdot t \cdot C_a,$$

Where:

C_s : is the Sample concentration at any given time

F : is the flowrate of the sampler

n : is the sampling efficiency of the sampler for a given particle size

v : is the volume of the liquid sample produced by the system

t : is the sampling duration

C_a : is the ambient concentration

Note that this equation also applies to non-concentrating liquid based air samplers, however the sample volume will generally be time dependent for those systems and therefore the sampling duration will cancel the time factor in the equation and will provide a fixed sample concentration based only on the ambient concentration and sampler characteristics.

One traditional measure of sampler performance is the Concentration Factor C_f , which is a dimensionless number indicating that the sample concentration is some number of multiples of the air concentration. By rearranging the above formula as shown below, one can arrive at an equation for Concentration Factor, C_f .

$$C_f = \frac{C_s}{C_a} = \frac{F \cdot n}{v} \cdot t,$$

From this equation one can see that the concentration factor is time dependent, and therefore it will change based on sample duration. A concentration factor should normally be stated for a specific sampling duration; without this duration stated the performance of the sampler can be ambiguous.

Note that sometimes the Concentration Factor is stated in unequal units of Air volume per liquid volume, rather than being completely dimensionless. For instance it may be stated as X liters of air per mL of sample, or L/mL, which will show the factor as being 1000 times less than an equal unit, dimensionless, Concentration Factor. Evogen will always

state Concentration Factor in equal dimensionless units, or in other words, Liters of Air per Liters of Sample (L/L).

In order to unambiguously define the performance of our samplers, Evogen uses Concentration Rate, R_{conc} , as the measure of performance. The Concentration Rate is a function of only the key sampler characteristics and is based on multiples of air concentration per unit time or rather is the Concentration Factor per minute. Using this measure of performance, a user can determine exactly what sample duration is required to provide a given sample concentration assuming a known ambient concentration. By yet again rearranging the above formula, one can arrive at an equation for Concentration Rate, R_{conc} which is dependent on only the sampler characteristics as shown below.

$$R_{conc} = \frac{C_f}{t} = \frac{F \cdot n}{v}$$

This measure may also be stated in unequal units of air volume per liquid volume, however as indicated above regarding Concentration Factor, Evogen will always state this value in equal units of Air to Sample, (L/L/min).

An example calculation of Concentration Rate is as follows using characteristic values for the OMNI 3000 air sampler:

$$R_{conc} = \frac{F \cdot n}{v} = \frac{300L/\text{min} \cdot 0.46}{0.009L} = 15,333/\text{min},$$

This indicates that the number of particles in one unit of sample increases by approximately 15,333 multiples of the number of particles in the same unit of air in every minute of sampling.