Facts – Reflections - Methods

Cyclones

Flow rate corrections

It sometimes happens that a study involving a size selective sampler, such as a cyclone, will be run at the wrong flow rate. What can be done about it? The correct answer is "Repeat the work"! However, there are many reasons why this can not be accomplished or should not be done.
Can the data be corrected? Not if you are going into court with it, or putting it to an equally serious use. With this advice and the requisite protective disclaimer (Disclaimer & Limit of Liability), the subject may be addressed.

Cyclone Size Selective Samplers all have a "Size Cut" associated with them. It is D_{50}, the mid point of the penetration curve(A). As the flowrate (Q) through the device increases, the D50 will decrease. As Q decreases the D_{50} will increase. Although there are practical limits, Cyclones will have a number of cut points associated with a range of flows. For every cyclone manufactured by BGI, a spread sheet has been prepared which will permit the calculation of a D_{50} for any practical flow rate.
The next question is, can the measured concentration be adjusted to what it would have been had the correct flow rate been used. With reservations, it can be done. The reservations relate to the fact that the wrong flow rate may have caused aerosol aspiration errors. This means that at a different velocity you may be inspiring the wrong segment of the spectrum. How aspiration is accomplished is further compounded by the velocity of the air passing by the cyclone inlet. If we are willing to ignore this potential problem, the answer is to reduce (or increase) the determined concentration by the ratio of the flow rates. Using a simple example:

The GK2.05 cyclone was run at 4.5 lpm instead of 4 lpm. From the calculator page for this cyclone we determine that the D_{50} was 2.18 µm rather than the correct 2.5 µm.
Once the filters have been weighed and the concentration calculated, it should be reduced by the ratio 4/4.5=0.889. However, while we indeed over sampled, we did not gather enough of the larger particles. To compensate for this error, we must increase the concentration by the missing particles between 2.18 and 2.5 µm. This varies as the volume of the AED, so a simple cubical relationship will suffice:

(2.53 - 2.183)= (5.264)1/3 =1.736

Taking the increase and the decrease together, the adjustment amounts to a concentration multiplier of:
1.526 X 0.889 = 1.356

(A) The penetration curve is an experimentally derived plot of particle diameter (AED) vs. penetration. The Mid point of the curve is called the D_{50}. Some investigators prefer to plot efficiency rather than penetration. There are arguments for either approach but, the value of the D_{50} will be the same in either case. AED stands for Aerodynamic Equivalent Diameter. The aerosol is always normalized to spheres of unit density.

58 Guinan Street ● Waltham, MA 02451 ● Tel: 781-891-9380 ● Fax: 781-891-8151
http://www.bgiusa.com e-mail: g@bgiusa.com