Size Selective Sampling with the BGI 4 Cyclone

Introduction

Size Selective Sampling has been in vogue for over 30 years. Initially, it was used to determine the Respirable Fraction of an Aerosol relevant to occupational health exposures. In 1987, the US EPA introduced a standard for ambient air sampling called PM-10 (Particulate Matter 10 micrometers). Currently, in the occupational health area, we have new international standards defined as:

Respirable: 4
Thoracic: 10
Inhalable: 100

The US EPA currently defines both PM-10 and PM-2.5. PM-1 has not been mandated but is of interest to health effects investigators. The old EPA standard was for TSP (Total Suspended Particulates) which related to particles 100 micrometers or less.

All standards past and present refer to an Aerodynamic Equivalent Diameter (A.E.D.). This simply means that no matter what a particle's size, shape or density, it is considered to have properties equivalent to the sedimentation velocity of a unit density sphere. There are sufficient mathematical relationships to cover virtually all conversions. In reality, it is not necessary to make these conversions since rules are written in terms of A.E.D. and all sampler calibrations are converted to A.E.D.

The "cuts" which are mandated by regulation, are not sharp, but are defined by the diameter corresponding to the 50% point.

In the case of the respirable sampling this means that of the distribution sucked into the sampler 50%, 4 micrometer-A.E.D. and greater is captured (not available for analysis) and 50%, 4 micrometer-A.E.D. and less goes onto the filter to be analyzed. This definition applies to all standards listed except for the old TSP ex-standard, which is defined as 100 micrometers A.E.D. and less. Additionally, all standards (except TSP) define a shape to the collection curve and a tolerance.

Practical Applications:

There are approved, recommended or mandated devices for all current standards, which must be used for Federally regulated compliance sampling. Nevertheless, there are many occupational, ambient and particularly, indoor (sick building) situations, wherein it is desirable to be able to sample for investigatory purposes to some selected cut. A publication by Bartley et al. and another one by Kenny et al. present data which makes it possible to sample over a wide range of cuts.

In utilizing the information presented below, a number of factors must be borne in mind.

1. All size cuts given are \(D_{50}\).
2. All size cuts refer to aerodynamic equivalent diameter.
3. Some values given are outside the ranges tested and are extrapolated.
4. Both the Bartley\(^a\) and Kenny\(^b\) equations yield a \(D_{50}\) of 4.37 micrometers, for the respirable cut rather than 4 micrometers. This is because they based their equations on the best overall fit to the entire (defined) respiratory curve.
5. For the details of the equations, the original references \(^5,6\) should be consulted. For practical purposes, the following look up table is presented, as it applies to BGI4CP and Casella Cyclones only.
<table>
<thead>
<tr>
<th>$D_{50}$ Diameter Micrometers</th>
<th>Bartley Flow Rate LPM</th>
<th>Kenny Flow Rate LPM</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.E.D.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7.5</td>
<td>8.4</td>
<td>Potential PM-1</td>
</tr>
<tr>
<td>2</td>
<td>4.25</td>
<td>4.48</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>3.5</td>
<td>3.65</td>
<td>PM-2.5</td>
</tr>
<tr>
<td>4.37 (4)</td>
<td>2.2</td>
<td>2.2</td>
<td>Respirable</td>
</tr>
<tr>
<td>5.2</td>
<td>1.9</td>
<td>1.88</td>
<td>Old Respirable (UK)</td>
</tr>
<tr>
<td>10</td>
<td>0.8</td>
<td>0.8</td>
<td>Thoracic</td>
</tr>
</tbody>
</table>

References

1. American Conference of Governmental Industrial Hygienists (1964) Particle Size Selective Sampling in the Workplace. Pub. No. 0830 ACGIH, Cincinnati, OH.