L3. Weighting Error — the Often Neglected Component of the Sampling Errors

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Pierre Gy has developed a complete sampling theory [1-3]. He divides the sampling errors into two main classes: 1) Errors arising from incorrect sampling equipment and procedures and 2) Statistical sampling errors. To class 1) belong sample delimitation, sample extraction and preparations errors and into class 2) fundamental sampling error, grouping and segregation error, long range point selection error and periodic point selection error. There is also an eighth error component, called weighting error. Weighting error is made if a simple average is calculated from samples taken from a continuous object, e.g. from a process stream, where the flow-rate varies, or samples of equal sizes are cut from a continuous object, where the density varies along the object. In sampling process steams this error is eliminated, if proportional cross-stream sample cutters are used, the weights of the samples are recorded and the mean of the lot, a_L, is estimated as the weighted mean:

$$a_L = \frac{\sum M_i a_i}{\sum M_i} = \sum \frac{M_i}{\overline{M}} a_i \quad (1)$$

Here M_i is the weight, a_i the analytical result of sample i and the mean sample weight. Weighting error is also eliminated in this case if all the samples are combined into one homogenized composite sample, which is then analyzed. The uncertainty (relative standard deviation) of the mean, a_L, can be estimated from the variogram of the experimental heterogeneity, h_i, of the process by using the technique Gy has developed.

(2)

When high-volume gas or liquid streams are sampled it usually not possible to use cross-stream sampling. In this case the sample masses in Eq. 1 can be replaced by flow-rates at the sampling time, if reliable simultaneous flow-rate measurements are available. To avoid sampling in composite sample in this case, the sampling time must be related to the low-rate measurement; either sample increments of equal size are drawn when a fixed volume has passed the sampling point, ore time intervals during which the samples are drawn are proportional to the flow-rates at sampling time.

Depending on case the weighting error can be really significant. Examples, both simulated and real cases, are shown.

1. Gy P.M., Sampling of Particulate Materials, Theory and Practice, Elsevier, Amsterdam, 1982.
2. Gy P.M., Sampling of Heterogeneous and Dynamic Material Systems, Elsevier, Amsterdam, 1992.
3. Gy P.M., Sampling for Analytical Purposes, John Wiley & Sons Ltd, Chichester, 1998.