



A New High Precision Method of Calibrating Test Sieves

Author:

Dr Graham Rideal
Founder and Senior Scientist
Whitehouse Scientific Ltd

Background

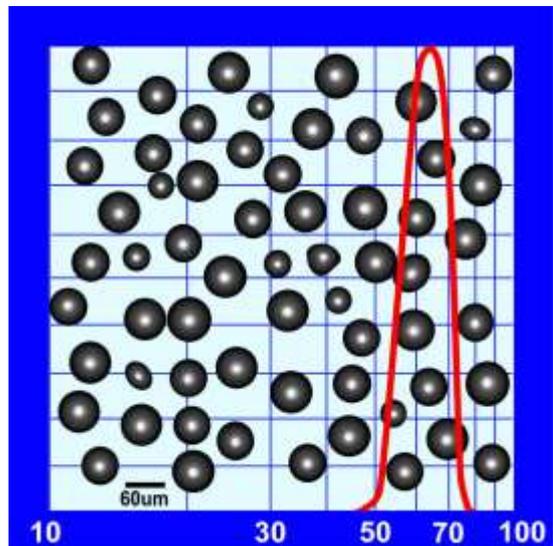
Sieve analysis has been described as the 'Cinderella' of particle metrology in that it does most of the work, but gets little of the credit. The popularity of the method is evidenced by the fact that there are literally millions of sieves currently in use around the world. Sieving remains unchallenged as the least expensive method of particle size analysis. However, with the introduction of increasingly stringent quality assurance specifications, users are demanding higher precision from the technique.

Microscopy has been the preferred method of sieve calibration but it has a number of limitations:

- (1) Equivocal measurement. Two sets of data are produced: the average widths in the X and Y directions, which are invariably different.
- (2) Less than 0.1% of the apertures are inspected
- (3) The measurements are not directly traceable to the National Institute of Science and Technology (NIST)
- (4) The equipment required for the analysis is too expensive for the average laboratory so the sieve have to be sent away.

A second method employed has been the use of sieve calibration microspheres. Here microscopy was used to characterise fine glass beads, which in turn were used to measure the sieve aperture size. There are two main disadvantages with this method.

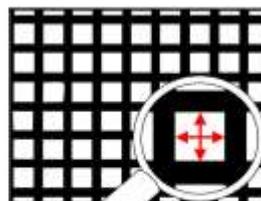
Firstly, because microscopy products an average circle diameter, the accuracy is dependent on the sphericity of the beads. If the beads are not totally spherical, the equivalent circle diameter can be quite different from the bead width, the parameter required to measure aperture size. Secondly, the wide particle size distribution of the calibration beads results in poor resolution during interpolation of the calibration graph.



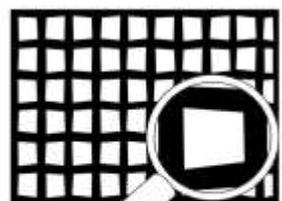
Narrow size distribution sieve calibration microspheres

63µm Electroformed Sieve

63µm Wire Woven Sieve



Uniform square apertures



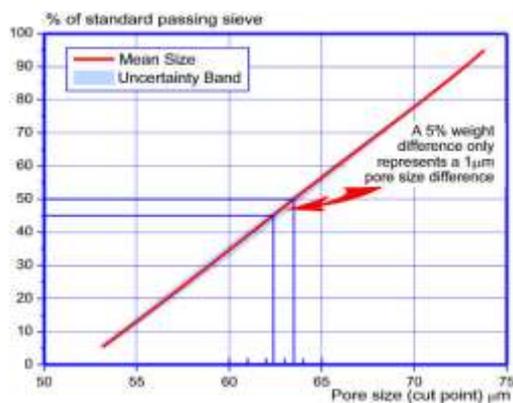
Indeterminate irregular apertures

The Precision Microsphere Approach

The new approach to sieve calibration has been to produce a range of narrow size distribution glass microspheres for individual test sieves from 20 – 3,350 microns. The standards are then certified by NIST traceable Electroformed sieves where aperture variations are typically less than 1 micron. As the certification method imparts a particle width dimension to the calibration microspheres, there are no particle shape implications as in the case of microscope analysis. Furthermore, the narrow size distributions give much better resolutions compared with broad distribution calibrating microspheres.

In order to eliminate sampling problems, the standards are individually packaged in single dose bottles sufficient to analyse a 200 mm diameter test sieve. The weights in each bottle are calculated to analyse over 80% of the available sieve apertures. For example, a 200 mm diameter, 63 micron test sieve has approximately 2.5 million apertures. The 1 g sample bottle contains approximately 2 million microspheres.

Certifying the Standards



A sieve calibration graph from a test certificate

Because the size distributions of the standards are so narrow, only three or four electroformed sieves could be used for an analysis so interpolation of the data could be suspect if there was not a uniform distribution of all the particle sizes within each standard. For this reason the higher resolution technique of microscopy was used to confirm the particle size distribution and so gave confidence in the interpolation of the sieving data. Only when the two sets of data were superimposeable was the Electroformed sieve data used to produce a calibration graph.

Calibrating a wire woven sieve

To calibrate a sieve, the complete contents of a single dose bottle is poured onto the sieve surface and shaken for about 1 minute. As standards are spherical they have a very high sieving rate that is independent of the shaking method. Therefore manual shaking, mechanical or electromechanical action, Airjet and sonic sieving all give the same results.

The percentage of the microspheres passing is then used to determine the aperture size from the calibration graph on the Certificate of Analysis. Because the size distributions are so narrow, variations of 5% in the percentage passing corresponds to micron for a 63 micron sieve making the technique highly accurate a mean aperture difference of only about 1 micron for a 63 micron sieve making the technique highly accurate.

Conclusion

The introduction of narrow particle size distribution standards has at last brought sieve calibration directly into the laboratories using the sieves and answers the demand for routine inspection by regulatory bodies. This novel approach to sieve calibration fulfils all of the requirements of the quality control laboratory by delivering simplicity, speed, accuracy and above all, NIST traceability to the International unit of length.

Bibliography

1. International Standards – ISO 3310-1: 2000, BS 410: 2000 and ASTM E11
2. F G Carpenter and V R Deitz, Glass Sphere for the Measurement of Effective Opening of Test Sieves, J. Res. NBS 47, 139 (1951) – now NIST
3. T Alan, and A A Khan, Critical Evaluation of Powder Sampling Procedures, The Chemical Engineer, May 1970
4. National Physical Laboratory, Teddington, Middlesex, TW 0LW, U.K
5. NIST, 100 Bureau Drive, Gaithersburg, MD 20899-8520, USA