U. S. Department of Commerce
Peter G. Peterson
Secretary

National Bureau of Standards

Certificate of Calibration

Standard Reference Material 1004

Calibrated Glass Beads

R. K. Kirby

This Standard Reference Material is intended for use in the evaluation of the effective opening of wire-cloth sieves in the range 34 μm through 120 μm (Test Sieve Nos. 400, 325, 270, 230, 200, 170, and 140). The weight of glass beads in each bottle is about 63 g. While most of the beads are spherical about 6 percent by number range from nearly spherical beads to ellipsoidal beads and fused beads.

The distribution of sizes in this SRM as determined by microscopic measurement is given in Table 1 as the weight percent of glass beads that are smaller than those that have the indicated diameter.

Over 13,000 beads were measured in the course of this calibration. These beads were sampled from 6 bottles that were selected at intervals throughout the bottling process. Repeat measurements were made on 2 of the bottles. The beads in these bottles were also carefully compared by sieving with the beads from 21 other bottles, also selected at random. These intercomparisons show no significant difference between beads from all 27 bottles. Considering the values of percent finer to be exact, the mean of the standard deviations associated with each diameter is 0.9 ± 0.4 μm. This error includes those errors due to the bottling and measuring processes and is to be expected when a given sieve is calibrated with different bottles of this SRM. In addition to this error, the user may impose a sieving error of about ± 2 μm, the result of differing ambient conditions. The reproducibility is, of course, dependent upon the sieving method and the care exercised by the operator.

The method that was used in the preparation of these calibrated glass beads (U.S. Patent No. 2,693,706, November 9, 1954) is described in a paper by F. G. Carpenter and V. R. Deitz, Glass Spheres for the Measurement of the Effective Opening of Testing Sieves, J. Research NBS 47, 139 (1951).

The overall coordination and evaluation of data leading to certification of this SRM was performed by R. K. Kirby.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by W. P. Reed.

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J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Table 1

Cumulative Size Distribution by Weight

Weight percent finer %	Diameter (Effective sieve opening) µm	Weight percent finer %	Diameter (Effective sieve opening) µm	Weight percent finer %	Diameter (Effective sieve opening) µm
2	28	34	61	68	89
4	31	36	62	70	90
6	34	38	63	72	92
8	36	40	65	74	94
10	38	42	67	76	96
12	40	44	69	78	100
14	42	46	71	80	105
16	45	48	74	82	109
18	47	50	76	84	111
20	49	52	78	86	113
22	51	54	80	88	115
24	53	56	82	90	117
26	55	58	83	92	119
28	56	60	84	94	121
30	58	62	86	96	123
32	59	64	87	98	126
		66	88		

Directions for Using Calibrated Glass Beads for the Evaluation of the Effective Opening of Sieves

The Calibration Process

The aperture size of a sieve can be determined as the average size of the openings in the sieve. However, the purpose of a sieve is to measure the size of particles, and therefore, it is the effective opening that must be determined. This is done by using particles of known size. Thus the effective opening is determined by the size of calibrated glass beads that will just pass through the sieve. This in turn permits the measurement of the particle size of an unknown material that will also just pass through the sieve.

The openings of a sieve are not all the same size, and particles that are coarser than the average opening can pass through the larger holes. Thus, the effective opening is generally larger than the average opening. In addition, the separation achieved by a sieve is not sharp. A few particles capable of passing the sieve are always retained. The number of particles retained or passed depends upon the manner and time of shaking, and any measurement of the effective opening must take these variables into account. To a large extent, the glass bead method of calibration automatically includes these effects because the sieves are shaken in the same manner when calibrated as when measuring an unknown material.

The sieve openings are essentially square in shape and particles of irregular shape can pass through even though one of the dimensions of the particle is considerably larger than the diameter of the opening. This is especially true for needlelike shapes. The average diameter of such irregular particles that pass a sieve cannot be considered equal to the effective opening of the sieve as measured by the diameter of spheres that just pass.

For the application of the calibrated glass beads to sieve analysis, see Carpenter, F. G., and Deitz, V. R., Methods of Sieve Analysis with Particular Reference to Bone Char, J. Research NBS **45**, 328 (1950).

Calibration Procedure

To evaluate the effective opening of testing sieves with glass beads, the entire standard is placed on the top sieve. The sieves are then shaken in a shaking device, or by hand, in exactly the same manner as that to be followed in routine analysis.

After the shaking has been completed, the stack of sieves is disassembled, and the beads are removed from each sieve and placed into a suitable weighing bottle. Experience has shown that loss of beads is very likely to occur during this operation. Therefore, the whole operation should be carried out over a large piece of glazed paper to permit recovery of any beads that may accidently be spilled. Such loss can also be minimized by the use of a funnel large enough to completely contain the sieve. The stem of the funnel should be fitted snugly into the mouth of the weighing bottle so that none of the beads can escape. The sieve is inverted into the top of the funnel and all of the glass beads are removed with a soft brush. Any beads that stick to the funnel should be swept into the weighing bottle with the brush.

Each of the sieve fractions is weighed to the nearest 0.01 g. After weighing, all beads are returned to the original container and kept for reuse. The weight percent retained on each sieve is calculated from the weights of the sieve fractions. The percent passing through each sieve is determined by subtracting the percentage on the coarsest sieve from 100 percent, the percentage on the next sieve from that result, and so on. The effective size of the sieve opening is determined by interpolation between the nearest values given in the calibration table.

Example of Calculation Procedure

An example of data and calculations are shown below. Seven sieves were calibrated at the same time. The original weight of the glass beads was 63.30 g. It may be noted that the sum of the weights shows a loss of 0.09 g. This loss is assumed to be evenly distributed and the sum of the weights is used to evaluate the percentages.

Example of calculation for effective opening

U.S. sieve No.	Weight on sieve	Weight percent		Opening of sieve	
		On sieve	Finer than sieve	Effective[a]	Nominal
140	9.99 g	15.81	84.2	111 μm	106 μm
170	5.88	9.30	74.9	95	90
200	14.86	23.50	51.4	77	75
230	8.12	12.84	38.6	64	63
270	6.44	10.19	28.4	56	53
325	7.73	12.23	16.1	45	45
400	3.29	5.21	10.9	39	38
Pan	6.90	10.92			
	63.21				

[a]Determined by interpolation between values given in the calibration table.

Foreign Material and Dirt

If the sieves are not cleaned sufficiently before the calibration, some foreign material will be found among the glass beads. If possible, this foreign material must be removed by hand. A dirty appearance of the glass beads indicates that they have picked up a small amount of dust. The weight of the dust is usually so small that only a negligible error is introduced.

If the sieves to be calibrated have been used they may be cleaned thoroughly with a soft brush, soap and water or solvents. Under no circumstance should a sharp object be used to dislodge particles that are stuck in the meshes.

Loss of Weight with Use

Experience has shown that there is a loss in weight of the beads with use. How great a loss can be tolerated without introducing large errors in the calibration is difficult to state. However, a quick check of the accuracy of the beads can be made by "cross-calibrating" a single sieve with the questionable beads and new or relatively little used beads. A variation significantly greater than ± 3 μm would indicate that the accuracy of the questionable beads has suffered from a loss of weight. If an SRM is ruined by either repeated use or accident, the only recourse is to purchase a new SRM from the National Bureau of Standards.