U. S. Department of Commerce
John T. Connor, Secretary
National Bureau of Standards
A. V. Astin, Director

Certificate of Calibration

Standard Reference Material 1017

Glass Spheres

This Standard Reference Material is primarily meant to be used in the evaluation of the effective opening of test sieves in the size range U. S. Standard No. 70 through No. 270. The effective opening is defined by the average size of particles which just pass the sieve.

The weight of glass spheres in each sample is about 22 grams.

The particle size distribution has been evaluated by measuring the diameter of 9,750 individual spheres selected by an adequate sampling procedure. The results are expressed in the table as the weight percent of the glass spheres that will just pass through the effective sieve opening.

Weight percent finer	Effective sieve opening	Weight percent finer	Effective sieve opening	Weight percent finer	Effective sieve opening
Percent	*Microns*	*Percent*	*Microns*	*Percent*	*Microns*
1.0	45	34.0	85	67.0	137
2.0	49	35.0	87	68.0	140
3.0	51	36.0	89	69.0	143
4.0	52	37.0	91	70.0	146
5.0	53	38.0	92	71.0	149
6.0	54	39.0	94	72.0	152
7.0	55	40.0	95	73.0	155
8.0	56	41.0	97	74.0	157
9.0	57	42.0	98	75.0	159
10.0	58	43.0	100	76.0	161
11.0	59	44.0	101	77.0	163
12.0	60	45.0	102	78.0	166
13.0	61	46.0	104	79.0	169
14.0	62	47.0	105	80.0	172
15.0	64	48.0	106	81.0	174
16.0	65	49.0	108	82.0	176
17.0	67	50.0	109	83.0	178
18.0	68	51.0	110	84.0	181
19.0	69	52.0	112	85.0	185
20.0	70	53.0	113	86.0	189
21.0	71	54.0	114	87.0	193
22.0	72	55.0	115	88.0	197
23.0	73	56.0	116	89.0	200
24.0	74	57.0	117	90.0	203
25.0	75	58.0	118	91.0	205
26.0	76	59.0	119	92.0	207
27.0	78	60.0	121	93.0	209
28.0	79	61.0	123	94.0	212
29.0	80	62.0	125	95.0	216
30.0	81	63.0	127	96.0	220
31.0	82	64.0	129	97.0	225
32.0	83	65.0	131	98.0	230
33.0	84	66.0	134	99.0	235

From a statistical analysis of the calibration data, it is estimated that the reproducibility of evaluations of the effective opening of test sieves with this Standard Reference Material is within ±5 percent of the nominal width of the sieve openings. This degree of reproducibility includes errors in the measurement of the particles and variations that occur in the preparation of the samples, and is to be expected when a given sieve is calibrated several times, using different samples of glass spheres. The reproducibility is, of course, dependent upon the sieveing method and the care exercised by the operator.

The method that was used in the preparation of these calibrated glass spheres (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. Res. NBS **47**, 139(1951) RP2238.

Washington, D. C. 20234
January 17, 1966

W. Wayne Meinke, Chief,
Office of Standard Reference Materials.

(This certificate supersedes certificate of 4-10-59)

(OVER)

Directions for Using Calibrated Glass Spheres for the Evaluation of the Effective Opening of Test Sieves

Calibration Procedure

To evaluate the effective opening of test sieves with this Standard Reference Material of glass spheres, the following procedure should be used for each test:

(1) The initial weight of the glass spheres is determined to the nearest 1/100 g (the weight shown on the label of each of these Standard Reference Materials is only meant to be a guide and should not be used in the calculations).
(2) Place the entire sample on the sieve, or on the top sieve of a stack of sieves, and shake in exactly the same manner and for the same length of time that is used in the routine sieving.
(3) Determine the weight of the glass spheres remaining on each sieve and in the pan to the nearest 1/100 g.
(4) The weight percent retained on each sieve is calculated, using the initial weight of the glass spheres. The percent finer than each sieve is determined by subtracting the percentage on the coarsest sieve from 100 percent and the percentage on the next sieve from that result and so on.
(5) The size of the effective opening of each sieve is determined by interpolation between the nearest values given in the calibration table.

Example of Calculation Procedure

Sample data and calculations are contained in the following table. U.S. Standard Sieves Nos. 70, 100, and 140 were calibrated at the same time. The initial weight of the glass spheres was 22.24 g. It may be noted that the sum of the weights shows a loss of 0.10 g.

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
	g	*Percent*	*Percent*	*Microns*	*Microns*
70	1.76	7.9	92.1	207	210
100	5.22	23.5	68.6	142	149
140	5.69	25.6	43.0	100	105
Pan	9.47	42.6			
	22.14				

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

Precautions

This Standard Reference Material may contain some foreign material mixed in with the glass spheres, but it will not have a significant effect on the calibration. Brush hairs, and similar material, may be removed with tweezers before use. To avoid further contamination of the sample, the sieves to be calibrated should be cleaned thoroughly with a sturdy brush (not too stiff), soap and water or solvents.

It has been noted that there is a loss in weight of the sample with use. While glass spheres of any size may be lost in the sieving and transfer operations, the smaller particles (up to 100μ) are more easily lost because static electric charges and excessive moisture will cause a tendency for them to stick to any surface that they touch. To minimize such a loss, the relative humidity should be kept at about 50 percent and the sieves, bottles, and other equipment should be kept as dry as possible. To avoid a general loss of spheres when transferring them from a sieve to a bottle, it is suggested that the operation be carried out over a large piece of clean paper and that a funnel be used that is large enough to completely contain the sieve. The stem of the funnel should fit snugly into the mouth of the bottle so that none of the spheres can bounce out.

This Standard Reference Material may be reused even though some of the glass spheres becomes lost. It is difficult to state how great a loss can be tolerated without introducing a significant error in the results, but a quick check can be obtained by comparing the openings of a particular set of sieves as determined by the questionable sample of glass spheres, with the openings of the same sieves as determined by a little-used sample of glass spheres. A variation significantly greater than ± 5 percent of the sieve opening of any sieve in the set would indicate that the accuracy of the questionable sample has suffered from the loss of spheres. If the sample is ruined either by repeated use or by accident, the only recourse is to obtain a new sample from the National Bureau of Standards.

Notes Regarding the Calibration Procedure

The effective opening is a measure of the size of particle which will just pass the openings rather than the size of the openings themselves. The openings of a sieve are not all the same size, and hence particles which are coarser than the average opening can pass through the larger holes. Thus, the effective opening is in general somewhat 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. Obviously, the number of small particles retained and the number of large particles passing through the oversize holes depend upon the manner and time of shaking, and any measurement of the effective opening must take these variables into account. The glass sphere method of calibration to a large extent automatically includes these effects because when the sieves are calibrated they are shaken in the same manner as with the unknown material.

It is recognized that the sieve openings are essentially square in shape and that particles of irregular shape can pass through even though one of the dimensions of the particle or "an average" of all dimensions, is considerably larger than the diameter of the opening. This is especially true for needlelike shapes. The average diameter of such irregular particles which pass a sieve cannot be considered equal to the effective opening of the sieve as measured by the diameter of spheres which just pass. The "average diameter" of irregular particles which pass a sieve of a certain effective size is a separate problem and is in no way dependent upon the method of evaluating the sieve opening.

A marked nonuniformity in the size of openings cannot be corrected by the glass sphere calibration. It is difficult to state how much nonuniformity can be tolerated in a testing sieve. At present there is no convenient simple test to measure the nonuniformity of the size of opening other than visual observation. Sieves which do not appear obviously deformed are usually sufficiently uniform, so that the glass sphere calibration will correct for the small amount of nonuniformity that does exist.

For the application of the calibrated glass spheres to sieve analysis see the following paper by F. G. Carpenter and V. R. Deitz, Methods of sieve analysis with particular reference to bone char, J. Res. NBS **45,** 328(1950) RP2143.