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

Certificate of Calibration

Standard Reference Material 1018

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. 20 through No. 70. 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 40 grams.

The particle size distribution has been evaluated by measuring the diameter of 10,000 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	199	34.0	399	67.0	645
2.0	206	35.0	404	68.0	653
3.0	211	36.0	409	69.0	662
4.0	216	37.0	414	70.0	671
5.0	221	38.0	419	71.0	679
6.0	225	39.0	425	72.0	687
7.0	229	40.0	432	73.0	695
8.0	233	41.0	442	74.0	703
9.0	237	42.0	452	75.0	711
10.0	241	43.0	462	76.0	720
11.0	246	44.0	471	77.0	732
12.0	252	45.0	479	78.0	745
13.0	259	46.0	485	79.0	758
14.0	266	47.0	490	80.0	771
15.0	273	48.0	495	81.0	783
16.0	279	49.0	500	82.0	794
17.0	285	50.0	505	83.0	804
18.0	290	51.0	510	84.0	814
19.0	294	52.0	517	85.0	824
20.0	299	53.0	526	86.0	834
21.0	305	54.0	537	87.0	844
22.0	312	55.0	550	88.0	854
23.0	319	56.0	562	89.0	864
24.0	326	57.0	572	90.0	874
25.0	332	58.0	579	91.0	884
26.0	338	59.0	584	92.0	894
27.0	343	60.0	589	93.0	905
28.0	349	61.0	595	94.0	916
29.0	356	62.0	605	95.0	927
30.0	365	63.0	615	96.0	939
31.0	375	64.0	623	97.0	951
32.0	385	65.0	630	98.0	965
33.0	393	66.0	637	99.0	985

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 ±2 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 sieving 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 2-5-59)

(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. 20, 30, and 40 were calibrated at the same time. The initial weight of the glass spheres was 42.08 g. It may be noted that the sum of the weights shows a loss of 0.01 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*
20	5.78	13.7	86.2	836	840
30	10.54	25.0	61.2	596	590
40	10.65	25.3	35.9	409	420
Pan	15.10	35.9			
	42.07				

[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. To avoid a general loss of spheres, the sieves and bottles should be dry and the relative humidity kept below 70 percent. When transferring the spheres 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 ±2 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.