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Appendices

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## Appendix A

Density of water at any temperature.

Temperature (°C)	Density (g/cm <sup>3</sup> )
20	0.9972
21	0.9970
22	0.9968
23	0.9966
24	0.9964
25	0.9962
26	0.9959
27	0.9957
28	0.9954
29	0.9952
30	0.9949
31	0.9946
32	0.9943
33	0.9940
34	0.9937
35	0.9934

Appendix B

°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C	°C	mV	mV/°C
-200	-5,891	0,016	-100	-3,553	0,031	= 0	± 0	0,040	+ 100	+ 4,095	0,041	+ 200	+ 8,137	0,040	+ 300	+ 12,207	0,042
190	5,730	0,018	90	3,242	0,032	+ 10	+ 0,397	0,040	110	4,508	0,041	210	8,537	0,040	310	12,623	0,042
180	5,550	0,020	80	2,920	0,033	20	0,798	0,040	120	4,919	0,041	220	8,938	0,040	320	13,039	0,042
170	5,354	0,021	70	2,586	0,034	30	1,203	0,041	130	5,327	0,041	230	9,341	0,040	330	13,456	0,042
160	5,141	0,023	60	2,243	0,035	40	1,611	0,041	140	5,733	0,041	240	9,745	0,041	340	13,874	0,042
150	4,912	0,024	50	1,889	0,036	50	2,022	0,041	150	6,137	0,040	250	10,151	0,041	350	14,292	0,042
140	4,669	0,026	40	1,527	0,037	60	2,436	0,041	160	6,539	0,040	260	10,560	0,041	360	14,712	0,042
130	4,410	0,027	30	1,156	0,038	70	2,850	0,042	170	6,939	0,040	270	10,969	0,041	370	15,132	0,042
120	4,138	0,029	20	0,777	0,039	80	3,266	0,042	180	7,338	0,040	280	11,381	0,041	380	15,552	0,042
110	3,852	0,030	10	0,392	0,040	90	3,681	0,041	190	7,737	0,040	290	11,793	0,041	390	15,974	0,042
+ 400	+ 16,395	0,042	+ 500	+ 20,640	0,043	+ 600	+ 24,902	0,043	+ 700	+ 29,128	0,042	+ 800	+ 33,277	0,041	+ 900	+ 37,325	0,040
410	16,818	0,042	510	21,066	0,043	610	25,327	0,042	710	29,547	0,042	810	33,686	0,041	910	37,724	0,040
420	17,241	0,042	520	21,493	0,043	620	25,751	0,043	720	29,965	0,042	820	34,095	0,041	920	38,122	0,040
430	17,664	0,042	530	21,919	0,043	630	26,176	0,042	730	30,383	0,042	830	34,502	0,041	930	38,519	0,040
440	18,088	0,043	540	22,346	0,043	640	26,599	0,042	740	30,799	0,042	840	34,909	0,041	940	38,915	0,040
450	18,513	0,044	550	22,772	0,043	650	27,022	0,042	750	31,214	0,042	850	35,314	0,041	950	39,310	0,039
460	18,938	0,043	560	23,198	0,043	660	27,445	0,042	760	31,629	0,041	860	35,718	0,040	960	39,703	0,039
470	19,363	0,044	570	23,624	0,043	670	27,867	0,042	770	32,042	0,041	870	36,121	0,040	970	40,096	0,039
480	19,788	0,043	580	24,050	0,043	680	28,288	0,042	780	32,455	0,041	880	36,524	0,040	980	40,488	0,039
490	20,214	0,043	590	24,476	0,043	690	28,709	0,042	790	32,866	0,041	890	36,925	0,040	990	40,879	0,039
1000	+ 41,269		+ 1100	+ 45,108	0,038	+ 1200	+ 48,828	0,036	+ 1300	+ 52,398	0,035						
1010	41,657	0,039	1110	45,486	0,038	1210	49,192	0,036	1310	52,747	0,035						
1020	42,045	0,039	1120	45,863	0,038	1220	49,555	0,036	1320	53,093	0,034						
1030	42,432	0,039	1130	46,238	0,037	1230	49,916	0,036	1330	53,439	0,034						
1040	42,817	0,039	1140	46,612	0,037	1240	50,276	0,036	1340	53,782	0,034						
1050	43,202	0,038	1150	46,985	0,037	1250	50,633	0,036	1350	54,125	0,034						
1060	43,585	0,038	1160	47,356	0,037	1260	50,990	0,035	1360	54,466	0,034						
1070	43,968	0,038	1170	47,726	0,037	1270	51,344	0,035	1370	54,807	0,034						
1080	44,349	0,038	1180	48,095	0,037	1280	51,697	0,035									
1090	44,729	0,038	1190	48,462	0,037	1290	52,049	0,035									



## Appendix C

## Standard Test Method for WATER ABSORPTION, BULK DENSITY, APPARENT POROSITY, AND APPARENT SPECIFIC GRAVITY OF FIRED WHITEWARE PRODUCTS<sup>1</sup>

This standard is issued under the fixed designation C 373; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This method covers procedures for determining water absorption, bulk density, apparent porosity, and apparent specific gravity of fired unglazed whiteware products.

### 2. Apparatus and Materials

2.1 *Balance*, of adequate capacity, suitable to weigh accurately to 0.01 g.

2.2 *Oven*, capable of maintaining a temperature of  $150 \pm 5$  C ( $302 \pm 9$  F).

2.3 *Wire Loop, Halter, or Basket*, capable of supporting specimens under water for making suspended mass measurements.

2.4 *Container*—A glass beaker or similar container of such size and shape that the sample, when suspended from the balance by the wire loop, specified in 2.3, is completely immersed in water with the sample and the wire loop being completely free of contact with any part of the container.

2.5 *Pan*, in which the specimens may be boiled.

2.6 *Distilled Water*.

### 3. Test Specimens

3.1 At least 5 representative test specimens shall be selected. The specimens shall be unglazed and shall have as much of the surface freshly fractured as is practical. Sharp edges or corners shall be removed. The specimens shall contain no cracks. The individual test specimens shall weigh at least 50 g.

### 4. Procedure

4.1 Dry the test specimens to constant

mass (Note) by heating in an oven at 150 C (302 F), followed by cooling in a desiccator. Determine the dry mass,  $D$ , to the nearest 0.01 g.

NOTE—The drying of the specimens to constant mass and the determination of their masses may be done either before or after the specimens have been impregnated with water. Usually the dry mass is determined before impregnation. However, if the specimens are friable or evidence indicates that particles have broken loose during the impregnation, the specimens shall be dried and weighed after the suspended mass and the saturated mass have been determined, in accordance with 4.3 and 4.4. In this case, the second dry mass shall be used in all appropriate calculations.

4.2 Place the specimens in a pan of distilled water and boil for 5 h, taking care that the specimens are covered with water at all times. Use setter pins or some similar device to separate the specimens from the bottom and sides of the pan and from each other. After the 5-h boil, allow the specimens to soak for an additional 24 h.

4.3 After impregnation of the test specimens, determine to the nearest 0.01 g the mass,  $S$ , of each specimen while suspended in water. Perform the weighing by placing the specimen in a wire loop, halter, or basket that is suspended from one arm of the balance. Before actually weighing, counterbalance the scale with the loop, halter, or basket in place and immerse in water to the same depth as is used when the specimens are in place. If it is

<sup>1</sup> This method is under the jurisdiction of ASTM Committee C-21 on Ceramic Whitewares and Related Products. Current edition approved Aug. 29, 1972. Published October 1972. Originally published as C 373 - 55 T. Last previous edition C 373 - 56 (1970).

desired to determine only the percentage of water absorption, omit the suspended mass operation.

4.4 After the determination of the suspended mass or after impregnation, if the suspended mass is not determined, blot each specimen lightly with a moistened lint-free linen or cotton cloth to remove all excess water from the surface, and determine the saturated mass,  $M$ , to the nearest 0.01 g. Perform the blotting operation by rolling the specimen lightly on the wet cloth, which shall previously have been saturated with water and then pressed only enough to remove such water as will drip from the cloth. Excessive blotting will introduce error by withdrawing water from the pores of the specimen. Make the weighing immediately after blotting, the whole operation being completed as quickly as possible to minimize errors due to evaporation of water from the specimen.

## 5. Calculations

5.1 In the following calculations, the assumption is made that 1 cm<sup>3</sup> of water weighs 1 g. This is true within about 3 parts in 1000 for water at room temperature.

5.1.1 Calculate the exterior volume,  $V$ , in cubic centimetres, as follows:

$$V = M - S$$

5.1.2 Calculate the volumes of open pores and impervious portions in cubic centimetres as follows:

$$\text{Volume of open pores, cm}^3 = M - D$$

$$\text{Volume of impervious portions, cm}^3 = D - S$$

5.1.3 The apparent porosity,  $P$ , expresses, as a percentage, the relationship of the volume of the open pores of the specimen to

its exterior volume. Calculate the apparent porosity as follows:

$$P = [(M - D)/V] \times 100$$

5.1.4 The water absorption,  $A$ , expresses as a percentage, the relationship of the mass of water absorbed to the mass of the dry specimen. Calculate the water absorption as follows:

$$A = [(M - D)/D] \times 100$$

5.1.5 Calculate the apparent specific gravity,  $T$ , of that portion of the test specimen that is impervious to water, as follows:

$$T = D/(D - S)$$

5.1.6 The bulk density,  $B$ , in grams per cubic centimetre, of a specimen is the quotient of its dry mass divided by the exterior volume, including pores. Calculate the bulk density as follows:

$$B = D/V$$

## 6. Report

6.1 For each property, report the average of the values obtained with at least 5 specimens, and also the individual values. Where there are pronounced differences among the individual values, another lot of 5 specimens shall be tested and in addition to individual values the average of all 10 determinations shall be reported.

## 7. Precision and Accuracy

7.1 This method is accurate to  $\pm 0.2$  percent water absorption in interlaboratory testing when the average value recorded by all laboratories is assumed to be the true water absorption. The precision is approximately  $\pm 0.1$  percent water absorption on measurements made by a single experienced operator.

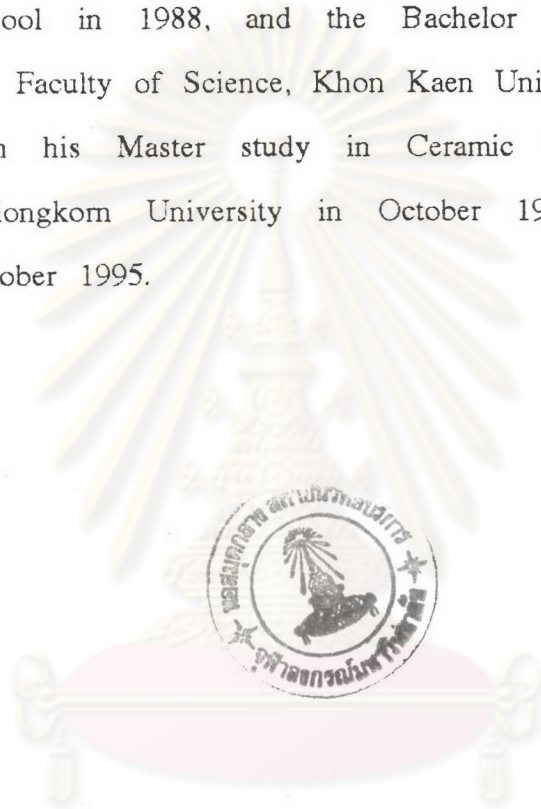
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