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REFRACTORIES

Publications by members of the staff of the National Bureau of Standards, together with a list of Federal Specifications and Standard Samples.

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GENERAL INFORMATION

Some of the publications in this list have appeared in the regular series of publications of the Bureau and others in various scientific and technical journals. Unless specifically stated, papers are not obtainable from the National Bureau of Standards.

Where the price is stated, the publication can be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. The prices quoted are for delivery to addresses in the United States and its territories and possessions and in certain countries which extend the franking privilege. In the case of all other countries, one-third the cost of the publication should be added to cover postage. Remittances should be made either by coupons (obtainable from the Superintendent of Documents in sets of 20 for \$1.00 and good until used), or by check or money order payable to the "Superintendent of Documents, Government Printing Office" and sent to him with order. Letter Circulars are obtainable, without charge, from the Bureau. Publications marked "OP" are out of print, but, in general, may be consulted at technical and public libraries.

For papers in other scientific or technical journals, the name of the journal or of the organization publishing the article is given in abbreviated form with the volume number (underscored), page and year of publication, in the order named. In general, the Bureau cannot supply copies of these journals, or reprints from them, and it is unable to furnish information as to the availability or price. However, in a few cases (publications preceded by a single asterisk (*)) a very limited supply of reprints is available for distribution, and copies will be sent free upon request to the Bureau. They, too, can usually be consulted at technical libraries.

Serial letters are used to designate the several series of Bureau publications:

S = "Scientific Paper." S1 to S329 are "Reprints" from the "Bulletin of the Bureau of Standards." S330 to S572 were published as "Scientific Papers of the Bureau of Standards." This series was superseded by the "Bureau of Standards Journal of Research" in 1928.

T = "Technologic Paper." T1 to T370. This series was superseded by the "Bureau of Standards Journal of Research" in 1928.

RP = "Research Paper." These are reprints of articles appearing in the "Bureau of Standards Journal of Research" and the "Journal of Research of the National Bureau of Standards," the latter being the title of this periodical since July 1934 (volume 13, number 1).

C = "Circular."

R = "Simplified Practice Recommendation."

Circular C24 and supplements, the complete list of the Bureau's publications (1901-1944), is sold by the Superintendent of Documents for \$1.30. Announcement of new publications is made each month in the Technical News Bulletin, which is obtainable by subscription at \$1.00 a year in the United States, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama; other countries at \$1.35.

PART I - TECHNOLOGIC PAPERS

| | <u>Series</u> | <u>Price</u> |
|--|---------------|--------------|
| The testing of clay refractories, with special reference to their load-carrying ability at furnace temperatures. A.V.Bleininger and G.H.Brown. Tech. Pap. BS (1911). | T7 | OP |
| The melting point of fire brick. C.W.Kanolt Tech. Pap. BS (1912). | T10 | OP |
| Properties of some European plastic fire clays. A.V.Bleininger and H.G.Schurecht. Tech. Pap. BS (1916). | T79 | OP |
| The effect of size of grog in fire clay bodies. F.A.Kirkpatrick. Tech. Pap. BS (1918). | T104 | OP |
| Silica refractories - factors affecting their quality and methods of testing the raw materials and finished ware. D.W.Ross. Tech. Pap. BS (1919). | T116 | OP |
| Constitution and microstructure of silica brick and changes involved through repeated burnings at high temperatures. H. Insley. Tech. Pap. BS (1919). | T124 | .10 |
| Porosity and volume changes of clay fire bricks at furnace temperatures. G.A.Loomis. Tech. Pap. BS (1920). | T159 | OP |
| Testing of fire-clay brick with special reference to their use in coal-fired boiler settings. R.F.Geller. Tech. Pap. BS (1925). | T279 | .20 |

PART II - SCIENTIFIC PAPERS

| | | |
|--|------|----|
| Melting points of some refractory oxides C.W.Kanolt. Bul. BS <u>10</u> , 295 (1914). | S212 | OP |
|--|------|----|

PART III - RESEARCH PAPERS

| | <u>Series</u> | <u>Price</u> |
|--|---------------|--------------|
| Analysis of bauxite and of refractories of high alumina content. G.E.F.Lundell and J.I.Hoffman. BS J. Research <u>1</u> , 91(1928). | RP5 | OP |
| The service of refractory blocks in a small experimental glass tank. W.I.Pendergast and H. Insley. BS J. Research <u>2</u> , 453(1929). | RP44 | .15 |
| Preparation of experimental sagger bodies according to fundamental properties. R.A. Heindl and L.E.Mong. BS J. Research <u>3</u> , 419 (1929). | RP104 | OP |
| Progress report on investigation of fire-clay bricks and the clays used in their preparation. R.A.Heindl and W.I.Pendergast. BS J. Research <u>3</u> , 691.(1929). | RP114 | OP |
| On a modified method for decomposing aluminous silicates for chemical analysis. A.N.Finn and J.F.Klekotka. BS J. Research <u>4</u> , 809 (1930). | RP180 | OP |
| Fire clays. Some fundamental properties at several temperatures. R.A.Heindl and W.I. Pendergast. BS J. Research <u>5</u> , 213 (1930). | RP194 | OP |
| Special refractories for use at high temperature. W.H.Swanger and F.R.Caldwell. BS J. Research <u>6</u> , 1131 (1931). | RP327 | OP |
| The life of the sagger as affected by varying certain properties. R.A.Heindl and L.E.Mong. BS J. Research <u>7</u> , 1017(1931). | RP387 | OP |
| Kaolins. Effect of firing temperature on their thermal expansion. R.A.Heindl, W.I. Pendergast and L.E.Mong. BS J. Research <u>8</u> , 199 (1932). | RP410 | .05 |
| Phase equilibria in the system SiO ₂ -ZnO-Al ₂ O ₃ . E.N.Bunting. BS J. Research <u>8</u> , 279 (1932). | RP413 | OP |
| The interference method of measuring thermal expansion. G.E.Merritt. BS J. Research <u>10</u> , 59 (1933). | RP515 | OP |

RESEARCH PAPERS (Continued)

| | <u>Series</u> | <u>Price</u> |
|---|---------------|--------------|
| The thermal expansion of refractories to 1,800°C. R.A.Heindl. BS J. Research <u>10</u> , 715 (1933). | RP562 | OP |
| Olivine as a refractory. R.A.Heindl and W.L. Pendergast. BS J. Research <u>12</u> , 215 (1934). | RP645 | .05 |
| Young's modulus of elasticity at several temperatures for some refractories of varying silica content. R.A.Heindl and W.L. Pendergast. J. Research NBS <u>13</u> , 851(1934). | RP747 | .05 |
| A study of sagger clays and sagger bodies. R.A.Heindl. J. Research NBS <u>15</u> , 255(1935). | RP827 | .05 |
| Young's modulus of elasticity, strength, and extensibility of refractories in tension. R.A.Heindl and L.E.Mong. J. Research NBS <u>17</u> , 463 (1936). | RP923 | OP |
| Deformation and Young's modulus of fire-clay brick in flexure at 1,220°C. R.A. Heindl and W.L.Pendergast. J. Research NBS <u>19</u> , 353 (1937). | RP1030 | .10 |
| Fire-clay ladle sleeves. R.A.Heindl and Geo. J.Cooke. J. Research NBS <u>20</u> , 411(1938). | RP1084 | OP |
| Properties of air-setting bonding mortars of the wet type. R.A.Heindl and W.L. Pendergast. J. Research NBS <u>23</u> , 7 (1939). | RP1219 | OP |
| Preparation of crucibles from special refractories by slip-casting. John G. Thompson and William M. Mallet. J. Research NBS <u>23</u> , 319 (1939). | RP1236 | OP |
| Length changes and endothermic and exothermic effects during heating of flint and aluminous clays. R.A.Heindl and L.E.Mong. J. Research NBS <u>23</u> ; 427 (1939); | RP1243 | .05 |
| A resistor furnace, with some preliminary results up to 2,000°C. R.F.Geller. J. Research NBS <u>27</u> , 555 (1941). | RP1443 | OP |

RESEARCH PAPERS (Continued)

| | <u>Series</u> | <u>Price</u> |
|--|---------------|--------------|
| Some properties of the dry, air-setting type of refractory bonding mortar. R.A. Heindl and W.L.Pendergast. J.Research NBS <u>28</u> , 401 (1942). | RP1461 | .15 |
| Some properties of heat-setting refractory mortars. R.A.Heindl and W.I.Pendergast. J. Research NBS <u>30</u> , 303 (1943). | RP1534 | .05 |
| Panel tests for thermal spalling of fire-clay bricks used at high temperatures.R.A. Heindl and W.I.Pendergast. J.Research NBS <u>34</u> , 73 (1945). | RP1630 | .15 |
| Effects of some oxide additions on the thermal length changes of zirconia. R.F.Geller and P.J.Yavorsky. J.Research NBS <u>35</u> , 87(1945). | RP1662 | .10 |
| Melting point of alpha-alumina. R.F.Geller and P.J.Yavorsky. J. Research NBS <u>34</u> , 395 (1945). | RP1649 | .05 |
| Attack on refractory clay pots by optical glasses. Willard H. Parsons and Herbert Insley. J.Research NBS <u>36</u> , 31(1946). | RP1689 | .10 |
| Elastic behavior and creep of refractory bricks under tensile and compressive loads. I.E.Mong. J. Research NBS <u>38</u> , 229(1947). | RP1770 | .10 |

PART IV - CIRCULARS

| | | |
|--|------|-----|
| Fire-clay brick: their manufacture, properties, uses and specifications. Cir.BS(1926). | C282 | OP |
| The slip casting of clay pots for the manufacture of optical glass at the National Bureau of Standards. R.A.Heindl, Gordon B. Massengale and Louis G. Cossette. NBS Circular, (1946). Also, the Glass Industry, <u>27</u> , no. 4, 177 (April 1946.) | C452 | .10 |

PART V - SIMPLIFIED PRACTICE RECOMMENDATIONS

| | <u>Series</u> | <u>Price</u> |
|---------------------------------|---------------|--------------|
| Malleable Foundry Refractories. | R79-28 | .10 |
| Cupola Refractories. | R154-38 | .10 |

PART VI - FEDERAL SPECIFICATIONS

(Issued by the Federal Specifications Executive Committee, Washington, D.C., and obtainable from the Superintendent of Documents, Government Printing Office, Washington, 25, D.C., at the prices stated.)

| | | |
|---|-----------|-----|
| Federal Specification for Brick; Fire-clay. | HH-B-671c | .05 |
| Federal Specification for Clay; Fire, ground | HH-C-451b | .05 |
| Federal Specification for Refractories; Fire-clay Plastic. | SS-R-191 | .05 |
| Federal Specification for Brick; Silica. | HH-B-681 | .05 |
| Federal Specification for Cement; Silica. | HH-C-176 | .05 |
| Federal Specification for Mortar; Air- Setting, Refractory, Bonding, (Wet and Dry types). | HH-M-611a | .05 |
| Federal Specification for Mortar; Heat- Setting, Refractory. | HH-M-622 | .05 |

PART VII - OUTSIDE PUBLICATIONS

(Papers which have appeared in the transactions; The Journal, or the Bulletin of the American Ceramic Society, 2525 N. High Street, Columbus, Ohio.)

The behavior of fire bricks under load conditions at a temperature of 1300°C. A.V.Bleininger and G.H.Brown. - Trans. Am. Ceramic Soc., 12, 337 (1910).

The behavior of fire bricks under load conditions: A.V. Bleininger and G.H.Brown. Trans. Am. Ceramic Soc., 13, 210(1911).

Note on load tests made on magnesite, chrome, and silica brick. G.H.Brown. Trans. Am. Ceramic Soc., 14, 391 (1912).

Melting points of some refractory oxides. C.W.Kanolt. Trans. Am. Ceramic Soc., 15, 167 (1913); also Bul. BS, 10, 295(1914), under the same title.

The development of special refractory bodies. E.T.Montgomery. Trans. Am. Ceramic Soc., 15, 606 (1913).

The relative thermal conductivities of silica and clay refractories. G.H.Brown. Trans. Am. Ceramic Soc., 16, 382(1914).

A method of testing the corrosive action of slag on fire brick. G.H.Brown. Trans. Am. Ceramic Soc., 18, 277 (1916).

Note on the volume changes of silica brick mixtures. A.V. Bleininger and D.W.Ross. Trans. Am. Ceramic Soc., 18, 519(1916).

Volume changes of some commercial silica bricks on heating. D.W.Ross. Trans. Am. Ceramic Soc., 19, 83 (1917).

The effect of size of grog in fire clay bodies. F.A.Kirkpatrick. Trans. Am. Ceramic Soc., 19, 268 (1917); also Tech Pap. BS, 104 (1918), under the same title.

Silica refractories - factors affecting their quality and methods of testing the raw materials and finished ware. D.W.Ross. J. Am. Ceramic Soc., 1, 477 (1918); also Tech. Pap. BS, 116(1919), under the same title.

Porosity and volume changes of clay fire bricks at furnace temperatures. G.A.Loomis. J. Am. Ceramic Soc., 1, 384(1918); also Tech. Pap. BS, 159 (1920), under the same title.

Siliceous sagger mixtures. M.R.Hornung. J. Am. Ceramic Soc., 3, 69 (1920).

Note on the load behavior of aluminous refractories. A.V. Bleininger. J. Am. Ceramic Soc., 3, 1955(1920).

*The transverse strength of fire-clay tiles at furnace temperatures. R.F.Geller. J. Am. Ceramic Soc., 4, 608(1921).

Progress report on specifications for refractories. R.F.Geller. J. Am. Ceramic Soc., 6 1098 (1923).

*Notes on the behavior of refractories in glass melting furnaces. H. Insley. J. Am. Ceramic Soc., 7, 583 (1924).

*The laboratory testing of aluminous refractories. R.F.Geller. J. Am. Ceramic Soc., 7, 663 (1924).

*The laboratory testing of plastic refractories. R.F.Geller and W.L.Pendergast. J. Am. Ceramic Soc., 8, 441 (1925).

An electric furnace for softening point determinations. W.L.Pendergast. J. Am. Ceramic Soc., 8, 319 (1925).

Progress report on the investigation of sagger clays. R.A.Heindl. J. Am. Ceramic Soc., 9, 131 (1926).

*A study of mullite refractories formed by calcining cyanite; their industrial application. M.L.Freed. J. Am. Ceramic Soc., 9, 249 (1926).

*Comparative tests of some American and German fire-clay brick. R.F.Geller and W.L.Pendergast. J. Am. Ceramic Soc., 9, 370 (1926).

II. Progress report on investigation of sagger clays - some observations as to the significance of their thermal expansions. R.F.Geller and R.A.Heindl. J. Am. Ceramic Soc., 9, 555 (1926).

Characteristics of pyrometric cones. C.O.Fairchild and M.F. Peters. J. Am. Ceramic Soc., 9, 700 (1926).

*III. Progress report on investigation of sagger clays; their elasticity and transverse strength at several temperatures. R.A.Heindl and W.L.Pendergast. J. Am. Ceramic Soc., 10, 524 (1927).

*Notes on cyanite and diaspore refractories. E.J.Vachuska and G.A.Bole. J. Am. Ceramic Soc., 10, 761 (1927).

*IV. Progress report on investigation of sagger clays; their elasticity, transverse strength and plastic flow at 1,000°C. R.A.Heindl. J. Am. Ceramic Soc., 10, 995 (1927).

*A petrographic study of some slags from boiler furnaces. S.J.McDowell and H.C.Lee. J. Am. Ceramic Soc., 11, 35 (1928).

*The service of refractory blocks in a small experimental glass tank. W.L.Pendergast and H. Insley. J. Am. Ceramic Soc., 12, 123 (1929); also BS J. Research 2, 453 (1929), under the same title.

*Progress report on investigation of fire-clay bricks and the clays used in their preparation. R.A.Heindl and W.L.Pendergast. J. Am. Ceramic Soc., 12, 640 (1929); also BS J. Research 3, 691 (1929); under the same title.

*V. Progress report on investigation of sagger clays. Preparation of experimental sagger bodies according to fundamental properties. R.A.Heindl and L.E.Mong. J. Am. Ceramic Soc., 12, 457. (1929).

*Fire clays. Some fundamental properties at several temperatures. R.A.Heindl and W.L.Pendergast. J. Am. Ceramic Soc., 13, 725 (1930); also BS J. Research 5, 213(1930), under the same title.

*Sixth progress report on investigation of sagger clays. R.A. Heindl and L.E.Mong. J. Am. Ceramic Soc., 14, 867 (1931).

Symposium on the physical chemistry of the alumina-silica refractories. III. Minerals with the composition $Al_2O_3.SiO_2$. H. Insley. J. Am. Ceramic Soc., 16, 58 (1933).

Selection of clays for sagers of predetermined resistance to thermal shock and predicting sagger life in service. R.A.Heindl and L.E.Mong. J. Am. Ceramic Soc., 16, 601 (1933).

Bonding strength of cold-setting refractory cements. R.A.Heindl and W.L.Pendergast. Bull. Am. Ceramic Society 15, 182 (1936).

An electric furnace for determination of pyrometric cone equivalents. W.L.Pendergast. Bull. Am. Ceramic Society, 18, 1 (1939).

Effect of water content and mixing time on properties of air-setting refractory mortars containing sodium silicate. R.A. Heindl and W.L.Pendergast. Bul. Am. Ceramic Society 19, 430(1940).

Reliability of the workability index of fire-clay plastic refractories. R.A.Heindl and W.L.Pendergast. Bul. Am. Ceramic Soc. 1947.

(Papers appearing in publications other than the Transactions, the Journal or the Bulletin of the American Ceramic Society.)

Possibilities for research and development in the field of refractories. H.F.Staley. Chemical and Metallurgical Engineering (McGraw-Hill Publishing Co., 330 West 42d Street, New York City). Dec. 1920.

The status of thermal conductivity in specifications for refractories. W.A.Hull. Proc. Am. Soc. for Testing Materials (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.) June 1922.

Refractories in the steel plant. W.A.Hull. Yearbook of Am. Iron and Steel Institute (350 Fifth Avenue, New York City) 1922.

Refractories for melting pure metals; iron, nickel, platinum. L. Jordan, A.A.Peterson and L.H.Phelps. Trans. Am. Electrochemical Soc. (Columbia University, New York City), L, 1926.

The thermal expansion of some fused oxides used as refractories. G.E.Merritt. Trans. Am. Electrochemical Soc., L, 1926.

The behavior of clay refractories in service. R.F.Geller. Fuels and Furnaces (F.C.Andresen and Associates, Inc., House Building, Pittsburgh, Pa.), V, Sept. 1927. (Ceased publication in 1934).

The significance of the elasticity and thermal expansion of fire clays with reference to the spalling of the fired product. R.F.Geller. Am. Refractories Institute (Mellon Institute, Pittsburgh, Pa.) T.P. 4, October 1927.

Laboratory testing of refractories; a general discussion. R.F.Geller. Bul. Am. Refractories Institute, 1927.

A study of the crystalline compounds formed in slags on boiler furnace refractories. T.A.Klinefelter and E.P.Rexford. Fuels and Steam Power Section, Trans. Am. Soc. Mech. Engrs. (29 West 39th Street, New York City), Sept.-Dec. 1929.

On a modified method for decomposing aluminous silicates for chemical analysis. A.N.Finn and J.F.Klekotka. Ceramic Age, P.O.Box 173, Newark, N.J., 16, Sept. 1930; also BS J. Research 4, 809 (1930), under the same title.

*Comparative tests of thermal spalling of fire-clay bricks. R.A.Heindl. Proc. Am. Soc. for Testing Materials (1916 Race Street, Philadelphia, Pa.) 31, Part II, 703 (1931).

Action of slags on fire brick and boiler furnace settings. T.A.Klinefelter and E.P.Rexford. Trans. Am. Soc. Mech. Engrs., (29 West 39th Street, New York City), Fuels and Steam Power Section, Sept.-Dec. 1931.

Bonding magnesite linings. L. Jordan. Metals & Alloys (3619 Forbes Street, Pittsburgh, Pa.) Jan. 1932.

Olivine as a refractory. R.A.Heindl and W.I.Pendergast. Ceramic Age 24, 17 (July 1934); also J. Research BS 12, 215 (July 1934).

A discussion of thermal spalling of fire-clay brick with relation to Young's modulus of elasticity, thermal expansion and strength. R.A.Heindl. Tech. Bul. Am. Ref. Inst., Bul. 58, May 1935.

STANDARD SAMPLES

Standard samples of certain materials which are recommended for control work may be obtained from the National Bureau of Standards by prepayment of the indicated price. Such samples were prepared for checking the accuracy of methods of analysis, and those of particular interest to the ceramic industry are listed below. The Supplement to Circular C393, which can be obtained from this Bureau without charge, contains a complete list of our standard samples.

| Standard Sample Number | Name | Constituents determined or intended use | Weight of sample in grams | Price |
|------------------------|--|---|---------------------------|--------|
| 1a | Argillaceous limestone | Complete analysis | 50 | \$2.00 |
| 39e | Benzoic acid | Acidimetric and calorimetric values | 30 | 2.00 |
| 40c | Sodium oxalate | Oxidimetric value | 60 | 2.00 |
| 69 | Bauxite | Complete analysis | 60 | 2.00 |
| 70 | Feldspar | " " | 40 | 2.00 |
| 76 | Burnt refractory (40%Al ₂ O ₃) | " " | 60 | 2.00 |
| 77 | Burnt refractory (60%Al ₂ O ₃) | " " | 60 | 2.00 |
| 78 | Burnt refractory (70%Al ₂ O ₃) | " " | 60 | 2.00 |
| 79 | Fluorspar | " " | 60 | 2.50 |
| 80 | Glass, soda-lime | " " | 45 | 2.00 |
| 81 | Glass sand | Fe ₂ O ₃ , Al ₂ O ₃ , TiO ₂ , ZrO ₂ , CaO, MgO | 60 | 2.00 |
| 83 | Arsenious oxide | Oxidimetric value | 75 | 2.00 |
| 84 | Acid potassium phthalate | Acidimetric value | 60 | 3.00 |
| 88 | Dolomite | Complete analysis | 50 | 2.00 |
| 89 | Glass, lead-barium | " " | 60 | 2.00 |
| 91 | Glass, opal | " " | 45 | 2.00 |
| 92 | Glass, low boron | B ₂ O ₃ only | 60 | 2.00 |
| 93 | Glass, high boron | Complete Analysis | 60 | 2.00 |
| 97 | Flint clay | " " | 60 | 2.00 |
| 98 | Plastic clay | " " | 60 | 2.00 |
| 99 | Soda feldspar | " " | 40 | 2.00 |
| 102 | Silica brick | " " | 60 | 2.00 |
| 103 | Chrome refractory | " " | 60 | 2.00 |
| 104 | Burned magnesite | " " | 60 | 2.00 |
| 112 | Silicon carbide | " " | 85 | 2.00 |
| 154 | Titanium dioxide | TiO ₂ only | 40 | 2.00 |

