BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Cooperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIALS

MACON'S REACTION

Macon entertained, got acquainted, and now wants to have a more intimate relation with the ceramists who convened in Georgia during the week of February 8. Macon voted overwhelmingly to exempt new industries from taxation for a period of five years. Only twenty-two voters were against the measure. Columbus, Augusta, and other clay centers are mulling over similar plans for attracting manufacturing plants. With the rapidly increasing local market; with excellent rail facilities to inland and coast gateways; with the modern power developments and water availabilities; and with the moderate climate and cheap labor Georgians should not find it difficult to put across the economic advantages of manufacturing in Georgia.

But of equal if not of more importance is a demonstration by laboratory developments and by plant proving that in Georgia there are vast quantities of available raw materials. Georgia, North Carolina, and Louisiana have set up ceramic laboratories in their State Universities, and Central of Georgia Railway is continuing surveys and investigations of southern ceramic materials. Investment of money and energy in making such agencies and procedures most productive of proved plant availability data on their raw materials is absolutely as essential as the obtaining and making known of favorable economic conditions. The railroads and public utilities which do not invest in this sort of informing surveys and investigations are shirking their share of the burden and are delaying the day when the South will have ceramic factories equal to its resources and market.

FEDERAL BUREAU CERAMIC RESEARCH

On March 4th on call issued by J. W. Drake, Assistant Secretary of Commerce, representatives of ceramic trade groups gathered at the Bureau of Standards to consider:

1. The creation of a Permanent Conference on Ceramics and the Allied Industries, advisory to the Department of Commerce, which will properly represent all of the important industries within the field.
2. The formation of a smaller group, under the chairmanship of A. V. Bleininger, to act as an executive committee of the Permanent Conference.

George K. Burgess, director of the Bureau, announced the Bureau organization which would be in full consummation next July. He then asked the delegates present to organize & permanent conference board and an advisory executive committee. This was done as requested.

P. H. Bates will be in charge of all ceramic work at the Bureau of Standards and A. V. Bleininger wall be chairman of the advisory committee.

To all honest efforts toward effective research in ceramics this SOCIETY will give every support. Its committees and officers will fall into line wholeheartedly with the plans of the Bureau of Standards, details of which have been reported by the current ceramic press. In addition this SOCIETY will continue its efforts to obtain a more substantial and more effective technical research organization of ceramic manufacturers.

That the scheme set forth by the Bureau of Standards is a shadow, true in outline, of the organization scheme proposed by the SOCIETY in May, 1925, is evident but that it is only a shadow is also evident. The scheme as adopted leaves the manufacturers impotent and wholly at the mercy of the judgment of the Bureau in the planning and executing of ceramic investigation. The manner in which and the degre.e to which the present set-up was dictated is typical of what will be continued.

It cannot be expected that either Mr. Bleininger or, through him as chairman, the individual members of his committee will be able to give that continuity of thought which is so essential to success to coordination in technical research. The formation of this committee is a distinct step in the right direction but is it only a step. What the ceramic manufacturers need is a chairman who will give his full time o planning and coordinating the scientific and technical investigations by and for the manufacturers. Rather than Bureau men taking the lead in this planning for the manufacturer, the manufacturers should take the helm.

It is neither legal nor workable for the manufacturers and Bureau to jointly employ a person to serve as research director for the Bureau and chief adviser for the manufacturers.

The character of work done and the interpretation of results obtained by the Bureau rest with the chief of the Division. Ceramics has been grouped with cement and a cement technologist placed in charge. There can be no question of the ability to organize and direct, nor of the honesty in intentions of Mr. Bates to perform and interpret, but it would be expecting something beyond human limitations for anyone other than a ceramist to serve satisfactorily as director and interpreter of ceramic research.

We continue our urging that ceramic manufacturers, through their respective trade associations so organize and employ a full time chief research adviser. The plan recommended in the May, 1925, editorial in this *Bulletin* had working strength and vitality whereas the scheme dictated at the conference on March 4 at the Bureau of Standards is only a shadow without effectiveness, resembling the plan proposed by this SOCIETY only in outline.

PAPERS AND DISCUSSIONS

OBSERVATIONS ON THE DEVELOPMENT AND USE OF STEEL DRYING EQUIPMENT IN THE CERAMIC INDUSTRY[1]

By H M. Schaab

The following observations are made in regard to a matter of great importance to the ceramic industry. Progress in efficiency and advancement in design of new types of equipment are the results of careful experimentation and hearty cooperation of a number of the members of the Society. Much progress has been made which could not otherwise have been obtained.

With the rapid depletion of our timber resources and the declining quality of wood suitable for drying boards and shods, it was necessary to look around for a satisfactory substitute. If the results which have already been obtained and the tests going forward at present continue to show favorable results, it will be apparent that not only has a satisfactory substitute for wood been obtained, but a material has been brought into use which opens up possibilities for economies in operation, expenses and superior quality of product that were never dreamed of before.

A great deal of progress has been made against prejudice to a new material, to a higher first cost, and to a departure from old accepted standards. Everyone realizes that the first cost should not necessarily govern the decision on the type of equipment to be installed. It should, rather, be the ultimate cost figuring in and recognizing the factor of reduction in operating costs on the product. Very little information is available as to the cost of operating wooden boards and shods and for that reason the difference in first cost looks like a mountain whereas actually is only a mole hill. Reduction in the cost of maintenance of better boards, reduction in insurance rate due to elimination of fire hazard, reduction of cost of reconditioning warped ware, and elimination of back charges on defective ware may, all taken together, more than offset any difference in first cost in a very short time.

In turning away from wood for use in drying boards and shods, we are getting away from a material which has been relatively low in price. It is therefore necessary to adopt the lowest priced suitable metal, which, as you all know, is steel.

There are quite a number of inherent advantages in the use of steel over wood. Steel is equally strong in all directions and therefore any shape may be given to the steel: rectangular, circular, cubical or spherical. Steel will not warp under ordinary conditions except by

[1] Presented at the Annual Meeting, American Ceramic Society, Atlanta, Ga., Feb., 1926. (Terra Cotta Division). Received January 6, 1926.

abuse. Connections between various components of steel boards may be made everlasting and rigid by welding, a result which is not obtainable with wood. Steel presents a smooth surface which permits the clay to slide easily and therefore shrink without cracking. Steel is a conductor of heat, whereas wood is an insulator. Steel lends itself to an infinite variety of designs, which makes it possible to fabricate almost any type of equipment desired.

FIG. 1.—Curled edge, curled corners, brick pallet. Bottom view.

With these features in mind, it has been possible for the steel fabricators to attain the following desirable results: (1) a very material reduction in the percentage of spoiled ware; (2) a lessened expense for reconditioning warped ware; (3) a considerably reduced drying time, and (4) a marked increase in quantity of ware that may be handled in a given space.

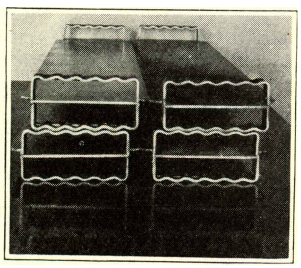

FIG. 2.—Double-reversible brie pal lets stacked. Endviewshow ing how feet nest together.

Probably the main reason why steel has not heretofore been seriously considered by the ceramic industry as a whole is the inbred aversion of the clay worker to iron oxide.

However, there is a large field for the use of steel in that portion of the industry where the action of the metal is not injurious, namely in the manufacture of architectural terra cotta, sewer tile, conduit, grinding wheels and brick. Improved methods of protecting steel with metals which do not corrode, make steel available for use in the pottery industries making china ware, sanitary ware, porcelain insulators, etc.

The question may be asked just how it was found possible to use a steel board in the ceramic industry.

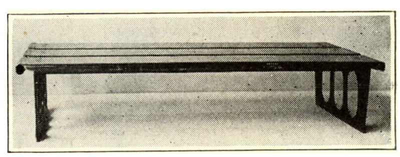

FIG. 3.—Terra cotta drying board. Terra cotta type.

Pressed steel pallets had been previously developed to replace those made of wood and cast iron in the manufacture of cement brick, cement block, concrete tile, and in the silica fire brick industries. It was but a logical step, therefore, to the drying of other articles, such as sewer tile, terra cotta block, grinding wheels, etc.

The first portion of the ceramic industry to realize that their difficulties with wood could be largely overcome by steel was the terra cotta plant. Quite a number of costly experiments were made with the aid of several well-known people in that industry, and as a result, a steel board has been perfected which has proved 100% in performance of its duty.

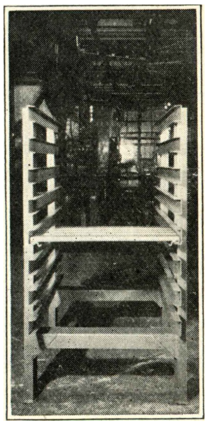

FIG. 4.—Dryingracks for terra cotta. End view showing board in rack.

A board has been produced which remains flat, whether hot or cold, wet or dry, yet provides a large percentage of openings to allow air circulation to the back of the hollow blocks. It is practically indestructible. The supporting surface is flat at all times and is smooth, which allows the ware to creep uniformly, when shrinking. The steel conducts heat to the back of the blocks as well as letting hot air through, therefore promoting more uniform drying conditions.

The manufacture of this steel board is so flexible that it may be produced to meet the requirements of each individual plant, and work in with any system of handling, such as floor drying, rack drying or self-racking.

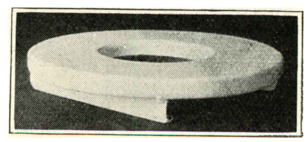

FIG. 5.—Sewer tile shod.

We might mention that a similar board has been designed and is being adopted by sanitary ware manufacturers.

The advantages of the steel boards are very real and vital to the terra cotta, but the advantages of steel are much more important to the sewer pipe and conduit industry, owing to peculiar conditions of drying. In this industry, it is common for the heated air to ascend from the basement through slatted floors on which the ware is placed to be dried.

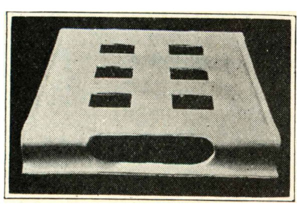

FIG. 6.—Conduit board. Six ducts.

Wood boards, of necessity, were made rectangular in shape and when placed edge to edge practically cut off the vertical flow of air through the slat. When steel was proposed it was immediately apparent that a circular shape was desirable which would allow, no matter how close together the boardswere placed, a vertical stream of air to pass over the outside of the crock.By cutting out the center of the steel, a corresponding vertical flow of air is allowed to pass through the inside of the crock, thereby making for uniform drying condition on the outside and inside, and the top and bottom.

Tests have shown that this feature alone reduces the drying time as much as one-third. The smooth surface of the steel permits the clay to creep easily and therefore cracked ware is practically eliminated. This is especialy true in the larger diameters, where the total shrinkage is correspondingly great.

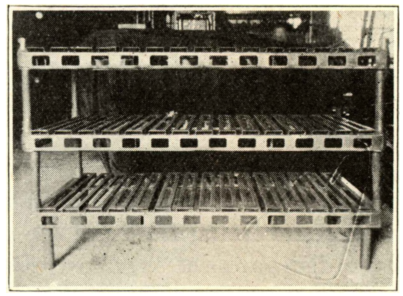

FIG. 7.—Conduit drying racks.

Due to the large flow of air past the drying surfaces, it is now possible to produce a three-foot length of pipe in large diameters, which has heretofore not been feasible, owing to a large percentage of defective material produced. The circular shape, the manufacture of which is possible only through the use of a metal such as steel, permits, by staggering, a large increase in the amount of ware which may be placed on a floor.

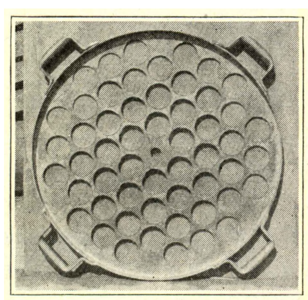

FIG. 8.—Round bat filled with ' plaster for drying grinding wheels, etc. Four handles.

While no new plants have yet been designed for the exclusive use of the steel shod, it is possible that the use of the circular steel shod in connection with certain advanced types of trucks and especially designed steel racks will make a very marked decrease in the cost of the building required.

For those plants that make conduit, a steel board nas been developed, which, while rectangular in shape, produces the same results as for the sewer pipe. These are accomplished in a similar manner, namely, by providing a maximum of interior ventilation.

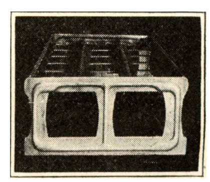

FIG. 9.—Rectangular bat for drying grinding wheels, etc. End view.

For the china ware, porcelain and grinding wheel industries, a steel bat holder has been provided, which materially reduces the thickness of plaster of Paris required, the result being that drying is considerably expedited and that the life of the bats is greatly increased.

Special types of coated ware boards and sagger boards are being produced for use in the pottery industries. Special shapes of pallets and mold holders are now being tried out in the porcelain insulator factories.

In all of the industries a properly designed and manufactured steel board has been found to result in considerably lower operating costs, due to increased production of first grade ware and decreased loss of ware in its manufacture. Steel shods eliminate the fire hazard and thereby reduce insurance rates. Steel equipment can be designed in most cases to work along with wood, so that the replacement expense may be distributed over a period of time, although it would be a paying proposition to make a complete change-over and thus realize the total advantages accruing from the use of steel.

To disregard the first cost in the light of lower operating costs is a matter of sound, progressive business policy.

THE COMMERCIAL SHEARING AND STAMPING CO.,
YOUNGSTOWN, OHIO.

SERVICE REQUIREMENTS FOR PLASTIC REFRACTORIES[1]

BY HUGH E. WEIGHTMAN

Introduction

Plastic refractories first appeared on the market as plastic fire brick Since that time many such materials have appeared, some better and some not fit for use. There has been much of the "follow the leader" type of production in these materials with the result that few, if any, of such materials are as good as they might be. If the plastics are to be the best possible in service quality, more cooperation must be given the manufacturer by the user.

When a setting is made with fire brick the greater part of the structure has been pre-fired to a high temperature, not more than 3 to 15% consisting of unfired mortar. With plastic refractories the entire structure consists of wet material with a grog or fired portion of only 25 to 50%.

Service Requirements

Heat can only be applied to one side of a plastic refractory wall. This makes the maturing of such walls very difficult. To overcome the danger incident to one side firing, the grog content of the plastic refractory has been increased to the maximum. Conduction of heat through the wall is needed to lessen the temperature differences, since such temperature differentials tend to stimulate shattering of the refractory. A certain amount of porosity is needed to insure a rapid dewatering of the mass. Firing control is hard to accomplish in the case of boiler

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlanta, Ga., Feb., 1926. (Refractories Division). Reed. Dec. 31, 1925.

furnaces and similar updraft furnaces, and as a consequence not much dependence can be placed in the ability to fire the average plastic refractory structure carefully.

Often barely enough heat is released in small furnaces to raise the temperature to a suitable point for maturing fire brick. Convection of heat from the outer walls causes a rapid decrease in temperature from the fire side to the outside. Under such conditions only a thin skin on the fire side has been matured. If the plastic has been well made for such service, the outer portion has "air set." Often some portion between the low temperature outer portion and the fire side of the refractory will have lost its air set quality and not gained a fire set. In such cases the refractory is fragile, dusty, and easily damaged.

While permeability to gases is desirable as allowing safer maturing of the structure, some furnaces make corrosive gases that attack the refractory. Porosity is desirable for rapid dewatering, but on the other hand it permits the walls to become an easy prey to adhering dust and slag.

Salty compounds in coal and oil, and iron dust in coal exert a rapid fluxing action on refractories containing free silica and especially in refractories containing sodium silicates.

In good average construction with plastic refractories, wall heights do not go over six feet. With properly buck-stayed walls the outer wall will not throw a load on the plastic wall. In some cases where the plastic linings have been added to old installations without repairing the outer walls the latter throw some load on the plastic. The load appears after the furnace has been in service. If the refractory is of sufficient mechanical strength and well matured not much harm in the average case will be done. Often the plastic either lacks strength to resist the load or is improperly matured.

Working floors or hearths in industrial furnaces are easily and reliably constructed of plastic refractories if care is taken to avoid buckling by expansion. The drawing of materials over such floors causes excessive wear unless the texture is made right by careful grading of the grog.

In the construction of deflecting pieces, arches and similar parts, plastic refractories are very convenient. Mechanical strength is the principal requirement for this service. Additional strength can be obtained in such structures by iron reinforcement. To insure a good bond between the iron and plastic, and to eliminate rupture due to expansion differences, the iron supports may be given a coating of sodium silicate and clay in a thin slip. The addition of some iron compounds to the slip helps. In such reinforcements care must be taken to allow for the growth of the metal.

Plastic refractories bear the same relation as fire brick in their limitations in metallurgical work. We cannot use the most refractory materials where oxides of the metals are produced, especially oxides of antimony, bismuth and zinc.

Deficiencies in Plastic Refractories

Strength The outstanding deficiency in plastic refractories is that of mechanical strength. When these are installed the material is pounded into forms with a mallet. The strength of the wall depends on how well this pounding is done. To simulate practice the plastic should be pounded into the molds. If this is done the breaking strength of the average samples on the present market will be from 50 to 100% higher than shown by Geller and Pendergast.[1]

The dry strength of some materials tests as high as 500 pounds per square inch. These materials were made of well-graded grog and considerable plastic clay.

Sizing of Materials Many plastic refractories are made of poorly graded materials. Occasional large pieces of ganister exert a tremendous pressure, spalling the refractory. The screen sizes used in the manufacture of plastic refractories should be such that the sample can be easily built into thin sections. Finer and more uniformly graded material will greatly improve the forming of plastic refractories and give greater mechanical strength.

Price Price is one factor that has retarded the more general use of plastic refractories. There appears to be no reason why such fancy prices should be asked for these materials. Some plastic refractories sell at $24 to $60 a ton and a few fancy ones at as much as $160 a ton. Even considering warehousing and extensive sales work, these prices are far out of line when it is considered that fired shapes of equal and better quality may be purchased for $20 a ton and less.

In spite of these exorbitant prices, plastic refractories are increasing in use on account of the ease with which they may be handled, and the ever-increasing cost of the furnace brick layers. Few, if any, plastic furnace linings exceed the life of a good fire brick installation, though often the operating labor can make a better plastic installation than to lay a firebrick setting. A reduction in the price to a more equitable level will greatly increase the use of plastic refractories.

Conclusion

The following requirements can be made in plastic refractories to meet service requirements:

[1] "The Laboratory Testing of Refractories," *Jour. Amer. Ceram. Soc.,* **8** [7], 441-51 (1925).

1. Increase the mechanical strength by better grading of grog and the use of plastic clay of greater binding power.

2. Elimination of an excess of ganister and soluble silicates. Where soluble silicates are used to increase the binding power, it should be indicated on the container.

3. When molded and fired the fracture of a sample of plastic refractory should present a flinty structure without large nodules. Sandy and rounded off particles should be avoided.

4. The body should not vitrify to a glassy structure to more than one-eighth inch. Closing of the surface pores is desirable to reduce slag and dust penetration and to prevent excessive clinging of ash to the wall.

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A FOUR-POINT MIXING DIAGRAM[1]

By K. M. Smith and W. L. Sample

Having considerable glaze development to do, the need was felt for a method of mixing glazes using four variables. The current literature yielding nothing, a method was evolved. Prior to the description of the four-point diagram, we shall take the liberty to review the triaxial diagram, with its three variables.

The triaxial diagram is a means of obtaining a multiplicity of glazes, (or other compounds) with the use of only three; in other words, in the pursuit of a glaze, instead of mixing and grinding batch after batch of glaze, three only are made, and mixed together in various proportions to produce an unlimited quantity of glazes, each one different from the rest. The saving of time and labor is obvious.

The triaxial diagram consists of an equilateral triangle having the sides divided into equal parts, the number being optional. The smaller the division, the more mixtures there will be. The divisions are then connected by straight lines, the connected lines being parallel to the unconnected side.

Figure 1 shows a diagram having the sides divided into six parts. This gives a total of 28 intersections, which correspond to the total number of glazes that will result from the

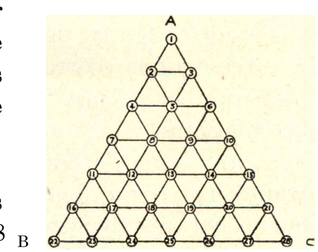

Fig. 1.

[1] Presented at the Annual Meeting, American Ceramic Society, Atlanta, Ga., Feb. 1926. ' (White Wares Division). Received Dec. 28, 1925.

Editor: The authors recognize that this is not new, yet it is not generally known.

mixing. Point 1, 22, 28, represent the three glazes A, B, and C respectively. All other points contain parts of two or all the glazes. To determine the amount of each glaze in each point, count the spaces between the point and the side of the triangle away from the glaze. For example: point 8 in Figure 1. Counting away from "A," that is, toward the base, from point 8 there are 3 spaces, representing 3 parts of glaze "A"; from point 8 to the side A-B, away from "C," there is one space, representing one part of glaze "C"; from 8 to the side A-C there are two spaces, representing two parts of the glaze "B." Tabulating, point 8 is made-up of

Glaze A	3 parts
Glaze B	2 parts
Glaze C	J^part
Total	6 parts

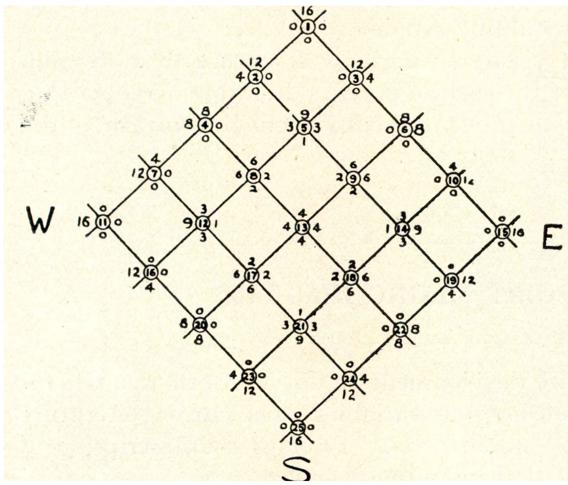

FIG.2.

The total parts will always coincide with the divisions in the side of the triangle. The glazes in the sides will contain none of the glaze in the corner formed by the other two sides.

The Four-Point Diagram

The four-point diagram is essentially a square subdivided into smaller squares, and like the triaxial, the number of subdivisions is optional. Figure 2 shows a square divided into 16 small squares. It is made of ten straight lines, forming 25 intersections, corresponding to the total number of mixtures formed. In the diagram, the intersections have been numbered from 1 to 25, and around these numbers will be found four other numbers, representing the parts of each of the four glazes that go to make up the series. The four corner points represent the four glazes "N," "W," "S," and "E." The rule for computing the number of parts in each point is rather hard to give, and harder to understand; an example will be far simpler, so we shall sacrifice form for simplicity.

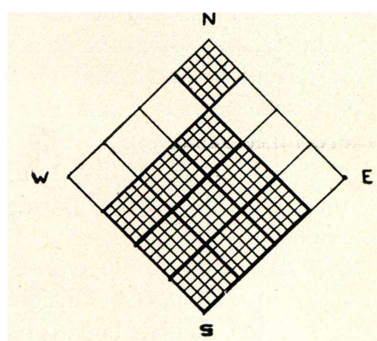

FIG.3.

Let us take point 5, Figure 2. How much of glaze "N" in this? Count the squares enclosed in the angle to the south of the point. There are 9. This represents 9 parts of glaze "N," and corresponds to the number north of the point. Figure 3 shows this more clearly, the nine squares being shaded. Similarly, there is one square north of point 5, meaning one part of glaze "S." There are three squares East and West of the point, representing three parts each of "W" and "E." Having visualized this with the aid of Figure 3, we can state the rule in brief—count the squares in the angle opposite the angle containing the glaze.

The rule holds good for any size diagram, obviously enough. The writers have used this diagram in mixing colored glazes with very gratifying results. Using three colored glazes, and one uncolored, some rather pleasing tints have been developed, taking the series as a whole.

CAMBRIDGE SANITARY MFG. CO.
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DISCUSSION OF "THE THERMAL EXPANSION OF REFRACTORIES"[1]

M. C. BOOZE:[2] The data on thermal expansion of refractories given in this paper add to our knowledge since, as the author states, previous determinations of this property have rarely been made at temperatures above 1000°C. A number of conclusions are drawn, however, which warrant discussion. In some cases these conclusions are not supported by sufficient evidence to make them have as general application as is implied and in others there appears to be disagreement with known facts.

In the introduction the author states that "the tendency of a brick to spall, other things being equal, is proportional to the coefficient of linear expansion." The "other things" to which reference is made are diffusivity and elasticity or shearing strain. These latter factors are of first importance, as the author himself in a previously published paper[3] has shown, although he appears to have lost sight of that fact and leaves the impression in the paper under discussion that the spalling tendencies may be judged on the basis of coefficient of expansion alone. This impression is gained by such statements as "the materials most resistant to spalling are zircon, silicon carbide and kaolin . . . . ;" "the different materials are listed . . . . to bring

[1] F. H. Norton, *Jour. Amer. Ceram. Soc.,* 8 [12J, 826-28(1925). Discussion received Feb. 10, 1926.

[2] Senior Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] "A General Theory of Spalling," *Jour, Amer, Ceram, Soc.,* 8 [1], 29-39(1925).

out their spalling resistance," and "in Table III the various specimens are listed in the order of excellence." In all of these cases the order of excellence is determined entirely by the coefficient of expansion values obtained by the author.

In the paper, "A General Theory of Spalling," by Mr. Norton, that has been referred to, he develops a formula showing the relation between spalling and the three properties, diffusivity, coefficient of expansion and (maximum) shearing strain. He then proceeds to measure these properties on various refractory brick and finds a relation between the values obtained by substitution in his formula and the results of spalling tests. This formula is simply

$$\frac{\text{coefficient of expansion}}{\sqrt{\text{diffusivity}} \times \text{(maximum) shearing strain}}$$

which in itself is ample evidence to show that spalling cannot be judged on the basis of coefficient of expansion alone.

In the data given in the earlier paper, one fireclay brick having a coefficient of expansion of .0000051 at 500°C withstands 26.5 quenchings, while another with very similar expansion (.0000053) withstands only 15.6 quenchings. Hard fired kaolin brick with a coefficient of expansion of .0000063 are shown as being only fair in resistance to spalling, since they fail in 10.6 quenchings. On the other hand, fireclay brick with a very high coefficient of expansion (.0000104) are somewhat more resistant to spalling, failing only after 12.2 quenchings. These appear as discrepancies only under the assumption that the coefficient of expansion is the dominant factor. The author himself shows that they are not discrepancies, explaining them by differences in the other properties named.

In the article under discussion, results are given on a variety of refractory products and there is no reason to believe that these products are alike in diffusivity and shearing strain. In fact, it is practically certain that they are very much unlike. In a paper by the writer and S. M. Phelps[1] it has been shown that the degree of firing affects the spalling tendencies to a marked extent, but may not have a pronounced effect upon the coefficient of expansion. The same was found to be true of the fineness of grind.

If our assumption that the samples tested by Norton are dissimilar in diffusivity and shearing strain is correct (and there can be little basis for contesting it) then the listing of these samples according to the values obtained for coefficient of expansion "to bring out their spalling resistance" is meaningless.

[1] "A Study of the Factors Involved in the Spalling of Fireclay Refractories with Some Notes on the Load and Reheating Tests and the Effect of Grind on Shrinkage," *Jour. Amer. Ceram. Soc.,* 8 [6], 361-82(1925).

A number of the data shown on fireclay brick are far from complete and so are neither conclusive nor in a number of cases are they fair.

Since only one curve is plotted for brick from each of the Pennsylvania, Maryland, Missouri, and Colorado fireclay districts, and no mention is made of averages or check determinations, we assume that only one specimen was tested in each case. Certainly there was only one brand tested from each of the districts named. It hardly seems necessary to point out that one sample, or even one brand, of fireclay brick cannot ordinarily be chosen as being representative of the product of one manufacturer and that each of the districts named produces a wide variety of fireclay products. They vary in composition, grind, method of manufacture, and firing. It is not just, therefore, to assume that the brick tested by Norton represent the districts from which they came, that the average coefficient of expansion as given by him for fireclay brick will hold for other brands of brick, or that the statement, "fireclay brick start to shrink at about 1220°C," made in the conclusion, is an accurate one. Shrinkage, of course, depends upon composition, structure, and firing treatment, as is generally realized, and these are varied by the manufacturer to suit the needs of his customers. However, even the average shrinkage temperature given by Norton for fireclay brick is not an accurate one for his own results. The average is stated as being computed on samples 6, 7, 8, 9. For No. 6 he found a shrinkage temperature of 1320°C, no shrinkage on No. 7 at any temperature up to the highest used in the test (1600°C), 1250°C for No. 8, and 1100°C for No. 9. Using the value of 1600°C for No. 7 even though it showed no shrinkage at that temperature, the average is 1317°C, instead of 1220°C, as given. This, of course, has no more meaning than the figure given by Norton. There is some evidence that the determinations themselves were not accurate and that shrinkage was found at temperatures below the true ones. The kaolin brick fired at 1300°C are shown as shrinking at 1100°C and the rate of heating when the shrinkage was noted was 100°C per hour so that the time effect during the test was almost negligible. The specimen made from white Florida zircon was fired at 1650°C for two hours and yet shrank rapidly in the test at 1500°C. The specimen made from brown Florida zircon was fired for 4 hours at 1590° and yet began to shrink at 1550°C in the test where it was rapidly heated. Specimen No. 13 was made from Brazilian zirconia and fired at 1675°C for 8 hours. It shrank rapidly in the test at 1600°C. With the spinel brick shrinkage was found to take place 90°C below the stated firing temperature and 50°C below in the case of the fused alumina brick. A rather wide experience with refractory materials has never shown the writer a parallel case where marked shrinkage took place during rapid heating and at temperatures well below the initial firing temperature, especially where the latter was held for a period of several hours' duration. If the firing temperatures are correctly given, we are inclined to believe that the shrinkage temperatures as observed are inaccurate and from 40°C to 200°C too low.

In dealing with the fireclay brick from Pennsylvania, the statement is made "above this temperature (1200°C) the specimen exhibited a peculiarity that is inherent in Pennsylvania clays and in few others. This is the so-called secondary expansion which starts in where most clay brick shrink and increases rapidly up to 5 or 6% at the softening point." This is in error in two ways. In the first place, the peculiarity of secondary expansion is only exhibited by flint clays from a rather definite locality in Pennsylvania and is not found on all or even a major percentage of flint clays from that State. In the second place, the expansion occurs only on soft-fired brick and does not necessarily take place even during the initial firing on medium- or hard-fired brick. Secondary expansion, therefore, is not an "inherent characteristic" of Pennsylvania brick.

In addition to those mentioned here, there are a number of other statements in this article to which exceptions might be taken, but they are not of first importance, and we do not want to cloud the issue by making this criticism of unnecessary length.

Reply by F. H. Norton: Mr. Booze seems to have misinterpreted my purpose in listing the refractories in the order of their maximum coefficient of expansion. It was clearly stated that the tencendy to spall is proportional to the expansion coefficient if other properties are the same. In making a refractory of a given material, the coefficient of expansion can be altered but little, but the flexibility can be varied greatly by the structure and firing. This being true the coefficient of expansion of different materials gives the relative spalling possibilities of the manufactured refractory. For example, there is much more chance of making a good spallin brick out of silicon carbide than out of magnesite. There is no intention to infer that brick made from the materials listed would have the same order of spalling merit.

In giving data for the expansion of fireclay brick, it was not intended to give a complete or representative set. A few high grade brick were selected to bring out certain characteristic peculiarities in the expansion curves. The specimens are not necessarily typical of their region.

[1] Received February 23, 1926-

In regard to the average shrinkage temperature of 1220°C, the average was made by considering that specimen No. 7 started to shrink at the temperature of permanent change in length (negative shrinkage). A number of other unpublished tests on fireclay refractories substantiate this average value. I have no reason to doubt the relation between the firing and shrinking temperature of the specimens, although the firing temperature was not determined with the precision of the temperatures in the expansion test.

The secondary expansion of flint clays may not be general in Pennsylvania but some of the best known brands of Pennsylvania brick exhibit this property. The brick showing secondary expansion in my paper was a well-fired commercial brick and would not be considered soft.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM FEBRUARY 16 TO MARCH 15.

PERSONAL

Louis Deverin, Professor of Mineralogy and Petrography at the University, Lausanne, Switzerland.

Waldemar F. Dietrich, Box A, Stanford University, California. Associate Professor of Mining and Ceramics.

Chas. M. Dodd, Box 268, New Philadelphia, Ohio. Student.

Carlo Ferrari, Colonial Hotel, 81st. & Col. Ave., New York City. Technical Manager, Societa Meridionale di Elettricila, Naples, Italy.

John M. Flanigen, Alliance, Ohio. Distribution Supt., Ohio Public Service Co.

Wm. G. Halloin, 904 Lock St., Tarentum, Pa. Lab. Asst., Research Dept., Pittsburgh Plate Glass Co.

Russell L. Hendricks, Lisbon, Ohio. R. Thomas and Sons Co.

Gustav Keppeler, Hannover, Korunstr. **11,** Germany. Professor at the Technical High School.

Edward A. McNerney, 11 Kennedy St., Bradford, Pa. Plant Supt., Hanley Ceramics Society.

Henry M. Porter, Box 238, South Gate, Calif. Plant Manager, Calif. Clay Products Co.

Harry E. Potteiger, P. O. Box 23, Sinking Spring, Pa. Asst. Supt., Glen Gery Shale Brick Co.

Adrian T. Preston, Safe-Cabinet Laboratory, Marietta, Ohio. Chemist.

Chas. N. Skalla, Rua Andrade Neves 56, Rio de Janeiro, Brazil.

Willard G. Young, Box F, Sta. A., Ames, Iowa. Student.

Eberhard Zschimmer, Boeckh-Str. 4, Karlsruhe (Germany). Professor in the Technical High School.

CORPORATIONS

D. O. Cunningham Glass Co., Carson Station, Pittsburgh, Pa. A. C. Sohn, Representative.

Harper Electric Furnace Corp., 400 Bankers Trust Bldg., Philadelphia, Pa. H. P. Rust, Representative.

Geo. D. Roper Corp., Rockford, **111.**

Membership Workers' Record

	Personal		Personal	Corporation
F. E. Allen	1	W. E. S. Turner	1	
Walter B. Ebert	1	Hewitt Wilson	1	
C. E. Fulton	1	W. H. Zimmer	1	
Roy A. Horning	1	Office	7	3
Francis T. Owens	1			
			15	3

PERSONAL NOTES OF MEMBERS

Eugen Becher is now corporation representative of the Metal & Thermit Corp. in place of Homer F. Staley.

Wm. J. Bidleman, formerly at Wellsville, Mo. with the Wellsville Fire Brick Co., is situated with the Chicago Fire Brick Co., Chicago, **111.**

Wm. K. Booth of Chicago has moved to Sierra Madre, Calif.

H. R. Borland has changed his residence from Peoria, **111.** to Thurber, Texas.

Geo. E. Crawford has moved from Trenton, N. **J.** to Academy Apts., Kittanning, Pa.

E. A. Eigenbrot of St. Louis is no longer with the Bucks Stove & Range Co. but is now associated with the J. B. Ford Co.

Francis E. Finch has been designated corporation representative of the Hardinge Co. in place of Harlowe Hardinge.

Walter L. Fitzgerald, formerly with the Haws Refractories Co., Philadelphia, Pa., is now Vice President of the United Clay Mines Corp., Trenton, N. J.

R. B. Gilmore has recently moved to Lock Haven, Pa., where he is located with the Queen's Refractories Co. Mr. Gilmore was formerly with the Carborundum Co., Niagara Falls, N. Y.

Virgil K. Haldeman is now located at **1061** Alameda St., Burbank, Calif. He was formerly with the Beaver Falls Art Tile Co., Beaver Falls, Pa.

R. B. Keeler is no longer with the California Clay Products Co. but is located at 8175 Victoria Ave., South Gate, Calif.

E. Kenneth Koos is now with the D. E. McNicol Pottery Co., Clarksburg, W. Va. Mr. Koos has been connected with the Red Wing Union Stoneware Co. of Red Wing, Minn.

J. S. **Leibson,** who has been in this country for some time, has returned to France where he is with the Porcelainerie de Lesquin at Lesquin-les-Lille.

C. C. Leigh has recently become manager of the Belmont Tumbler Co. at Bellaire, Ohio. Mr. Leigh was previously located at Philadelphia with Gillinder & Sons, Inc.

Los Angeles Pressed Brick Co. and **Gladding-McBean & Co.** are now jointly occupying rooms in the New Pacific Finance Bldg., 621 S. Hope St., Los Angeles, Calif.

C. G. **Powell** has moved from Montezuma, Ind. to 512 Maurry St., Alcoa, Tenn.

Ernest C. Schmatolla has left the A. C. Spark Plug Co. in Flint, Mich, and is now located in New York City.

H. P. Smith has been substituted for Malcolm McNaughton as representative of the Joseph Dixon Crucible Co.

NOTES AND NEWS

REPORT OF COMMITTEE ON BOILER FURNACE REFRACTORIES[1]

The organization meeting of the Special Research Committee on Boiler Furnace Refractories was held at the Engineers' Club, New York City. The following persons attended: C. F. Hirshfeld, Chairman, G. A. Bole, M. C. Booze, R. F. Geller, C. W. Parmelee, J. S. McDowell, E. B. Ricketts, and O. P. Hood. Guests: R. A. Sherman, P. Nicholls, W. H. Fulweiler, W. A. Carter, C. B. LePage, and Chas. Taylor.

C. F. Hirshfeld outlined briefly the steps which have led to the organization of this Committee. As a purely individual activity he had during the past 15 months collected certain funds which he had placed at the disposal of the Bureau of Mines to cover the expenses of a beginning in a research on boiler furnace refractories. At the suggestion of O. P. Hood, Director of the Bureau of Mines, Mr. Hirshfeld called this activity to the attention of the A. S. M. E. Main Research Committee and suggested its acceptance as one of the A. S. M. E. projects. This suggestion was favorably received by the Main Committee and on its recommendation the Council approved the organization of the Committee to carry forward this investigation. The Main Committee asked Mr.

[1] Tuesday, December, 1, 1925.

Hirshfeld to accept the Chairmanship and with his help has named the personnel of the Special Committee.

Mr. Hirshfeld informed the Committee that two progress reports had appeared in the August 18th and August 25th, 1925 issues of *Power*. These reports cover the important details relating to this research. He explained that no one material or form of material was to be investigated but that the research was to be conducted on broad and general lines in a search for information which would be of use to both the manufacturer and the user.

Ralph A. Sherman, Assistant Physicist of the Pittsburgh Experiment Station of the Bureau of Mines, gave a brief report on his work in this investigation. He said that the plan of attack called for the following four distinct movements: (1) to determine as definitely as possible the principal factors governing the failure of refractories in various types of installation, (2) to subject these factors to a detailed experimental analysis, (3) to undertake the formulation of tests that will measure the suitability of the tested material for the given conditions, and (4) to attempt the development of a suitable refractory, in case such a refractory is not available for a given service.

He discussed each of these items briefly and stated that he had made visits to more than 34 stations where careful inspection was made of boilers having various furnace sizes. These furnaces are fired by under-feed, chain grate and over-feed stokers, pulverized coal burners, fuel oil burners and natural gas burners.

G. A. Bole, Superintendent of the Ceramic Experiment Station, Bureau of Mines, described the preliminary experiments which have been carried on in his laboratory on sample refractories of various grain size and composition. He said these samples had various alumina-silica ratios and that some were hand made and others were produced by dry press processes. He expressed the opinion that this investigation was largely a fire clay refractory problem and said that his laboratory was planning (1) to study the action of slag on fire brick and then (2) to test various commercial refractories for freedom from the effects of slag.