EXPERIMENTS IN DEAD-BURNING DOLOMITE AND MAGNESITE[1]

By H. G. Schurecht

ABSTRACT

Stability of calcined dolomite; effect of fineness of raw material, nature of flux and temperature of burning.—Dolomite is difficult to dead-burn because the absorption of moisture from the air produces a gradual slacking due, probably, to the hydration of lime and various lime compounds, and this tends to cause disintegration. With all the fluxes tried, 100 mesh raw material gave greater resistance to slacking than 8 mesh size. This resistance decreased, however, with increasing temperature of calcining, by an amount which seems to depend on the silica and alumina content of the flux, being greatest for basic open hearth slag and kaolin, less for flue dust, and iron ore, and least for roll scale. The stability also varied with the proportions of flux used, being greater, as a rule, for smaller proportions.

Shrinkage, porosity and vitrification of calcined dolomite; effect of flux and burning temperature.—The shrinkage and porosity curves for mixtures containing flue dust, iron ore or roll scale are very similar. The higher the proportion of flux, the lower the temperature required to get maximum shrinkage and minimum porosity. Kaolin and basic open hearth slag behaved peculiarly in that vitrification depended more on the burning temperature than on the proportion of flux used.

Experiments in making dolomite brick.—It was found that ageing of the wet calcined material was necessary to prevent cracking of the bricks upon drying. With 5 per cent $MgCl_2$ as binder, comparatively strong brick were obtained. High shrinkage on firing caused excessive cracking, but the bricks were extremely dense and did not disintegrate until after four to six months. Unfired tar-bonded brick were made with sufficient strength to stand shipping and with a storage life of about four months. Fired tar-bonded brick showed less shrinkage and cracking than similar brick made with water. If dipped in tar to protect them from moisture, such brick will last five or six months before disintegration. It is possible, then to make dolomite brick with a storage life long enough to allow shipping and placing in furnaces.

Stability, shrinkage and porosity of calcined magnesite; effect of flux and temperature of burning.—Unlike dolomite, magnesite showed less slacking effect the higher the temperature of burning. Roll scale gave greater stability than iron ore, probably because of its lower silica content. The product was comparatively porous and with low shrinkage, even with high proportions of roll scale.

---

[1] By permission of the Director, U. S. Bureau of Mines

Introduction

In 1913, 158,519 tons of calcined magnesite[1] were imported into the United States from Austria Hungary. During the war this supply was cut off and American manufacturers were forced to rely chiefly upon California, Washington and Canadian magnesites. Chiefly as a result of this condition production of crude California magnesite increased from 9,632 tons in 1913 to 211,663 tons in 1917, while the importation of Canadian magnesite increased from 494 tons in 1913 to 20,872 tons in 1918.

Canadian magnesite was used largely because of the remoteness of the California and Washington deposits from the middle east steel centers. Dolomite in abundance occurs near the steel centers and an extremely pure material may be obtained at comparatively low cost.

The untreated domestic magnesite is rather pure and not as satisfactory as the Austrian magnesite, known as Breunnerite, which contains sufficient iron carbonate to render it suitable when calcined for the manufacture of refractories. Sufficient flux should be present in magnesite to prevent the calcined material from slaking and to produce a dense product.

Dolomite is comparatively difficult to dead-burn owing to its tendency to disintegrate. This disintegration may be divided into two classes:

(1) Disintegration due to change of state on heating and cooling.

(2) Disintegration due to slacking by taking up moisture from the air.

In the first case the disintegration is comparatively rapid, occurring during the cooling, and is due to the conversion[2] of the beta to the gamma from of calcium orthosilicate, $2CaO.SiO_2$ which starts at 675°C in cooling and continues even after it is taken out of the furnace. The conversion is accomplished by an increase in volume of 10 per cent, which shatters the calcine into fine dust and sometimes breaks off fragments of the sintered dolomite. This action is called "dusting" and is well known

---

[1] C. G. Yale, and R. W. Stone, "Magnesite in 1918," *U. S. Geol Survey, Mineral Resources of the U. S.* 1919, 141–158.

[2] G. A. Rankin, "The Ternary System CaO–Al_2O_3–SiO_2," *Am. Jour. Sci.*, 39, 7–8 (1915).

in the manufacture of Portland cement. Bates[1] found in Portland cements high in magnesia that the amount of orthosilicate formed is decidedly increased.

The writer noticed dusting in the cooling of calcined Canadian magnesite which contains a high per cent of lime. The conversion of the orthosilicate in the heating and cooling of Canadian magnesite has caused considerable trouble in the use of this mineral for making brick as the dusting tends to disintegrate the brick.

Disintegration due to taking up moisture from the air is due to the presence of free lime in the calcine, which readily takes up water and forms $Ca(OH)_2$. In the formation of the hydrate the lime increases in volume and finally disintegrates the mass. Disintegration of this type takes place comparatively slow.

Hydraulic compounds may be formed with lime which take up moisture from the air and cause the sintered dolomite to disintegrate. Some of the possible compounds formed in calcined dolomite are the following:

$CaSiO$
$3CaO.2SiO_2$
$2CaO.SiO_2$
$3CaO.SiO_2$
$CaOMgO.SiO_2$
$3CaO.Al_2O_3$
$5CaO.3Al_2O_3$
$CaO.Al_2O_3$
$3CaO.5Al_2O_3$
$2CaO.Fe_2O_3$
$CaO.Fe_2O_3$
$Al_2O_3SiO_3$
$CaO.Al_2O_3.2SiO_2$
$2CaO.Al_2O_3.SiO_2$
$3CaO.Al_2O_3.SiO_2$

Klein[2] found that $2CaO.SiO_2$ (B form) and $3CaO.SiO_2$ and all of the aluminates with the exception of the tricalcium aluminate developed hydraulic properties.

Campbell[3] found that calcium ferrites corresponding to the following empirical formulas showed hydraulic properties and when tested as to their ability to set, showed an initial set in 14 to 22 minutes, and a final set in about $^3/_4$ of an hour, being similar to the calcium aluminates found in Portland cement.

1. $5CaO.3Fe_2O_3$
2. $6CaO.3Fe_2O_3$

---

[1] P. H. Bates, "Properties of Portland Cement Having a High Magnesia Content," *Bureau of Standards Tech. Papers*, **102**, 40 (1918).

[2] A. A. Klein, and A. J. Phillips, "The Hydration of Portland Cement," *Trans. Am. Ceramic Soc.*, **16**, 313–841 (1914).

[3] E. D. Campbell, "Some Mix-Crystals of Calcium Ferrite and Aluminate," *Jour. Ind. Eng. Chem.*, **11**, 116–120 (1919).

Furthermore Bates[1] found that high magnesia cements show a tendency to disintegrate upon storage, which may be another cause of the disintegration of dolomite brick.

By "dead burning" is meant, the sintering of dolomite with a flux at a high temperature in order to place it in such a state that it will not disintegrate after storing for long periods. It should also be calcined high enough to remove most of the firing shrinkage.

In work previously reported[2] the writer conducted experiments in dead-burning dolomite by the addition of coal tar, flue dust, iron ore, basic open hearth slag, shale, kaolin, roll, scale, and chlorides when added to raw dolomite, and calcined to cone 18. Fluxes high in silica produced calcines which disintegrated on cooling due to dusting. Fluxes low in silica, as roll scale, iron ore and flue dust were more effective in dead-burning than the siliceous fluxes, as shale and blast furnace slag. The best mixtures, however, disintegrated at the end of 130 days when in the form of briquettes 1×1×1 in., whereas it is desirable to prepare calcined dolomite that will withstand storage for much longer periods.

The former work was done on coarsely ground dolomite (through 8 mesh) and the trials were calcined at cone 18. By grinding dolomite finer, a more intimate mixture is obtained and by calcining to higher temperatures a more thorough sintering takes place. In the following work the dolomite and fluxes were ground to 40 and 100 mesh size and calcined to cones 14, 20 and 26 to determine if finer grinding and higher calcination temperatures would produce a more stable product.

The effects of different fluxes and calcining temperatures on the shrinkage and porosity of dolomite and magnesite were also studied to determine the amounts of fluxes and calcining temperatures necessary to obtain maximum shrinkage.

Various methods for making brick from calcined dolomite were tried, both with hydrous and anhydrous binders.

Description of Work

The effects of fine grinding and different calcination temperatures were first studied.

---

[1] P. H. Bates, *Loc. cit.*, p. 32.

[2] *Jour. Am. Ceram. Soc.*, **2**, 291–805 (1919).

The following fluxes were added to dolomite ground to 100 mesh size, and similar mixtures were also made with dolomite ground to 40 mesh size:

(1) Flue dust; (2) iron ore; (3) basic open hearth slag; (4) kaolin; (5) roll scale.

The chemical analyses[1] of the fluxes are as follows:

	1	2	3	4	5
Silica (SiO_2)	9.5	7.9	15.9	43.8	4.2
Titanium oxide (TiO_2)	..	0.3	..	....	....
Aluminum oxide (Al_2O_3)	4.6	5.6	7.6	40.2	5.2
Ferric oxide (Fe_2O_3)	72.1	78.2	20.8	0.8	19.6
Ferrous oxide (FeO)	..	...	..	...	71.3
Manganese oxide (MnO)	..	trace	2.3	...	...
Calcium oxide (CaO)	2.5	none	40.6	none	none
Magnesium oxide (MgO)	1.0	0.6	13.0	0.06	0.20
Potassium oxide (K_2O)	0.6	0.04	none	none	0.20
Sodium oxide (Ng_2O)	0.3	0.3	none	none	none
Sulphur trioxide (SO_3)	0.3	none	none	none	none
Carbon dioxide (CO_2)	1.5	none	none	none	none
Hygroscopic water (at 105°C)	0.6	0.5	0.0	1.5	0.0
Loss on ignition	6.8	6.9	..	13.9	...
	99.6	100.1		100.2	100.9

One inch cubes of the various mixtures were molded and calcined to cones 14, 20 and 26 in a Hoskins carbon resistance furnace. Immediately upon being taken from the furnace they were cooled in a desiccator and weighed. After standing in air at room temperature for different periods they were reweighed in order to determine the increase in weight due to taking up moisture and CO_2. The cubes were weighed at the following intervals: 2, 5, 10, 18, 28, 38, 50, 65, 80, 100, 125, 150, 175, 200, 220, 250, 275, 300 and 325 days. The periods at which the briquettes disintegrated and no longer showed mechanical strength were also noted.

Below are given the chemical analyses of the Cedarville dolomite and Canadian magnesite used in the investigation. The analyses[2]

---

[1] The chemical analyses were furnished by A. G. Fieldner of the U. S. Bureau of Mines, Pittsburgh, Pa.

[2] Analyses were furnished by A. C. Fieldner of the U. S. Bureau of Mines, Pittsburgh, Pa.

of other Ohio dolomites and of calcined Austrian magnesite are given for comparison.

	1	2	3	4	5	6	7
Silica (SiO_2)	0.4	0.6	0.2	0.0	6.7	2.2	0.7
Aluminum oxide (Al_2O_3)	0.5	0.3	0.3	.01	2.5	.6	2.2
Ferric oxide (Fe_2O_3)	.5	.6	.4	.30	1.1	.8	7.2
Ferrous oxide (FeO)	..	..	..	..	..	..	none
Calcium oxide (CaO)	30.2	29.9	30.3	30.20	28.5	11.1	1.8
Magnesium oxide (MgO)	21.8	21.9	21.9	22.0	18.3	39.0	86.1
Potassium oxide (K_2O)	trace	0.2	none	none	0.4	none	none
Sodium oxide (Na_2O)	trace	.04	none	none	.1	none	none
Sulphur trioxide (SO_3)	none	none	none	.1	.1	none	0.2
Carbon dioxide (CO_2)	46.8	46.5	47.5	46.8	41.6	47.1	1.7
Hygroscopic water at 105° C.	0.1	0.1	0.01	0.0	0.2	0.0	0.3

1. Dolomite from Cedarville, O. 2. Dolomite from Springfield, O. 3. Dolomite from Genoa, O. 4. Dolomite from Woodville, O. 5. Dolomite from Hillsboro, O. 6. Magnesite from Canada. 7. Calcined magnesite from Austria.

To determine the effects of different fluxes and calcining temperatures upon the shrinkage and porosity of the dolomite and magnesite mixtures, briquettes ($1 \times \frac{1}{2} \times 2$ inches) were used. Small briquettes were employed in order to minimize cracking, resulting from excessive firing shrinkage, which occurs to a greater degree in briquettes of large size. Five per cent of dextrine was used as a binder in molding the briquettes and the raw volumes were determined in a small pycnometer volumeter. The briquettes were then fired in an electric furnace to cones 14, 17, 20, 23, 26 and 30. After firing the volumes were again determined to obtain the firing shrinkage. The apparent porosities were determined in the customary manner, using kerosene as the liquid. The true specific gravity determinations were made in a pycnometer specific gravity bottle with kerosene as the liquid.

In the experiments in making dolomite brick, the following mixtures, screened through a 100 mesh sieve, were calcined at cone 20, Cedarville dolomite being used.

1. 10 per cent iron oxide, 90 per cent dolomite
2. 15 per cent iron oxide, 85 per cent dolomite
3. 25 per cent iron oxide, 75 per cent dolomite

The following binders were tried:

1. 5 per cent sodium silicate
2. 5 per cent caustic lime
3. 5 per cent magnesium chloride
4. 12 per cent coal tar

Effects of Degree of Fineness of Raw Dolomite and Different Fluxes and Calcination Temperatures on the Stability of Calcined Dolomite and Magnesite

Flue Dust and Dolomite.—Figures 1 and 2 show the effect of different calcining temperatures and fine grinding on the tendency of flue dust-dolomite mixtures to increase in weight upon storage. It is evident that grinding the dolomite to 100 mesh size before calcination decreases its tendency to increase in weight after calcination, when compared to results[1] obtained in dolomite which has been ground to 8 mesh size previous to calcination. For example, 8 mesh dolomite mixtures prepared with 15% flue dust increased in weight 7% at the end of 80 days after calcining at cone 18, whereas with 100 mesh dolomite, the same percentage mixture increased in weight only 0.9% at the end of 80 days after calcining to cones 14 and 20.

Raising the calcining temperatures increases the tendency of the calcine to increase in weight due principally to taking up moisture and CO_2. For example, the mixture prepared with 15% flue dust increased in weight 1.4% at the end of 150 days after calcining to cone 14, 2.9% after calcining to cone 20 and 3.9% after calcining to cone 26.

Figure 2 shows the effects of flue dust when mixed with 40 mesh dolomite and calcined to cone 26. Increasing the per cent flue dust decreases the tendency to increase in weight up to an addition of 10%. With 15% flue dust it has a tendency to increase in weight more than with 10%. Adding 25% again decreases the tendency to increase in weight and 30% again increases the tendency. A somewhat similar relation is obtained with the 100 mesh dolomite mixture (see figure 1) after calcining to cone 14, but when these mixtures are calcined to cones 20 and 26 increasing

---

[1] *Loc. cit.*, p. 295.

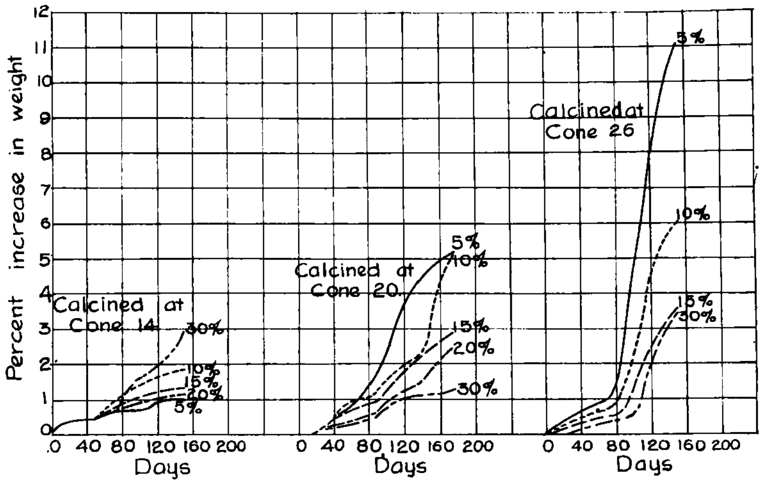

FIG. 1.—The effect of flue dust on the stability of dolomite after calcining at different temperatures. Dolomite and flue dust through 100 mesh.

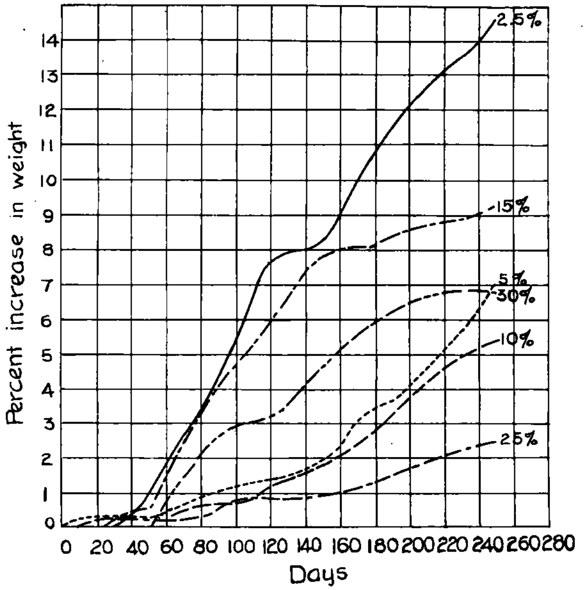

FIG. 2.—The effect of flue dust on the stability of dolomite after burning to cone 26. Dolomite through 40 mesh; flue dust through 20 mesh.

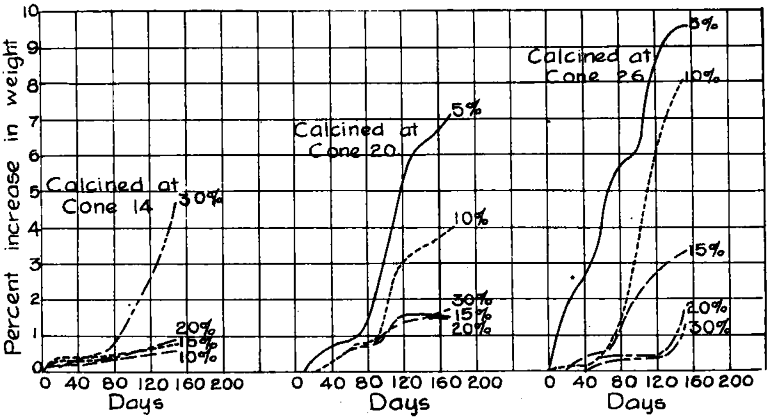

FIG. 3.—The effect of iron ore on the stability of dolomite after calcining at different temperatures. Dolomite and iron ore through 100 mesh.

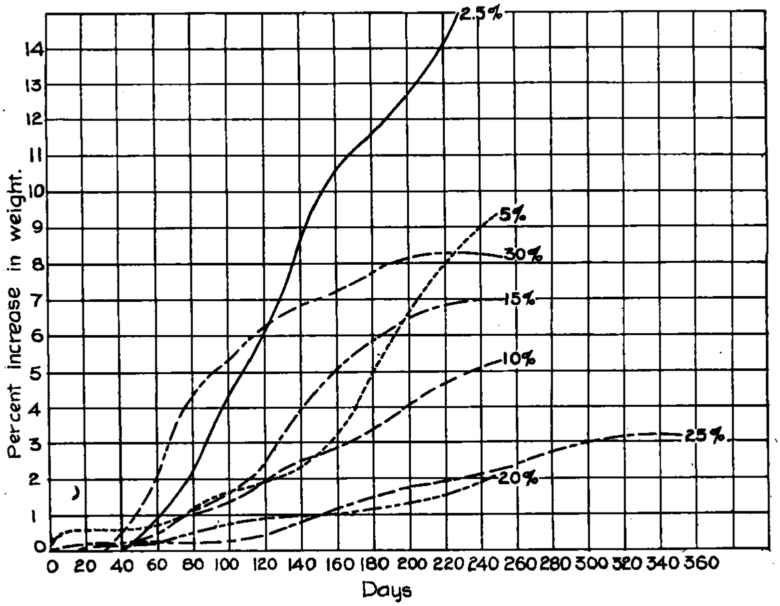

FIG. 4.—The effect of iron ore on the stability of dolomite after burning to cone 26. Dolomite through 40 mesh; iron ore through 20 mesh.

the flue dust content decreases the tendency to increase in weight upon storage.

It is evident that compounds which have a tendency to increase in weight when exposed to air are formed in calcined dolomite. Microscopic studies are now being made to determine the nature of these compounds and have already shown the presence of considerable $2CaO.SiO_2$, which evidently accounts for the disintegration due to dusting. Considerable uncombined iron was found as small globules of metallic iron together with free lime.

Iron Ore and Dolomite.—The results with iron ore and raw dolomite are shown in figures 3 and 4. Fine grinding of the raw dolomite again decreases the tendency to increase in weight during storage. Eight mesh dolomite prepared with 15% iron ore and calcined to cone 18, increased in weight 3% at the end of 80 days, while that prepared from 100 mesh dolomite and calcined to cone 20, increased in weight 1.5% at the end of 80 days. Increasing the calcination temperature again increases the tendency of the dolomite to take up moisture and CO_2. This agrees with the results obtained with flue dust and follows since flue dust and iron ore show similar chemical analyses.

Where dolomite is ground to 40 mesh size and calcined to cone 26 (see figure 4) it appears that increasing the iron oxide content up to 10% decreases the tendency to increase in weight. Adding 15% increases the tendency to take up moisture and CO_2 as compared to 10% mixtures. With a 20% addition decrease occurs, while adding 25% and 30% again increases the tendency to increase in weight. The effects produced by flue dust on 40 mesh dolomite are similar to those obtained with iron ore (see figure 2). Also, as was the case with flue dust, the mixture prepared from 100 mesh dolomite and calcined to cone 14 showed an increase in the tendency to take up moisture and CO_2 when prepared from mixtures high in iron ore. After calcining to cones 20 and 26, however, increasing the iron ore content decreases the tendency to increase in weight. These results also check with those obtained with flue dust (see figure 1).

Iron Ore and Magnesite.—Figure 5 shows the effects of different calcining temperatures on the increase in weight of

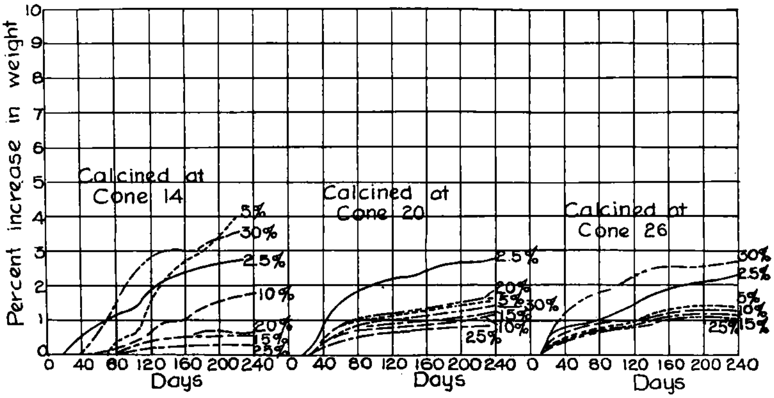

FIG. 5.—The effect of iron ore on the stability of magnesite after calcining at different temperatures. Magnesite and iron ore through 100 mesh.

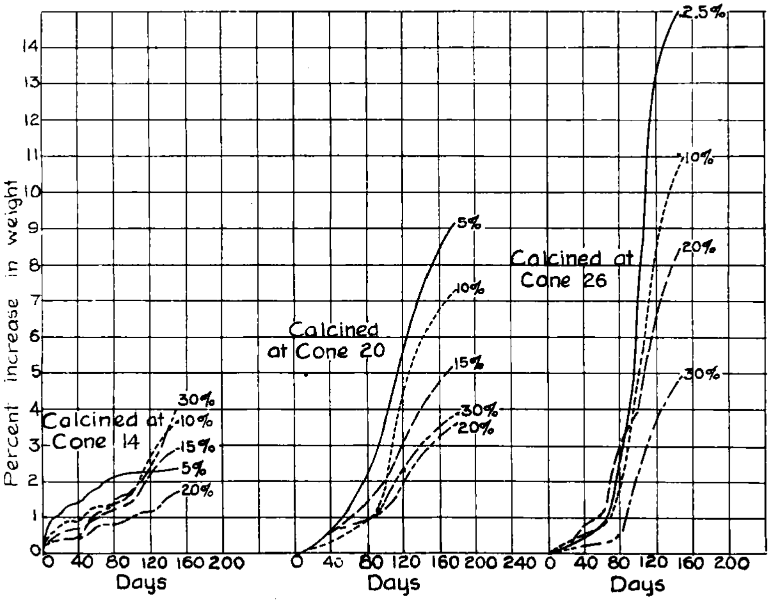

FIG. 6.—The effect of basic open-hearth slag on the stability of dolomite after calcining at different temperatures. Dolomite and slag through 100 mesh.

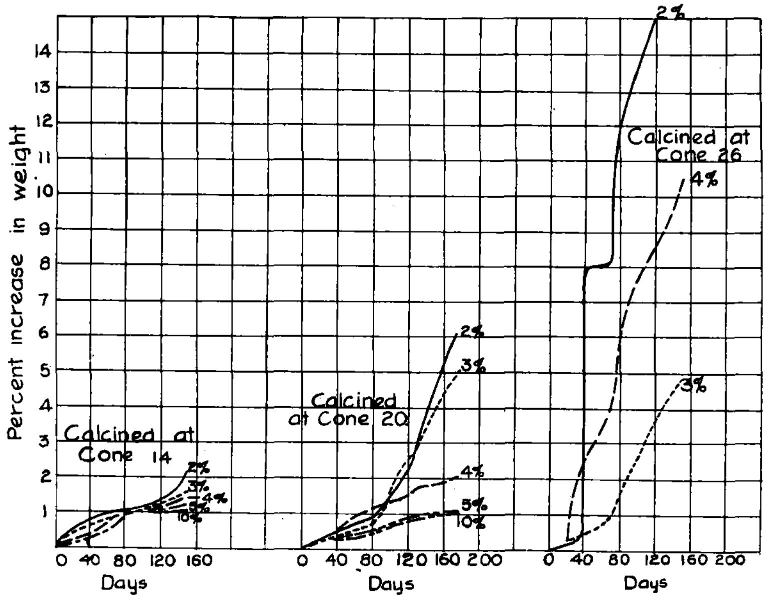

FIG. 7.—The effect of kaolin on the stability of dolomite after calcining at different temperatures. Dolomite and kaolin through 100 mesh.

Canadian magnesite and iron ore mixtures after storage. In most instances increasing the calcination temperature decreases the tendency of magnesite to increase in weight, although with those mixtures prepared from 15%, 20% and 25% iron ore, there is a slight increase in the tendency to take up moisture and CO_2 from the air after calcining at the higher temperatures. The magnesite employed contains 11% CaO. It shows a less tendency to slake than dolomite, due to the higher content of MgO which is comparatively easy to place in a dead burned condition. A mixture prepared from 10% iron ore with 100 mesh dolomite and calcined to cone 20 increased in weight 3.3% at the end of 160 days while the same percentage mixture with 100 mesh magnesite increased in weight only 0.85% which may be principally hygroscopic moisture.

Basic Open Hearth Slag and Dolomite.—Figure 6 shows the effects of fine grinding and different calcination temperatures

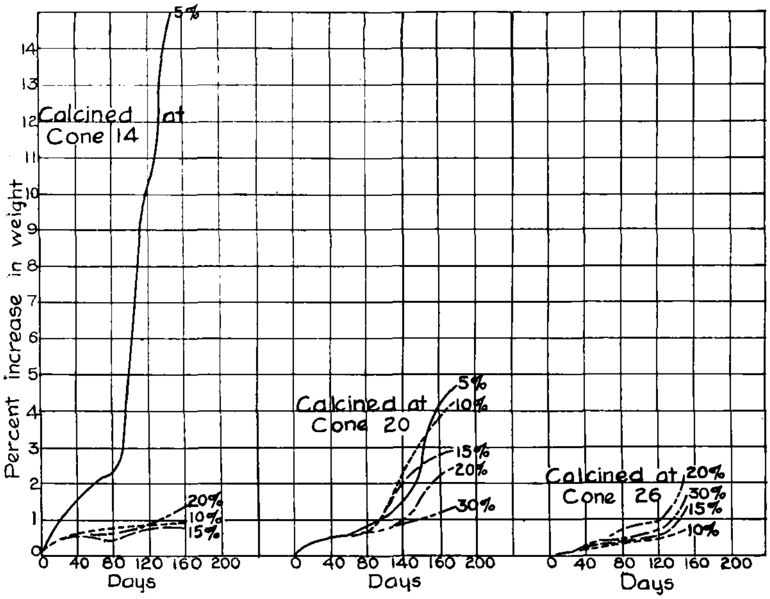

FIG. 8.—The effect of roll scale on the stability of dolomite after calcining at different temperatures. Dolomite and roll scale through 100 mesh.

on the tendency to increase in weight on storage. When a mixture prepared from 15% basic open hearth slag and 8 mesh dolomite is calcined to cone 18 it increases in weight 10.8% at the end of 80 days, whereas a similar mixture with 100 mesh dolomite, and calcined to cone 20 increases in weight only 1.4% in the same time interval.

Here again increasing the calcination temperatures increases the tendency of the calcined material to increase in weight. With basic open hearth slag as a flux, the high fired mixtures showed a greater tendency to increase in weight than with iron ore and flue dust as fluxes. This may be due to the lime and silica content of the slag which forms unstable compounds with the CaO of the dolomite.

Kaolin and Dolomite.—Figure 7 shows the effects of fine grinding and different calcination temperatures on the tendency of dolomite-kaolin mixtures to increase in weight. Increasing

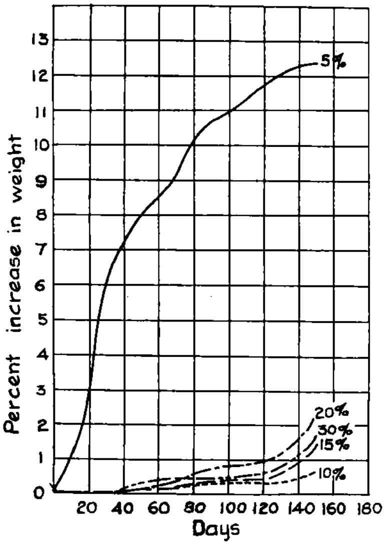

FIG. 9.—The effect of roll scale on the stability of dolomite after burning to cone 26. Dolomite through 40 mesh; roll scale through 20 mesh.

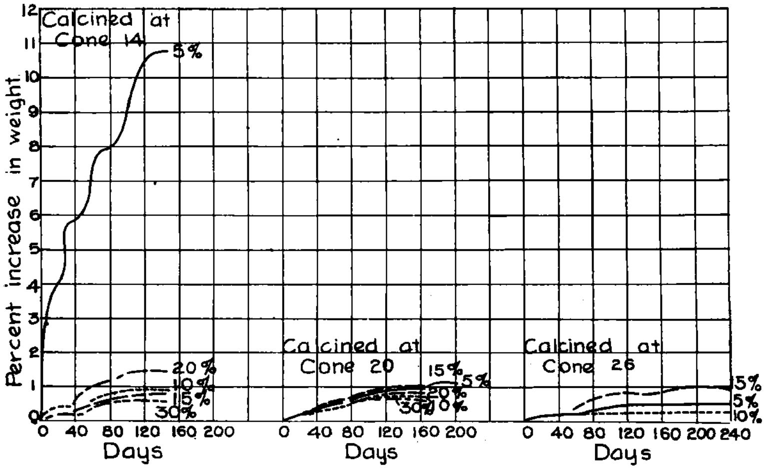

FIG. 10.—The effect of roll scale on the stability of magnesite after calcining at different temperatures. Magnesite and roll scale through 100 mesh.

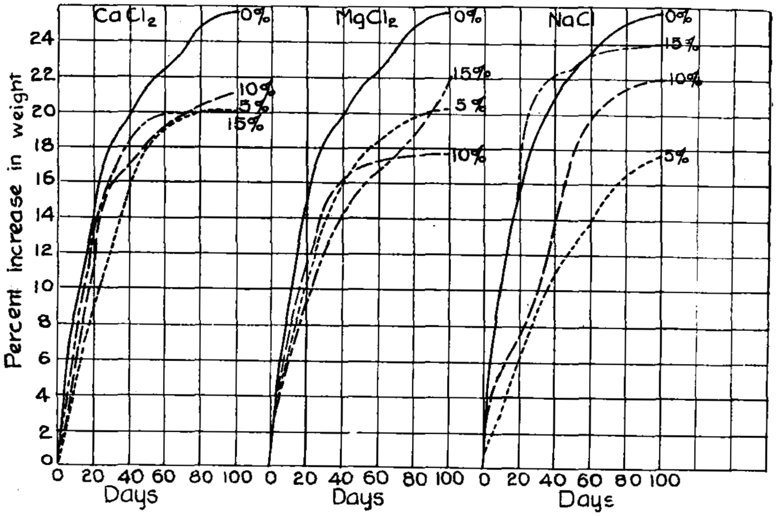

Fig. 11.—The effect of chlorides on the stability of dolomite after burning to cone 14. Dolomite through 8 mesh. Chloride through 20 mesh.

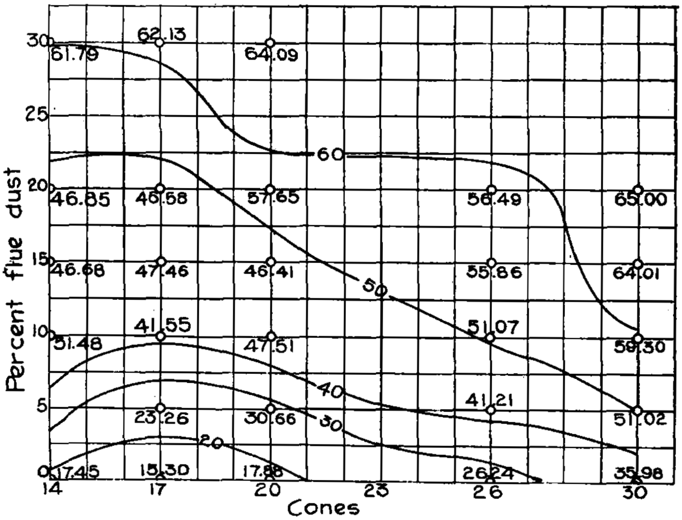

FIG. 12.—Burning, shrinkage, diagram. Dolomite—flue-dust mixtures.

the calcination temperatures again increases the tendency of the calcine to increase in weight. The increase in weight during storage is more pronounced on the high fired specimens than with the corresponding iron ore and flue dust mixtures. This is probably due to the comparatively high silica-alumina content of the kaolin which evidently forms hydraulic compounds with the lime similar to those found in Portland cement.

Finer grinding of the dolomite increases the resistance of the calcine towards moisture and CO_2, producing a more stable product than that obtained with coarser raw materials.

Roll Scale and Dolomite.—Figures 8 and 9 show the effects of calcination temperatures on the tendency of dolomite-roll scale mixtures to increase in weight. When mixtures of 15% roll scale and 8 mesh dolomite are calcined to cone 18, they increase in weight 5.5% at the end of 80 days[1] and where 100 mesh dolomite is employed with 15% roll scale and calcined to cone 20 the increase in weight is only 0.6% at the end of 80 days.

With roll scale, increasing the calcination temperature does not materially change the tendency of the product to take up moisture and CO_2.

Where the raw dolomite is screened through a 40 mesh sieve before mixing with roll scale and is calcined to cone 26, the mixture containing the highest per cent of roll scale increases in weight more than those containing a lower per cent.

Roll Scale and Magnesite.—Figure 10 shows the effects of varying percentages of roll scale and calcination temperatures on the tendency of roll scale magnesite mixtures to increase in weight during storage. Increasing the calcination temperature decreases the tendency to increase in weight. The comparatively small increase in weight of calcined magnesite mixtures as compared to calcined dolomite mixtures shows that calcined magnesite is much more stable than calcined dolomite.

In comparing the effects of roll scale on the slaking of magnesite to those of iron ore (see figure 5) it is obvious that the former is much more effective as a dead-burning agent for magnesite than the latter. This is probably due to the lower silica and

---

[1] *Loc. cit.*, p. 301.

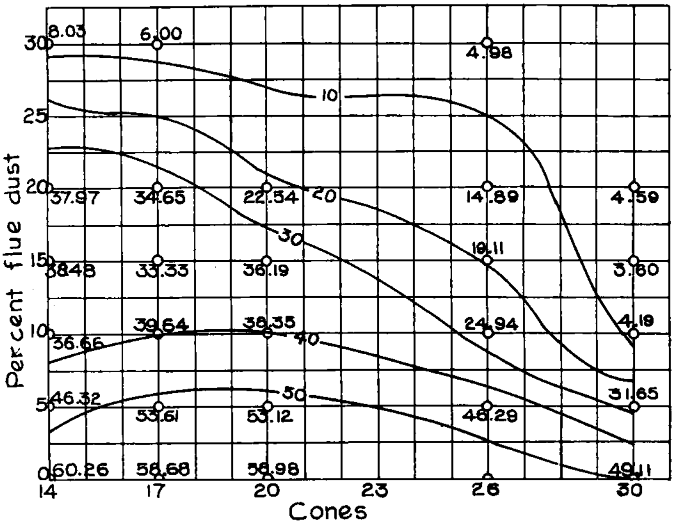

FIG. 13.—Burned porosity diagram. Dolomite—flue-dust mixtures.

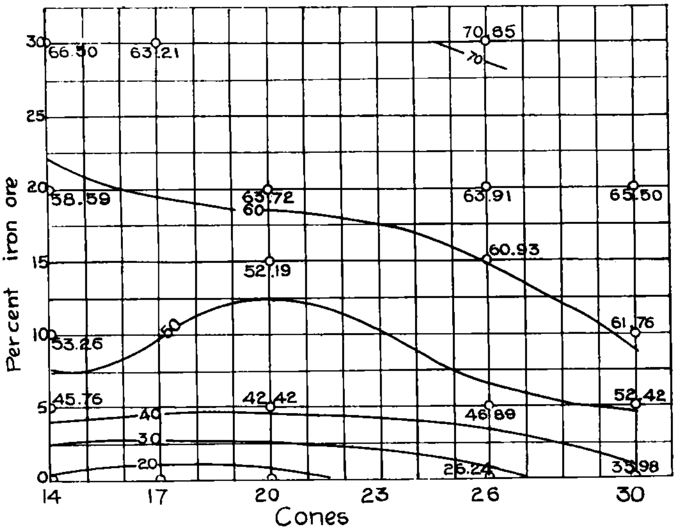

FIG. 14.—Volume, shrinkage, diagram. Dolomite iron-ore mixtures.

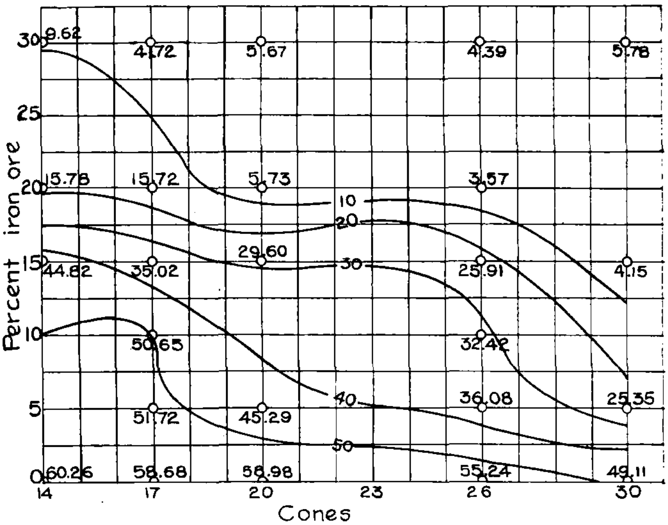

FIG. 15.—Porosity diagram. Dolomite—iron-ore mixtures.

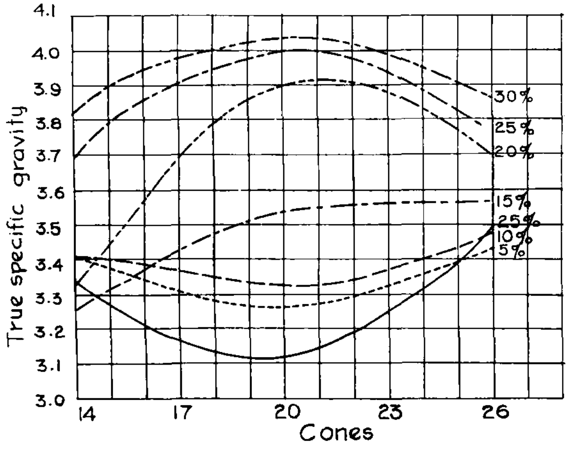

FIG. 16.—The effect of burning temperatures on the true specific gravity of dolomite and iron ore-mixtures.

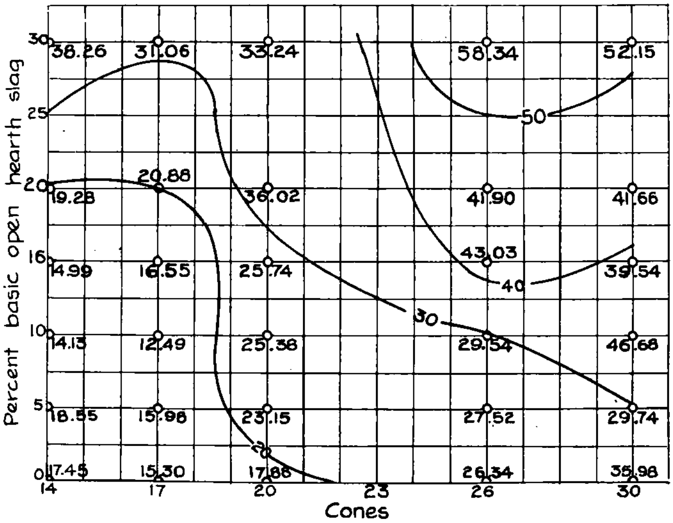

FIG. 17.—Volume shrinkage. Dolomite—basic open-hearth slag mixtures.

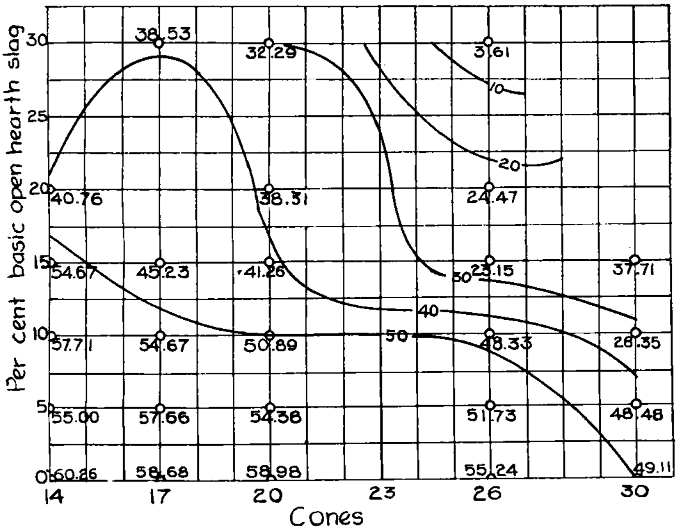

FIG. 18.—Burned porosity diagram. Dolomite—basic, open-hearth slag mixtures.

alumina content of the roll scale as silica and alumina tend to form unstable compounds with the lime of the magnesite.

Chlorides and Dolomite.—Figure 11 shows the results obtained by adding chlorides to 8 mesh dolomite and calcining to cone 14. Although the slaking is decreased to a slight extent, the benefits derived within the limits covered are too small to justify their use.

Effects of Different Fluxes and Calcining Temperatures on the Shrinkage and Porosity of Dolomite and Magnesite

Flue Dust and Dolomite.—Figures 12 and 13 show the effects of varying percentages and calcination temparatures on the shrinkage and porosity of the mixtures. To get maximum shrinkage and minimum porosity it is necessary to calcine a mixture of 30 per cent flue dust and 70 per cent raw dolomite to cones 14–20. It is necessary to calcine the mixture prepared with 25 per cent flue dust to cone 26 and the mixture with 10 per cent flue dust to cone 30 in order to obtain the same results.

Iron Ore and Dolomite.—Figures 14 and 15 show the effects of varying iron ore and temperatures of calcination on dolomite-iron ore mixtures. The behavior of iron ore is very similar to that of flue dust, which might be anticipated owing to their similarity in chemical analysis.

Figure 16 shows the true specific gravities of iron ore-dolomite mixtures when calcined at different temperatures. To obtain maximum specific gravity it is necessary to calcine mixtures with 2.5%, 5% and 10% iron ore to cone 26. That with 15% iron ore requires calcining to cones 20 or 26; and those with 20%, 25% and 30% to cone 20. When the high iron ore mixtures are calcined to cone 26, the specific gravity decreases, which may be due to over-burning.

Basic Open Hearth Slag and Dolomite.—Figures 17 and 18 show the effects of basic open hearth slag on dolomite mixtures when calcined at different temperatures. Vitrification is more dependent upon higher calcining temperatures than was the case with iron ore or flue dust. For example, a mixture containing 30 per cent basic open hearth slag must be calcined to cone 26

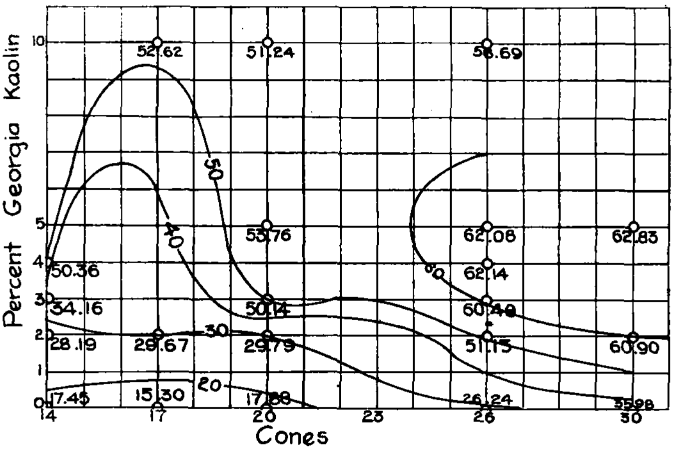

FIG. 19.—Volume shrinkage diagram. Dolomite—kaolin mixtures.

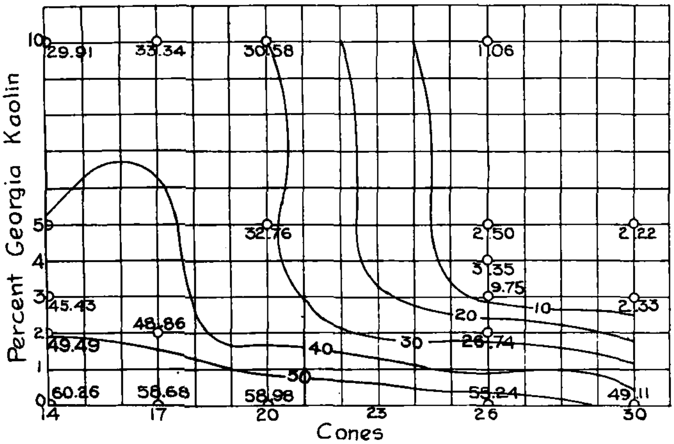

FIG. 20.—Porosity diagram. Dolomite—kaolin mixtures.

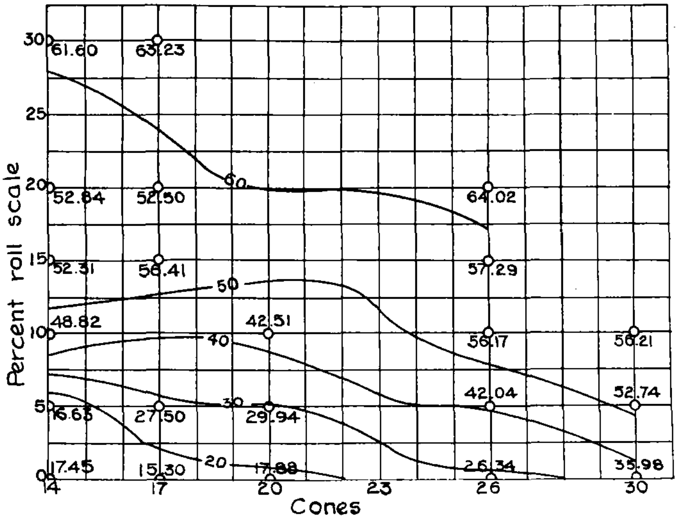

FIG. 21.—Volume shrinkage diagram. Dolomite—roll-scale mixtures.

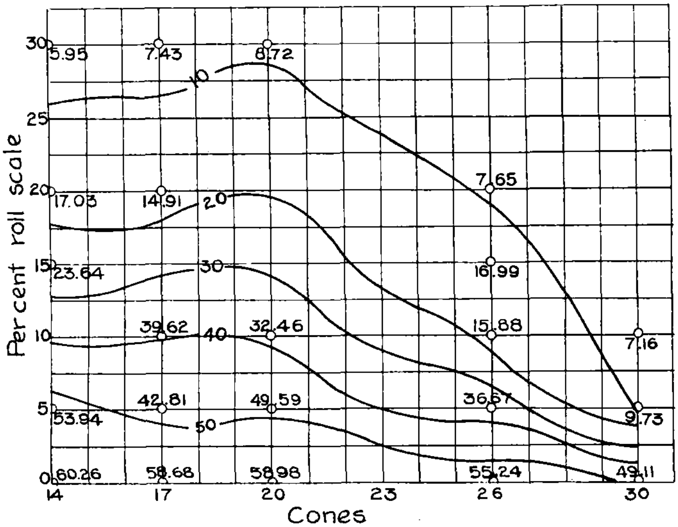

FIG. 22.—Porosity diagram. Dolomite—roll-scale mixtures.

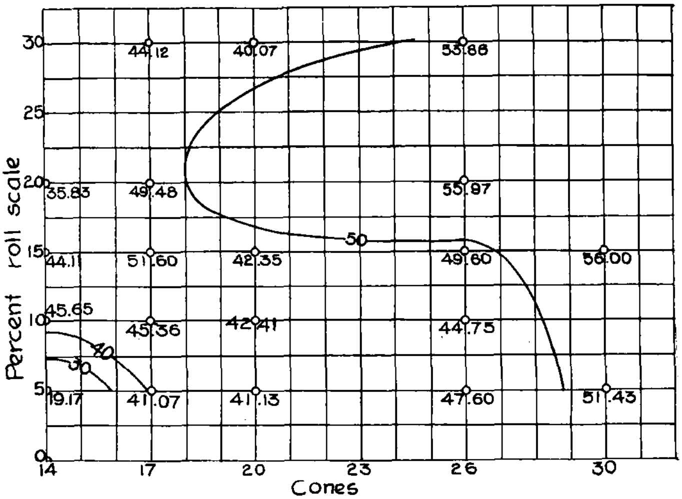

FIG. 23.—Burning, shrinkage, diagram. Magnesite—roll-scale mixtures.

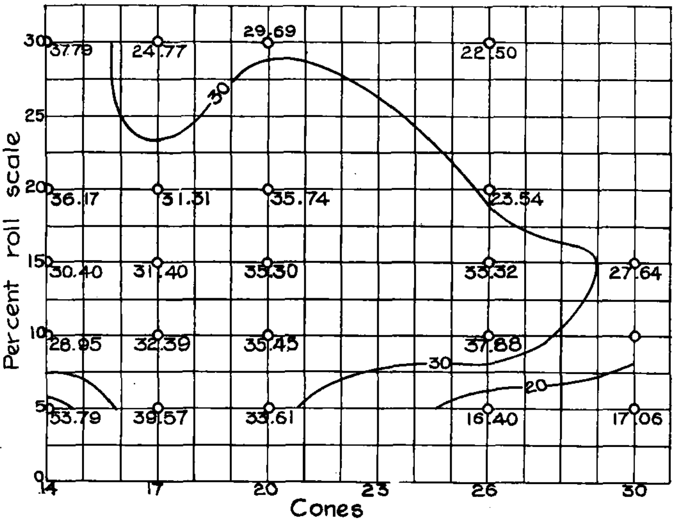

FIG. 24.— Burned porosity diagram. Magnesite—roll-scale mixtures.

to become vitrified, whereas a mixture containing 30 per cent iron ore or flue dust becomes vitrified at cone 14, (See figures 11, 12, 13 and 14).

Kaolin and Dolomite.—Figures 19 and 20 show the effects on shrinkage and porosity of Georgia kaolin and calcining temperatures on dolomite-kaolin mixtures. The vitrification is more dependent upon the calcining temperature than on the kaolin content when compared to flue dust and iron ore mixtures. Also kaolin is more effective than an equal weight of iron ore or flue dust in promoting vitrification. This is probably due to the higher silica content of the flux which combines readily with lime, forming lime silicates with a high per cent of lime, as $2CaO.SO_2$ and $3CaO.SiO_2$. For example, 5% kaolin and 95% dolomite has a porosity of 33.95% when calcined to cone 14 and is reduced to 2.50% porosity when calcined to cone 26, while a mixture of 5% flue dust and 95% dolomite has a porosity of 46.32% when calcined to cone 14 and 46.29% when calcined to cone 26.

Roll Scale and Dolomite.—Figures 21 and 22 show the effects of roll scale and calcining temperatures on the shrinkage and porosity of dolomite-roll scale mixtures. These diagrams are somewhat similar to those obtained with flue dust and iron ore. Bodies containing 30 per cent roll scale become vitrified at cones 14–20; those containing 20 per cent, at cone 26; and those containing 5–10 per cent are vitrified by calcining to cone 30.

Roll Scale and Magnesite. Figures 23 and 24 show the effects of roll scale and calcining temperatures on the shrinkage and porosity of magnesite-roll scale mixtures. It is seen that the shrinkage is much less and the porosity much greater with magnesite as compared to dolomite. The lime in the dolomite is more actively attacked by roll scale than the magnesia, which would account for the greater resistance of magnesite towards the corrosion of basic slags.

Results Obtained in Making Dolomite Brick

The mixtures of dolomite and iron ore were ground through a 100 mesh sieve and calcined to cone 20 in an air-gas furnace. As binders, one portion was mixed with 5% caustic lime, another with 5% sodium silicate, and a third with 5% magnesium chloride. These batches were thoroughly pugged in a wet pan and brick were molded by hand. Upon drying, all of the brick cracked, due to slaking.

To overcome the cracking, the above batches were aged with an excess of water for at least three weeks. The ageing caused the batch to expand considerably due to slaking. Brick made from the aged material could be dried safely, since hydration had taken place, hence no cracking due to hydration occurred in drying. Those made with magnesium chloride were very strong on drying, due to the formation of Sorel cement.

When these brick were fired to cone 18 they, however, showed excessive cracking due to high shrinkage in firing. These brick were extremely dense and withstood storage from four to six months when they began to show disintegration due to air slaking.

The next series of brick were made with coal tar as a binder. The calcined dolomite was ground to pass a 40 mesh sieve and mixed while hot with 12% coal tar which had previously been dehydrated by heating to 200°C. The brick were formed while still hot under a pressure of 500 pounds per square inch. By selecting a tar which becomes hard on cooling, brick with sufficient mechanical strength to withstand handling and shipping may be made without burning. Tar-bonded brick will stand storage about four months, after which they begin to disintegrate.

The tar-bonded brick when fired show less shrinkage and cracking than those prepared with water, since no hydration has taken place. It is desirable to dip dolomite brick in tar as soon as taken from the kiln in order to prevent rapid disintegration. Brick made in this manner withstand storage five to six months before showing signs of disintegration.

In conclusion the writer wishes to acknowledge his indebtedness to Mr. R. T. Stull for assistance in this work.

CERAMIC LABORATORIES, U. S. BUREAU OF MINES
MINING EXPERIMENT STATION, COLUMBUS, OHIO

NOTICE—*Further discussion of this subject is solicited. All communications should be sent to the Editor.*