THE RELATION OF THE VOLUME WEIGHT OF RAW CEMENT MATERIAL TO THE OUTPUT OF A ROTARY KILN.

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It has been demonstrated in factory practice that rotary kilns of the same size and exactly alike in shape, pitch, speed of rotation and having the same stack dimensions and with the same thickness of fire-brick linings give nearly twice the output in clinker when working on cement rock, or limestone and clay, that they produce when using a mixture of dry marl and clay. The chemical composition of the raw cement materials before calcination is approximately the same in both instances, and the resulting cement has the same chemical and physical properties. While the chemical composition of the marl and clay mixture is practically the same as a cement mixture prepared from limestone and clay, or from cement rock, there is a wide and distinguishing difference among such mixtures in volume weight, so that the chemists may judge of the relative value of limestone chalks, marls, cement rock, or natural cement mixtures, clays, shales, etc., by taking the volume weight of material, prepared by drying and grinding to 100 mesh and mixing in the proper proportions to give the required chemical composition for Portland cement, and comparing data thus acquired with results obtained from testing materials of known efficiency.

By the term "marl" in the above paragraph I refer to the lake deposits of Michigan, Indiana, Canada, etc., which are composed of about 90 per cent. of precipitated chalk, about 5 per cent. of shell lime and 4 to 6 per cent. of organic matter.

Determination of the Volume Weight.—Mixtures were prepared from dried samples of marl and clay, chalk and clay, limestone and clay, using the same clay in each instance, and grinding to pass a hundred-mesh sieve. These mixtures were made so that the resulting cement would have the same chemical composition. For the determination a small weighing-bottle of about 25 cc. capacity was used. It was dried and weighed, then filled with distilled water at a temperature of 15° C. and weighed again. The 100-mesh dry powder was then fed into the dried bottle, tapping the bottle carefully on the table to displace all air, and thus packing the bottle full, but no further compression was used, and when the bottle was full and somewhat rounded over the mouth the surface was carefully struck off with a steel spatula, care being taken to avoid any packing of the material. Results obtained by the writer gave for marl alone a weight of 48.7 pounds per cubic foot; for chemically pure precipitated chalk 32.7 pounds per cubic foot; for natural chalk of commerce 70 pounds per cubic foot.

It is evident that considerable variations in results would be obtained, by varying the size and shape of the vessel used for the determination, the method of tapping, etc., but if the chemist will adhere to like conditions throughout a series of tests, comparative results will be obtained.

EXPERIMENTAL PART.

A series of experimental burnings of cement were made to see if there would be any decided difference in the output of a small rotary kiln, working with different material, and if so, to ascertain the conditions to which such changes in output might be due; and thus develop conclusions from experimental data which might be of value in determining the commercial value of raw cement materials by simple chemical and physical tests.

For this purpose a small rotary was built 14 inches in diameter and 6 feet long, and lined with a 4-inch fire-brick lining, leaving a central opening of 6 inches. It was mounted on trunnions with adjustment for varying the slope, and was driven by an electric motor, the speed of which could be changed as desired. A brick housing was placed at the discharge end, and the escaping kiln gases were carried away by a brick chimney, with a 4- by 8-inch flue. The kiln was fed through an opening at the back of the chimney, the feeding being by hand with a small fire-shovel and sufficiently frequent to spread the material evenly the length of the kiln. Gasoline was used as fuel and was burned under 60 pounds pressure through a large burner specially made in the machine shop, and designed after the Hoskins patent hydrocarbon burner. A 10-gallon riveted steel, cylindrical tank, designated to stand 200 pounds per square inch, was used as a container for the gasoline. It was connected to the burner with a quarter-inch pipe. Pressure was supplied to the gasoline by connecting the tank with an air compressor working under

60 pounds pressure. The container was placed on a set of platform scales so the quantity of fuel consumed could be gauged and recorded. The burner was placed so that the flame passed through a circular 2-inch hole through the housing of the kiln, striking in the center of the kiln flue. With this apparatus about ninety minutes was sufficient to heat the kiln and get good clinker.

Mixtures were prepared of limestone and clay, and Michigan marl and clay, using the same clay for each, and great care was taken to keep the ratio of lime to clay alike in both cases. The analyses of these mixtures were as follows:

	Limestone and clay. Per cent.	Marl and clay. Per cent.
Carbonate of lime	74.80	72.20
Carbonate of magnesia	3.50	3.18
Silica	14.06	13.96
Alumina	5.11	4.72
Iron oxide	2.43	2.16
Organic matter, moisture, etc	0.40	3.78

Mixtures were also prepared from cement rock, and from chalk and clay, of as nearly the above chemical composition as possible. In each case the mixtures were ground to pass a 100-mesh sieve, then mixed with water to a slurry to insure a thorough amalgamation, and were then dried and reground to 100 mesh powder.

These materials were then burned in the small rotary kiln described above. The same quantity of fuel per unit of time was consumed with each different type of material tested and the same pressure of 60 pounds per square inch was used in each case. The same pitch of rotary and the same rate of rotation was preserved, the only change being in the quantity of material fed per unit of time, this being gauged by the appearance of the cooled clinker, the aim being to obtain dark green clinker with a fixed percentage of brown or underburned clinker, and to feed all the material the kiln would burn without producing more than 10 per cent. of underburned clinker. If the output of underburned clinker was more than 10 per cent. the amount fed was decreased and if the percentage was less than 10 per cent., the feeding was increased, and these changes were kept up until a constant quantity was produced, and the results were then computed into pounds per hour and are given in the following table:

Material used.	Weight per cu. ft. of fine ground mixture. Lbs.	Weight of raw material consumed. Lbs.	Weight of clinker produced. Lbs.
Marl and clay mixture	52	3.8	2.2
Limestone clay mixture	88	5.8	3.5
Cement rock mixture	92	6.2	3.8
Chalk and clay mixture	70	4.8	2.8

From these results it would appear that the higher the volume weight, or the greater the weight of the ground raw cement mixture per cubic foot, the greater is the output of a kiln, and that the quantity of raw cement material measured in cubic feet, that a kiln will heat to the necessary cement-forming temperature is nearly a constant, all other conditions being the same.

A kiln therefore, using a marl and clay mixture consuming 1125 pounds of coal per hour and producing 1600 pounds cement consumes 2760 pounds cement mixture having a volume of 53 cubic feet. A kiln of the same construction working on a cement rock mixture and consuming 1125 pounds of coal per hour and producing 3200 pounds of cement per hour, burns 52 cubic feet of raw cement mixture per hour. The more dense the raw material, the less space it will occupy in a kiln, and the greater will be the resulting weight of cement which a kiln will produce.

Drying the wet marls of Michigan, Ohio, Indiana, Canada, etc., will not suffice to make them economical materials. Marl is too bulky for a rotary kiln to handle economically; chalk is also too light, and both these materials must in time cease to be a factor in the cement industry. They will gradually be displaced for reasons of economy, and their place will be filled by limestone and cement rock, and even the lighter types of limestone will give way to the heavier class. The higher the specific gravity the better, from an economical point of view.

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THE PREPARATION OF 6-BROM-4-KETODIHYDROQUINAZOLINES FROM 5-BROM-2-AMINOBENZOIC ACID AND CERTAIN OF ITS DERIVATIVES.[1]

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IN A recent paper[2] on the preparation and properties of 5-

[1] Read at the Buffalo Meeting of the American Chemical Society, June 22, 1905.

[2] This Journal, 27, 1476 (1905).