enriching gas for illuminating purposes; (4) it produces illuminating gas at a lower cost and of superior quality to that made in a gas retort; (5) it furnishes cyanogen equivalent to 1¾ pounds of potassium ferrocyanide per ton of coal; (6) as one of the by-products, it supplies the pyridine soon to be in demand for denaturing alcohol; (7) the hydrogen sulphide recoverable from the ammonia liquors when oxidized is sufficient to supply nearly one-half the sulphuric acid required in converting the ammonia into sulphate.

Therefore, let those take courage who have been predicting universal famine from lack of fertilizer nitrogen when the nitrate deposits shall be exhausted, for as long as our mines yield bituminous coal, by-product coke ovens will produce an ever-increasing amount of ammonia. As long as carbon in any form may be obtained, calcium cyanamide will carry nitrogen to the soil, and even after all carbon has been consumed, if only the rain continues to fall and rivers to produce water-power and hills give forth their limestone, and the earth is enshrouded with its nitrogenous atmospheric mantle, basic calcium nitrate, by the Birkeland process, will furnish the languishing vegetation with its necessary nitrogen.

SOLVAY PROCESS CO.,
SYRACUSE, N. Y.

A REVIEW OF THE AMERICAN PORTLAND CEMENT INDUSTRY.

BY RICHARD K. MEADE.

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Now that the United States ranks first of the Portland cement producing countries of the world, not only in point of the quantity manufactured but also with regard to quality, it seems fitting to take a look backward at the industry and see by what steps this success has been gained. First the enormous amount of engineering work now being done in this country has created a steady demand for Portland cement; second, the cheapening of the process of manufacture has allowed it to displace to a large extent other hydraulic cements, and also wood, stone and brick; third, the introduction of reinforced concrete, concrete building blocks, sewer pipes, etc., has widened enormously the field of concrete construction. All these causes have contributed to the wonderful growth of the Portland cement industry.

Few people realize how much concrete construction is done in the United States. If all the Portland cement made in this country last year had been used for sidewalks, these would have been equivalent to a sidewalk over 16 feet wide, reaching entirely around the world, at the equator. If this same cement had been made into a solid cube of concrete, an edge of this would be three-sixteenths of a mile in length.

At the present time the Portland cement industry in America ranks second of the non-metallic industries in point of value, being exceeded only by the production of coal, oil and natural gas. It is entirely dependent upon the chemical profession for its existence and, indeed, gives employment to about 250 chemists.

At the present time there are approximately 90 Portland cement works in actual operation. According to the United States Geological Survey, these produced in 1905, 35,246,812 barrels of cement valued at $33,245,867. The enormous and rapid growth of the industry is shown by the fact that in 1880 only 42,000 barrels of cement were manufactured in this country, while last year's production was over 839 times this amount. The first Portland cement plant produced only 1,700 barrels a year, while one large modern cement plant claims a capacity of more than ten times this quantity daily.

The American Portland cement industry had its origin about 1874 when three small plants were started; one each in Pennsylvania, Michigan and Indiana. Roman, Rosendale or "Natural" cement had been made in this country since 1828, when cement rock (an argillaceous limestone) was discovered along the line of the Erie canal in New York. All the Portland cement used in this country prior to 1874 came from Europe, and chiefly from Germany and England.

In Pennsylvania, the Coplay Cement Co. was organized in 1866, to manufacture natural or Roman cement at Siegfried, Northampton Co. A few years later the manager of this company, Mr. David Saylor, as the result of experiments, became convinced that Portland cement could be manufactured from the rocks of his quarry, and after many trials and some failures and discouragements his company began the manufacture of Portland cement in 1875, and has been a continuous producer ever since. About 1871 Mr. Thomas Millen and his son, Duane Millen, began manufacturing cement sewer pipe at South Bend, Indiana, importing English Portland cement for the purpose. Their attention was called to the probability of manufacturing Portland cement from the marls and clays found around South Bend by a former employee of the English firm of Portland cement manufacturers, Knight, Bevan and Sturge, of Northfleet. They, thereupon, began investigations which led them to establish a plant at South Bend sometime about 1875. In 1872 a small plant, called the Eagle Portland Cement Co., was started at Kalamazoo, Mich., by Chicago capitalists. Plants were also built at Wampum, Pa., at Rockport, Me., and in the Rosendale District of New York, prior to 1880. Of these three plants, however, only one, that at Wampum, was at all successful. The Eagle Portland Cement Co. also failed. Of the six plants mentioned only one has achieved any marked success, namely the Coplay Cement Company, which is now a large manufacturer.

Other Portland cement plants which were established before 1890 are the American at Egypt, Pa. (near the Coplay); the Empire at Warners, Onondaga County, New York; the Buckeye at Harper, Logan County, Ohio; and the Western at Yankton, South Dakota.

Portland cement is now manufactured in this country from the following raw materials—cement rock and limestone, limestone and clay or shale, marl and clay, and limestone and blast-furnace slag. In 1905, 52½ per cent. of the Portland cement manufactured in this country was made from cement rock and limestone, 36½ per cent. from limestone and clay or shale, and 11 per cent. from marl and clay. The manufacture of cement from cement rock and limestone is distinctly an American process, but both limestone and clay, and marl and clay have been used for this purpose abroad.

Cement rock is an argillaceous limestone found in a narrow belt, extending in a northeasterly direction through the counties of Berks, Lehigh and Northampton in Pennsylvania and Warren County in New Jersey. The deposit is about 50 miles long and is nowhere more than four miles wide. Cement rock contains from 65 to 80 per cent. carbonate of lime and from 15 to 25 per cent. silica, oxide of iron and alumina taken together.

The early cement plants using clay and marl or limestone and clay all followed closely the European practice of cement manufacture, which consisted in finely grinding a wet mixture of marl and clay or limestone and clay and then moulding the mixture into bricks, which were burned in some form of upright kiln. Those plants using cement rock and limestone, however, found it impossible to get the fine crystalline mixture to cohere sufficiently to form briquettes which could be handled without crumbling. At the Coplay Cement Co's. plant, therefore, a small percentage of cement was added to the mixture as a binder, while at the American Cement Co's. plant at Egypt, coal tar was used for this purpose. The use of cement rock as a raw material and the employment of coal tar as a binding material constituted the first advancement of American over European practice.

The machinery for grinding both the raw material and the cement clinker at these early cement mills was very primitive. Mill stones, such as are used for grinding flour in the small water-power mills with which we are all familiar, were used to grind both the clinker and the harder raw materials while edge runner mills were used to grind clay and marl. As the output of these early plants increased the need of more efficient grinding machinery also grew, and ball and tube mills were imported from Europe and used for grinding both the clinker and the raw materials. Several distinctly American forms of grinders were also introduced in the early eighties. The Gates gyratory crusher was found to be best suited to the crushing of hard material, such as limestone and cement rock, preparatory to its final reduction by other means. The Griffin mill was introduced into the plant of the American Cement Company at Egypt, Pa., in 1885, and soon became a very popular mill. The Atlas Cement Company about the same time installed a somewhat similar type of pulverizer, the Huntington mill, the use of which never became general, however. Of recent years two new forms of fine grinders have been introduced—the Kent mill and the Fuller Lehigh mill. The Edison Portland Cement Company uses a system of fine grinding peculiar to itself, consisting of rolls followed by air separators, the idea of the well-known American inventor, Thos. A. Edison.

At the present time mill stones have been entirely done away with except at one or two small mills, and practically all the grinding is now done by one of the following systems:

FOR GRINDING LIMESTONE AND CEMENT ROCK.

I.	II.
(1) Gates crushers.	(1) Gates crushers.
(2) Ball mills or comminuters.	(2) Rolls.
(3) Tube mills.	(3) Griffin mills or Lehigh mills.

FOR GRINDING PORTLAND CEMENT CLINKER.

I.	II.	III.
(1) Ball mills.	(1) "Pot" crushers.	(1) Kent mills followed by air or screen separators.
(2) Tube mills or comminuters.	(2) Rolls.	
	(3) Griffin mills.	

The cement mills built prior to 1890 all used upright kilns similar to those used abroad. Some of these represented the most improved forms. The Coplay used the Schoefer kiln, the Buckeye employed the Dietsch kiln and the Western installed the Johnston kiln. These kilns were economical with respect to fuel but very costly as regards labor. A rotary kiln had been invented by an English engineer, Ransome, in 1885 but had never been successfully used there. The Atlas Portland Cement Company became interested in this form of kiln and installed it in the plant they built in 1888 at Northampton, Pa. After much experimenting they succeeded in operating this form of kiln successfully. The upright kilns all required the raw materials to be moulded into bricks which were fed into the kiln alternately with layers of coke or other fuel. With the rotary kiln on the other hand the fine material could be fed into the kiln in the form of a powder, thereby saving much labor. The clinker from the upright kilns is also very unevenly burned, necessitating hand-sorting to remove the underburned portions. The clinker from the rotary kiln on the other hand is very uniformly burned and requires no sorting.

The rotary kiln, though an English invention, has been developed and made practical entirely through American brains, Seaman, Hurry and Navarro being chiefly connected with the making of its success. Shortly after the utility of the rotary kiln upon dry materials had been proved, S. B. Newberry, formerly a professor of chemistry in Cornell University, adapted it to use with wet materials, pumping the mixture of clay and marl, containing 50 to 60 per cent. water, directly into the kiln.

Ransome heated his kiln by means of producer gas, but oil was generally used in this country until about 1899 when burning with powdered coal was introduced. This latter is now generally used for burning, except in sections where oil or natural gas is cheap.

At the present time, practically all the cement manufactured in this country is burned in rotary kilns. They have also been introduced extensively abroad and probably in the next ten years will displace other forms of kilns even in Europe.

As installed up to a few years ago rotary kilns were usually made 60 feet long and 6 feet in diameter. These kilns were found to be wasteful of fuel, as over 45 to 60 per cent. of the fuel energy was lost in the fuel gases and another 10 to 15 per cent. in the hot clinker.

At the present time two methods are being experimented with for the saving of the heat in the kiln gases.

(1) Lengthening the kiln, thereby giving greater time for the material to absorb the heat of the kiln gases.

(2) Passing the gases of the ordinary short kiln through an upright boiler and then through an economizer.

Thomas A. Edison is the chief exponent of the long kiln, as those in his plant at Stewartsville are 150 feet long. These kilns were put in operation in the fall of 1903 and proved entirely practical and effected the economy in fuel which the inventor had promised they would. His experiment was watched with great interest, and, as soon as the success of these mammoth kilns was known, several of the mills, then under construction lengthened their kilns to 80 feet. This plan has also been tried by some of the older mills who extended their kilns to from 100 to 140 feet. Several of the mills now being built are erecting 100, 125 and 140-foot kilns.

The attempt to utilize the heat of the kiln gases under boilers was first made, I believe, at the plant of the Nazareth Portland Cement Co., but after encountering many difficulties, the plan was abandoned and the boilers taken away. Prof. R. C. Carpenter, of Cornell University, however, has successfully tried this plan at the plant of the Cayuga Lake Cement Co., and also at that of Kosmos Portland Cement Company.

A number of devices have been patented, designed to utilize the heat carried off by the clinker. None of them is used to any extent. A rotary cooler below the kiln through which the clinker passes and through which the air for combustion is drawn by the kiln draft seems the simplest and most feasible device.

The improvement in the quality of cement has been as marked as the improvement in the process of its manufacture. General Gilmore, in a test made of the Eagle Portland cement, in 1876, found its strength to be less than 300 pounds per square inch after seven days, while to-day cements having a seven-day neat strength of 700–800 pounds are the rule and not the exception. Some of this improvement is no doubt due to the increased efficiency of grinding machinery and it is now an easy matter to obtain a cement 95 to 96 per cent. of which will pass a No. 100 test sieve.

American cement technologists have also made some very noteworthy contributions to the scientific literature of cement. Perhaps the most extensive investigations undertaken by an American chemist are those detailed by Mr. Clifford Richardson in his numerous papers on the chemical constitution of Portland cement. His investigations are perhaps the most interesting of any of the numberless attempts to solve the riddle of what is Portland cement and what gives it its binding properties. Another investigation made some ten years ago along the same line was that of Spencer B. and Wm. B. Newberry, Prof. A. V. Bleininger has also investigated the composition of Portland cement. While the volume of work done upon this subject in the United States is not as large as that published by German scientists, what has been done here is of probably just as high a grade as that carried out in Europe, in spite of the distinction of some of the foreign investigators. Prof. E. D. Campbell has carefully experimented to find out the influence of the ratio of lime to silicates and also of fine grinding of the raw materials upon the clinkering temperature. Richards, Soper and Carpenter all measured the thermal efficiency of rotary kilns. Richards investigated that of a 60-foot kiln, Soper that of one of 100 feet and Carpenter that of a kiln whose waste gases were used to fire a boiler. W. B. Newberry investigated the regularity of burning a 60-foot kiln and Meade proved the loss of alkalies and sulphur in burning. He also showed the contamination of the cement by the fuel ash to be smaller than it had generally been considered. Carpenter investigated the substitution of calcium chloride for gypsum to retard the setting time of cement and Meade and Gano showed that calcium sulphate in any form could be used for this purpose. In addition to the above more important papers, the technical press has contained frequent articles upon cement manufacture by Newberry, Lathbury, Spackman, Lesley, Carpenter, Eckel, Meade, Lewis and Lundteigen. Three books dealing exclusively with Portland cement manufacture and two others largely devoted to the subject have also been published. Four trade papers are now devoted exclusively to cement technology and the uses of cement and many valuable papers have been published in these.

On the physical testing of cement the work done in this country has been excellent. In the early eighties the American Society of Civil Engineers appointed a committee to investigate the subject of cement testing. This committee reported in 1885. Later another committee was appointed which reported January 21, 1903. This report was amended January 20, 1904, and the methods of test recommended by it are now considered the standard ones.

The American Society for Testing Materials turned its attention to the drafting of uniform specifications for cement and its committee reported June 17, 1904. This set of specifications was endorsed by the American Institute of Architects, the American Railway Engineering and Maintenance of Way Association, the Association of American Portland Cement Manufacturers and the American Society of Civil Engineers and may hence be considered the standard specifications.

The following are noteworthy examples of individual efforts along this line. Porter investigated the lack of uniformity in cement testing. Maclay, Lundteigen, Lewis and Taylor made a study of the accelerated tests for constancy of volume. Lazell showed the lack of uniformity in standard sieves. Meade proved the sieve test to be inadequate for determining fineness in cements ground by different processes. Taylor investigated the influence of aeration on specific gravity. Spaulding, Jamison, Meade and Taylor have published treatises upon the subject of cement testing.

Much improved apparatus for testing cement has also been perfected in this country. Jackson and McKenna have both devised apparatus for determining specific gravity. Gilmore's needles were for a long time used for testing the setting time of cement, and now that the Vicat apparatus has been recommended Bramwell has simplified this. The Fairbanks Co. manufactures an improved form of testing machine which is much used and possesses many points of advantage over its standard German counterpart, the Michaelis machine. Olsen and Riehle have also brought forward excellent testing machines which are much used in this country.

Much has also been done on improving methods of analysis. The New York section of the Society of Chemical Industry appointed a committee to investigate the subject as did also the Lehigh Valley section of the American Chemical Society. Both committees reported and advised methods of analysis. The New York section committee reported a somewhat long but very accurate scheme of analysis, while the Lehigh Valley section committee attempted merely to unify the existing methods and eliminate the seriously objectionable features from these. Both reports embodied much research work, painstaking investigation and laborious correspondence, and while probably neither method is extensively used just as published, the agitation over the matter accomplished much. Hillebrand's valuable paper upon silica determinations also threw much light upon the subject. The rapid determination of lime in raw materials is now largely made in this country by the method of solution in standard acid and titration of the excess of the latter with standard alkali. It has been found quicker and more reliable than the one of measuring the volume of carbon dioxide liberated, so largely used in Europe.

Newberry's method of determining magnesia by precipitation with a known volume of standard caustic soda is also much used as is Jackson's photometric method for sulphur. In 1901 the writer published his book on the "Chemical and Physical Examination of Portland Cement" which was the first book in any language treating to any extent of the analysis of Portland cement and its raw materials. Frequent papers upon the subject of cement analysis have also been published by W. B. Newberry, Hillebrand, Peckham and the writer.

NAZARETH, PA.

NOTES ON THE USE OF PEAT.

BY CULLEN W. PARMELEE.

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THE purpose of this paper is to review certain phases of the peat industry which are of especial interest to the agricultural chemist. As we know, the industry in all its various forms is of great antiquity on the continent of Europe and at the present time peat is being studied systematically at government experiment stations, a considerable periodical literature is devoted to the matter and there are a number of societies interested in developing its uses. In this country the industry has never flourished heretofore, chiefly for economic reasons. Of late, however, interest in the matter has been growing, and it will probably be only a short time before we give peat the same amount of serious study that it is having elsewhere.

The first point to which I would call your attention is the importance of the recovery of swamp land. Parsons, in a recent bulletin published by the New York State Geological Survey, states that "it is estimated that one-twentieth of the area of that state is swamp land" and he points out that unimproved land is assessed at about $5 per acre and the drained land sells ordinarily at $200 to $500. A similar condition undoubtedly exists in all our northern states to a greater or less degree. The practical value of this is twofold; first, the possibility of increasing the taxable wealth; second, recovering the cost of draining by utilizing