Journal of Accountancy

Volume 52 | Issue 3 Article 2

9-1931

Ceramics

R. Logie

Ceramics

By R. Logie

While attending the bankers convention I was informed by one of the delegates that he could find plenty of accountants to prepare intricate and elaborate statements on trends of an organization but few who had the technical knowledge of the industry to present them in a proper manner. This criticism of the accountant is, I fear, justified. The accountant's statement is generally presented to the president of the organization, who in most cases is well versed in the technical end of the business, and to the banker, who generally lacks the technical knowledge. No complete discussion of the results is made. This in most cases is due to the lack of accounting knowledge in the case of the president and to the lack of the technical knowledge in the case of the accountant and banker.

During my experience as an accountant I have watched the professional man being raised from a mere "thief catcher" to the business doctor and analyst. It is my opinion that a still further step can be made by acting as the connecting link between the technical and the accounting factors. Few accountants will deny that at least an elementary knowledge of the industry is of importance, since familiarity with the qualities and application of the product, raw materials employed and method of manufacture will enable him to make a more comprehensive study of the problems in the industry.

Recently I had the privilege of visiting a few of the clay product plants in Ohio and found this industry a very interesting study for the accountant. The presentation of this subject is not free from difficulties because most accountants have a limited knowledge of geology and ceramic technology. Therefore before taking up the finished product, a brief discussion of the extraordinary raw material used is desirable.

GENERAL DESCRIPTION OF RAW MATERIAL

Clay is one of the most fascinating materials found in nature. Argillaceous earth or clay, which we often think of as mere mud, is a remarkably complex material of untold geologic ages and offers an almost unlimited field for investigation. Many interest-

ing articles have been written on the origin of clays, but the best of them can do no more than speculate as to the sources from which clays have been derived, on account of their prehistoric origin and subsequent changes. This remarkable raw material includes a variety of substances that may differ widely in chemical, mineralogical and physical properties, no two clays being exactly alike. From researches made, it would appear that all clays are derived from the decomposition of certain rocks.

The technology of clay is covered by voluminous literature and affords interesting reading and study of this most useful, most unknown and most complex material so vital to our industries. The names of the many varieties of clay, derived from their principal uses, are too numerous for mention. However, for the purpose of this article, clays may be divided into three classes: surface clays of more recent formation or the upheaval of older deposits; shales of a clay formation, which natural pressure has changed into a more or less rigid nature, almost to the form of slate; and fire clays mixed at deeper levels and so called because of their refractory qualities.

All clays possess the property of becoming more or less plastic when mixed with water, thus permitting them to be moulded into articles in any desired shape or form, which they retain when dry and they can be converted into a hard rock-like substance by heat.

When one is asked what constitutes a list of ceramic products, the question is hard to answer, as clay has so many uses that it is impossible to list them all. A rough classification may be made as follows:

USES AND PRODUCTS

Structural products. Common, paving and face brick; sewer or sanitary pipe; drain tile; hollow block; terra cotta; conduits; roofing tile; flue lining and chimney pipe; floor, wall and fireplace tile.

Refractories. Fire-clay brick and special refractories.

Pottery, etc. Tableware; stoneware; art pottery; electrical insulators; porcelain specialties and enamel ware.

Minor uses. Food adulterant; paint fillers; crayons; paper filling; cosmetics; modeling; water softening; taxidermy; oil filtering; scouring soap; toilet and tooth powders; insecticides; ink bottles; emery wheels; pins; smoking pipes; filter tubes; plaster; alum.

Use as fillers. Extremely valuable as adulterants and as mineral fillers for rubber, linoleum, oilcloth, etc. The finer clays are extensively used in the manufacture of high-grade paper, window shades, etc.

The foregoing list, although not complete, will give one a general idea of the wide ramifications of the clay industry, and its importance to the metallurgical industry and others, not to mention its importance as fundamental in the growth of plant life.

ORGANIZATION

The various characteristics of clays and shales and their varied physical and chemical compositions should be recognized by those entering the clay industry. Each deposit of clay should be carefully studied in order to determine its economic value. Before a clay deposit can be commercially exploited, it ordinarily requires an expensive plant to be built, except in a fortunate discovery of a high-grade china or kaolin deposit. The many abandoned plants all over the country stand as silent testimony that the clay industry is no place for the amateur but one which requires a careful study by competent persons, with regard not only to the physical nature, behavior and extent of the clay deposit, but also to the cost of mining.

Other equally important matters to be studied are the kinds of product that can be made and type of machinery, drier and kilns to be used; cost of fuel, which is required in large quantities; the labor market; the investment required in cost of land, construction of plant, working capital and also, one of the chief considerations, market conditions. Points to be considered under the last heading are the probable demand for the product, comparison of the price obtainable with cost of production, competition from other sources, selling expenses and transportation costs. Clay mining is a long-time proposition. Mistakes are costly and too much stress can not be laid on the need of coöperation in ascertaining the most economical means of production and marketing of the products made.

MINING AND QUARRYING

Clays are obtained by quarrying those sufficiently near to the surface and by mining those at lower depth. Fire clays are usually mined like coal but the majority of shale clays are quarried with explosives. The stripping or removal of the overburden is

accomplished by means of steam-shovel, drag lines and cableways. In some instances, the overburden is used for tempering the clay itself. The excavation work is generally done by means of steam shovels, shale planers, drag lines and cableways and the loosened clay or shale is loaded on various types of conveyors. The preparation of the raw material for manufacture begins at the mine or pit and generally consists of a little hand-picking or screening, with the exception of the higher grade clays, which require more careful treatment.

The accounting procedure in recording the cost of mining the raw material offers no real complications and the cost of a ton delivered to storage bins at the plant should be readily obtainable. From a survey of cost sheets used by clay workers, it would appear that there is need of a standardized form for recording mining costs. A comparison of the cost of mining in various clay mines would show considerable variations because each mine presents a different problem, as some require the material mined to be selected and blended, some have a larger amount of overburden to be handled or longer hauls to the plant, and some have special problems met in mining. However, I believe that these problems are too often advanced as the explanation for high mining costs when the real trouble is due to inefficient mining methods, poor mechanical equipment and inefficient operations.

STORING RAW MATERIALS

The clay or shale is delivered to the factory in an uncrushed condition and is stored in bins. This practice guarantees a continuous supply of raw material, although in some cases it is necessary to blend materials, where one or more clays are used. Certain clays are easier worked if exposed to the weather, although for other clays exposure may be harmful. Bins are also used for storing the raw material after it has been crushed.

PREPARATION OF CLAY

The majority of clays used for manufacturing purposes require to be ground or pulverized. Large pieces of clay are reduced by means of a crusher and then conveyed to the grinders or dry pan. The grinder or dry pan consists of heavy rolls or wheels with steel tires set in a revolving pan with a perforated bottom. These heavy wheels grind the raw clay into fine particles, which are pushed through the bottom of the pan by a scraper. The pulver-

ized dry clay is then conveyed over a screen, through which the particles fine enough pass to the ground-clay storage bin. The ground clay is then tempered or mixed with water to a paste of uniform consistency. This operation is performed in a wet pan, which is similar to the dry pan, with the exception that the bottom is not perforated. A pug-mill is also used for this operation in some instances. The tempering or mixing is an important phase of the manufacturing and requires the exercise of great skill to form a mass of the proper plasticity. In some cases a coarse grog is used to reduce the density of the clay and stop blistering when under heat.

It should be noted that the foregoing is a general description of the methods used in the preparation of clay. The extent to which the operations are carried out depends on the ware produced. A bulky product, such as brick and tile, can not afford a complicated procedure, whereas in the case of higher grade ware a more minute preparation may be desired.

MANUFACTURE OF SEWER PIPE

On account of the rather large list of ceramic products, it is quite impossible to describe the methods of manufacture in every case. The description of manufacture will be confined to the sewer-pipe industry which will serve as an example.

Before describing the methods used in production, a brief description of the general appearance of a sewer-pipe plant may be desirable. The size of the building and the ground required for the plant may impress one. Let us take a hurried trip through the plant and see why so much space is required. On one side of the building adjacent to the railroad tracks is the power house. Near the middle of the building are the clay storage bins. From there we go to the dry pans or grinders and then to the screening operation and ground-clay bins. More conveyors lead to the wet pans, where the clay is tempered and conveyed by elevators to the press feeder and thence to the moulding machinery. The moulded clay is then taken to the drying room, where it is left to dry out. When we consider that some of the larger sizes of pipe remain as long as two weeks in this room, we can obtain an idea of the space required for this operation. When the green ware is properly dried, it is taken to the kilns, adjacent to the building, for burning. The burned ware is stored in the yard, which covers considerable ground as the manufacturer must keep a good supply on

hand on account of the length of time required to complete the product. The plant is so planned that full use is made of gravity to convey the raw material. The relation of floor space to press capacity and kiln floor space to drying space is well balanced.

PRODUCTION

Sewer pipe is made from a clay or shale whose physical properties are such that they will either burn to a vitrified body or one of low absorption and also take a salt glaze. The clay or shale is thoroughly ground and tempered into a dough of uniform consistency and then moulded in a special form of press. The tempered clay is fed into the mud cylinder of the press and is forced by steam pressure out of the lower end of the press through a die in the form of a sewer pipe. In the orifice end of the clay cylinder the bell or hub is formed first, and when the socket former portion of the die is released, the pipe issues in a cylindrical tube of the required length. The pipe is then turned end for end so that the bell or hub will be upward. The larger sizes of pipe are turned in a cradle; the smaller ones are turned by hand.

Sewer pipes are made in diameters from 3 to 36 inches, the length varying from 24 to 36 inches. For the construction of larger sewers generally ranging from 36 to 108 inches, segment blocks are used. These blocks are hollow and are manufactured in a manner similar to the manufacture of sewer pipe. Special shapes such as traps, sockets and elbows, are generally made by hand in plaster moulds. The green ware is then taken to the drying room by hand trucks. This operation requires great care in handling. The drying room is heated at a uniform temperature to prevent cracking. The waste heat from the kilns and the exhaust steam are forced through pipes running below the floors of the drying room. In some of the older plants, the floors are slotted and permit a complete circulation of hot air. However, in the more modern plants the floors are tight and the heating pipes are so arranged as to permit uniform drying, except in the manufacture of conduit, in which the slotted floors are more advantageous.

BURNING

The pipes when properly dried are placed vertically in a round down-draught kiln, the smaller size pipes inside the larger ones, and around the fire bags and piled vertically to the height of 8

feet, one on top of another but in such a way that there is complete circulation and draft around each piece. Trial pieces are placed near the doors in such a way that they can be taken out through spy holes. The floor of the kiln consists of large sized fire brick so placed as to span a small smoke duct. These small ducts are connected at the ends to a cross duct, which in turn discharges into the main flue leading to the chimney. Short chimneys from the fire boxes are arranged along the inside wall. The heat from the fire rises to the top of the kiln and thence passes downward through the pipe or "set" ware and out through the openings in the floor to the stack. An electrical pyrometer registers the temperature at the top and the bottom of the kiln. The pipe, when taken from the dry room, contains approximately 3% of moisture and in order to prevent cracking, the burning is commenced with small fires. This period is referred to as the "water-smoking" period and is employed for the purpose of taking all the moisture out of the pipe. The temperature is gradually increased until what is termed the oxidation period begins. Up to this period the firing is carefully conducted to permit the release of gases through the body of the pipe. Following this period the temperature of the kiln is rapidly increased to the vitrification point. The temperature required to produce the latter process will vary according to the character of the clay.

GLAZING

When the kiln has reached a temperature of not less than 1,150 degrees, salt is thrown into the fires. At this stage of burning, the outer and inner surfaces of the pipe or set ware are wet with melted silica. The intense heat separates the salt into two components—chlorine and sodium. The sodium vapor combines chemically with the melted silica to form the glaze so essential to sewer pipe product. The chlorine contents of the salt passes through the chimney as smoke. The entire period of burning sewer pipe takes from 2 to 12 days, depending upon the size of the pipe and the clay used. The temperature of the kiln is gradually reduced by slowly opening the top and the kiln door.

FINISHED PRODUCT

The burned ware is inspected as it is taken from the kiln and then is placed in the storage yard. No other product receives the severe test which the sewer-pipe product is required to stand,

namely "trial by fire." Any defects on account of poor workmanship or material used not found during the process of manufacture are accentuated by the intense heat at which the product is burned and they can be detected readily. The finished product must be clear from blemishes; the glaze should be smooth and continuous; the pipe should be straight and round and free from cracks. The percentage of first-class pipe obtained from each kiln setting is approximately eighty-five per cent. Of the balance of the setting, ten per cent. contains defects and is classed as seconds and five per cent. is worthless.

MATERIAL RECORDS

From a survey of the sewer-pipe plants visited, it would appear that no standard system of inventory records is maintained. At one plant a record of the finished product in total tonnage is kept on the monthly cost-of-production sheet by including a record of the tonnage sold. Most of the sewer-pipe plants have to borrow money, and the tendency on the part of the bankers is to demand monthly statements. An accurate inventory record, therefore, would seem desirable and I believe would be of material help to the plant operator. A perpetual inventory of the raw material and supplies, work in process and finished product would materially assist in finding unfavorable conditions and also to control overproduction. It appears to be the practice at many plants to take a physical inventory semi-annually. In pricing the finished goods the trade list price is used and a percentage is deducted from the total inventory to reduce to cost. The cost-per-ton figure is used in computing the percentage to deduct from the list price to reduce the inventory to cost. For all practical purposes the list is $60.00 a ton. In some cases the costs are kept on a list-price basis which results in showing costs at a percentage of the list. This percentage is applied in calculating the net amount of the inventory.

Both methods are theoretically inaccurate because there is a great variation in sizes and shapes of sewer pipe manufactured. As an example, if one manufacturer produced nothing but specials and fittings, his costs would not be more than twenty per cent. higher than if he was manufacturing nothing but straight pipe. However, his inventory would be twice as high as the inventory of straight pipe, because the list price of a fitting or special is four times the price of a foot of pipe or twice the price of one

length of two-feet pipe. Most of the manufacturers carry one fitting for every thirty feet of pipe in order to maintain a well balanced inventory. In using the cost method on the list basis, the double-strength pipe, which weighs considerably more than the standard pipe, is valued at the same list price as the standard pipe, no credit being taken for the additional weight.

In using the tonnage method of computing costs, advantage is taken of additional weight of double strength as compared with standard, but no credit is taken for fittings, as they weigh practically the same as straight pipe. Under the list method credit is taken for fittings as they are priced on the list basis at four times the price of one foot of pipe. In comparing the two methods of keeping costs, one advantage would appear to offset the other. At one plant both methods were kept for a period of three months and the variation proved to be only a matter of one-third of one per cent. of the list, or twenty cents a ton.

CONTROL OF PRODUCTION

Production and selling might be classified as the two principal activities of a plant. The success of a sales organization depends largely on the ability of the production department to make an article of quality at a price which will permit sale advantageously in a competitive field. The systematic control of production and methods of manufacture play an important part in the success of a business. The control of production is more or less a sales estimate or budget to which the whole organization works. The seasonal nature of the business demands that during the winter months the manufacturer build up his inventory to meet the requirements for the product in the spring. The lowest inventory point is generally about the month of November and the highest about March. If the manufacturer produced only small size pipe, the cost of a ton would be lower than one producing large and small pipe. This is due to the fact that the larger size pipe requires more time to burn and consequently more coal a ton than small pipe.

A carefully planned schedule is necessary to obtain the maximum efficiency through effective utilization of plant capacity. There must also be a well balanced inventory. However, the predominant factors in the determination of low costs are efficient plant planning and economical firing. In factory operation many of the older sewer-pipe plants are handicapped in compari-

son with more recently constructed plants with modern machinery, conveyor systems and efficient plant planning. A careful study of all operations from mining clay to the finished product is required to determine the most efficient methods. If necessary, labor must be replaced by mechanical equipment to effect increased production. It should be noted, however, that the installation of additional machinery and rearrangement of plant would entail additional investments with a resultant increase in overhead charges in the form of depreciation, etc., which can not be dismissed in case of a shut-down as can labor charges.

From statistics available, it appears that sewer-pipe plants are operated at an approximate average of sixty per cent. capacity and this requires careful consideration in plant reorganization. The cost of firing or burning the ware constitutes a major portion of the finished cost and offers quite a field for study. The determination of the best fuel, proper firing methods and efficiency of kilns are points to be considered. It is my opinion that an investment made for the services of an industrial engineer and the installation of a proper cost system would not only benefit the plant operator but would also tend to stabilize the industry in general.

COST OF PRODUCTION

If every producer knew his cost of production, there would be fewer failures in the sewer-pipe industry and higher and more nearly uniform prices would prevail. Of the cost systems at present in use, many are inadequate and are misleading in some ways. Most of the systems are merely a division of the monthly expenses by the total tonnage drawn for the month, and no consideration is given to work in process. No attempt is made to obtain costs by departments.

A few of the points a trustworthy system should cover follow:

(a) The recording of the actual cost in material and labor by departments. These departments may be classified under two general headings: producing—those through which the material passes; and non-producing—those not directly engaged in manufacture of the product but merely serve the producing departments.

(b) The determination of overhead and general expenses by departments and the proper allocation to the product.

(c) The establishment of a normal unit cost by operations for comparison with actual cost figures.

(d) The maintenance of perpetual inventory records to control quantities.

(e) The cost records should be in such form as to furnish the necessary data relative to all operations from start to finish in a manner which will permit close regulation. The records should also provide for the proper recording of exceptional conditions, such as those caused by the shut-down of plant.

(f) The establishing of controls in the cost records to afford a ready method of reconciling the results with the financial records.

The market conditions in the sewer-pipe industry have been in a rather unsettled condition for a few years and the producers association has made several attempts to effect a remedy. It is my opinion that an educational campaign among the erring members to encourage the installation of proper accounting records, would accomplish much.

BURNING COSTS

Fuel used in the burning operation is an important element of expense in the industry. The contents of the kiln must be in uniform states of progress at all points or else some of the finished product will be inferior or off grade. As a check on this operation a card is kept for each kiln setting and the readings are recorded periodically, with the amount of fuel used. Most companies use a master schedule as a guide for the firing operation.

LABOR COSTS

Labor requirements will vary with the locality and general layout of the plant. Even, in the more modern plants, however, where equipment has replaced labor to a certain extent, it still remains an important element in cost. The major portion of the labor employed is paid on an hourly basis. In certain departments (for example, clay mining, cleaning kilns, setting, drawing, moulding, car loading, etc.) where the quality of the product could not be reduced by hasty work, it has been found advantageous to use the piece-work basis.

Daily reports are compiled showing the distribution of the labor and the factory output. The daily reports should be compiled in such a manner that the output per man for each process can be readily ascertained. Too much stress can not be laid on the importance of keeping a close watch on labor costs. The establish-

ment of the labor cost of each process, based on normal production and a comparison with actual costs, will be found very advantageous.

OVERHEAD AND ITS DISTRIBUTION

In the factory, overhead or burden is often looked upon as a necessary charge compiled by the accounting office over which the factory has no control. This is an erroneous conclusion to draw, as the overhead expense should be ranked in importance with labor and burning costs. Like the latter it is more or less under the control of the factory. The distribution of overhead by departments and the establishment of a normal overhead rate will give the operator a better understanding of what part overhead plays in production costs. In all sewer-pipe plants, depreciation, renewals and maintenance charges are an ever troublesome problem.

At one of the large sewer-pipe plants in Ohio the rates of depreciation used are influenced by the large amount of expenditures for maintenance. In the case of buildings, machinery, equipment and automobiles this method of establishing depreciation rates does not appear to be practicable. However, some modification might be devised for this practice in the treatment of kiln depreciation. In order to obtain low burning costs, the kiln equipment must be maintained at a maximum efficiency. The maintenance of a maximum efficiency requires periodic expenditures for repairs, relining, new flues, new crowns, etc. These expenditures in a period of ten years may amount to the original cost of the kiln. It is interesting to note that under the British income-tax regulations, no depreciation is allowed on kilns, but an allowance is made for the cost of repairs, renewals and rebuilding. The cost of new kilns and of extensions to existing kilns is treated as capital in the ordinary course.

In the treatment of other equipment, a distinction should be made between capital expenditures and ordinary maintenance expense, and rates used for depreciation should be based on the life of the various classes of properties. In order to establish uniform rates a proper classification of the property accounts is necessary. From a survey of rates used in the industry, a reasonable rate of depreciation would appear to be as follows: buildings—frame four per cent.; brick two per cent.; machinery and equipment seven and one-half per cent.; kilns and stacks seven and one-half per cent.; automobiles twenty-five per cent.

The cry of "lower costs" is a familiar one to the factory superintendent. Generally the superintendent has no accurate cost system to guide him and in his attempt to lower costs he cuts the maintenance charges. The effect which this would have is best illustrated by the experience of a producer operating four factories. In a comparison of the cost per ton produced by each factory, it was disclosed that one of the plants maintained a lower cost than the other three. The succeeding period disclosed a reversal. An investigation and inspection of the factory was made and it was found that the low costs prevailing in the former period had been achieved at the expense of the equipment. In order to bring the equipment up to maximum efficiency, a heavy outlay of expenditure was necessary. The maintenance charge is an important element of cost, and provision should be made in the accounts at an estimated amount in addition to depreciation.

ELIMINATION OF WASTE

In every plant leaks of material, labor or expense are bound to occur. If proper records are kept showing the amount of material, labor and overhead expense necessary to complete each process through which the product passes, any increase in any one of these items will be revealed by a comparison.

At present the manufacturer is required to carry three different types of each size of pipe, namely American Society for Testing Materials' dimensions, deep and wide socket and standard socket. This is a heavy burden to the manufacturer and can only be remedied by an organized educational campaign for the standardization of the product. Other industries have made considerable progress towards standardization of their product and the sewer-pipe industry can be greatly helped.

GENERAL

A cost system properly installed is one of the greatest aids to factory efficiency. Untrustworthy or inadequate figures of cost of production are often the root of unfair competition and business failures. No attempt is apparently made by many of the companies to keep a record of production costs by sizes. The principal reason advanced is that to keep such a record would require an elaborate system, as a kiln setting does not, in most instances, contain the only one size of pipe. Smaller sizes are placed inside the larger sizes and in some cases specials are placed on top. It

would appear that the installation of a system to obtain costs by sizes would produce such information of sufficient value to offset the objection raised.

DELIVERY EXPENSE

The drive towards efficient operation and lower costs does not end when the product is made and placed in the yard. One more service must be rendered to the buyer, namely the delivery of the product. Most of the product is shipped by railroad and practically all plants have a railroad siding adjacent to the storage yard. The items of delivery expense include labor loading cars, lumber for packing and general overhead. Freight on delivery is included in the selling price and is an offset against gross sales.

MARKETING MANAGEMENT

Knowledge of market conditions is essential to the success of a business. It is one thing to manufacture a good product and another thing to sell that product. A careful study of the market conditions in the territory supplied should be made to learn the approximate amount of business, partiality to any particular product, trade channels and sales resistance in the form of price cutting, production of inferior goods and ignorance of prospective buyers as to merits of product.

SALES ORGANIZATION

The larger sewer-pipe companies have established sales offices and storage yards in the principal cities in their territories. However, although the trend appears to be toward direct contact with the buyers, a major portion of the product is sold through agents. Compensation is generally made to agents on a commission basis and to salesmen on a salary basis.

PRICE LISTS

Price lists published by the Eastern Clay Products Association are used by all eastern manufacturers. The listed prices are based on a price of $60.00 a ton for standard pipe and $45.00 a ton for double-strength pipe and are subject to various discounts of from forty-five per cent. to eighty-five per cent., depending upon strength, size and quality of pipe. Cash discounts are sometimes allowed of five per cent. to dealers and five and ten per cent. to jobbers. It is particularly noticeable that all specials are priced at a cost considerably higher than standard product.

COMPETITION

In former years clay products had little competition from other industries in the sewer-pipe field. However, of recent years, the concrete industry has made progress and at present is a keen competitor in the larger sewer-pipe productions. In the larger installations concrete pipe has a decided advantage because it can be constructed at the site of the project. The advertising done by the concrete association to promote concrete products of all description is of outstanding importance. The sewer-pipe manufacturers' dealings are generally made with contractors, architects or engineers and through advertising the merits of clay sewer pipe the industry could be benefited.