AN ELECTRIC VITREOUS ENAMELING OVEN[1]

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ABSTRACT

Comparison with older types of furnaces.—In marked contrast with the oil, coal and gas furnaces the electric furnace eliminates damaged ware and makes possible the utilization of the entire heating space. Its initial cost and the fuel costs are double those of the older types but it admits 25 per cent increase in weight per charge and 30 per cent in charges per hour.

Description and operation.—Details of construction are given. The electrical equipment is explained together with the methods of temperature record and control. Details of operation are given.

Cost of operation.—With an initial cost of $8000, the cost of the electrical power has been $2.00 per hour for a 10-hr. day which would be reduced to $1.56 per hr. for a 24-hr. day.

Production results.—With a production of 900 lbs. of ware per hr. the enamel finish is more satisfactory than with the older types of furnaces.

Future improvements.—Preheating chambers and double end operation are suggested.

One of the most momentous improvements of recent years in the art of vitreous enameling has been the application of the electric furnace to the heating process. The use of electric current for heating in the steel and in non-ferrous furnaces, in japanning, core baking, oil tempering and similar industrial operations has now been extended to the enameling process.

Brief reference may be made to the disadvantages and troubles which have been encountered in the operation of the older methods of obtaining the temperatures (1500° to 1800°F.) required for satisfactory enameling work. With regard to the coal furnace it may be pointed out that in order to maintain the temperature of 1700°F. it is necessary to employ an expert fireman and there are even then times when atmospheric conditions make it impossible, even with the very best of firing, to procure and maintain this constant temperature. The most serious defect in the coal furnace is the muffle which periodically sags and breaks, thereby

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causing damage to or loss of ware by allowing the rack rests to go down and regularly at intervals of from two to twelve months it is necessary to renew the muffle and overhaul the fire-box and furnace. This usually means a shut down and loss of production for from two to four weeks. Moreover, in the coal furnace the sulfur fumes which are injurious to the ware and frequently cause a high percentage of seconds or of job lots are so difficult to eliminate that a certain factor in production must ordinarily be allowed for the damaged output which will be obtained from the ordinary furnace.

The oil furnace and the gas furnace have the same draw backs as the coal furnace. They will not hold the heat in burning large ware and the bottom of the muffle burns out even faster than it does in the coal furnace. Likewise, the great variation in temperature between the front and rear ends of the oven usually reduces the actual space which may be productively used in burning. Such ovens are handicapped by the time required to bring them from a cold condition to operating temperature, and part time operation is practically impossible. Also the fuel supply for coal and oil furnaces is dependent upon railroad and labor factors which are not entirely dependable. The space occupied by the older ovens is greatly increased by the fuel storage room needed.

In sharp distinction from the preceding faults of the older type furnaces it may be indicated that in the electric furnace there is no trouble with the muffle and the consequent loss of ware by falling rack rests since the electric furnace has no muffle and the rack rest is built right up from the foundation. Furthermore, the even distribution of heat is a feature which can be obtained only by the electric installation and the furnace can be loaded from the rear wall right up to within six inches of the door and burned down to a finish, the operation giving a clean white enamel without spot or mar. Atmospheric conditions of course have no influence upon the electric furnace as it needs no draft.

The initial cost of the electric furnace is of course considerably higher than any of the other types, but the difference in maintenance cost, the saving in space, and the cleanliness soon make the difference in price a matter of secondary importance. The fuel cost on an hourly basis for the electric oven is likewise higher, running nearly double that of coal, gas, and fuel oil for twenty-four hour day operation. However, the additional output of the electric furnace as determined by relative tests shows that the actual cost per pound of metal handled will compare very favorably with any other form of fuel. When the electric furnace is able to handle in ten hours at least 170 heats of No. 22 gauge steel against 130 heats of the same material by the coal furnace, and with 25 per cent greater weight per charge, the comparison in actual cost of fuel assumes a different aspect and is actually in favor of the electric installation.

The oven in which we are interested is the first commercial installation of such an equipment in the United States, and has been installed within the past six months in the factory of the St. Louis Brass Mfg. Company at 2615 Washington Ave., St. Louis. The installation was made under the direct supervision of Mr. E. F. Guth, President of the St. Louis Brass Mfg. Company, and the record established thus far has fully justified him in the adoption of this method of furnace heating.

The furnace measures approximately 12 feet 11 inches in depth by 7 feet 8 inches in width and 7 feet 4 inches in height in overall dimensions. The actual enameling space is 4 feet wide by 2 feet high by 10 feet deep. The heat is obtained from nichrome ribbon woven up and down on each side of the furnace over special hanger brick in a lattice like arrangement. The winding on the lower sides is double while that on the upper sides is single except for about 22 inches back of the door where a double winding is installed to make proper allowance for the escape of heat when the door is opened and closed for loading and unloading. The nichrome ribbon is approximately 5/8 inch wide and 0.05 inch thick. There are six heating elements in the furnace and micrometer tests made after sixty days operation showed no physical change in the windings. Similar nichrome elements for heat treating, etc., have been in use for over three years without apparent change.

The furnace brick work is built up in the following fashion: There is first a four inch course of common fire-brick and the special hanger brick for the support of the heating elements are incorporated as a single row in this course. Outside the fire-brick there is a 9 inch course of insulating brick and then a 4 inch course of common red brick. It is proposed to cover the entire furnace with a coat of asbestos from two to four inches thick. The door is about $4^1/_2$ feet wide by 3 feet high and is made of insulation brick and steel frame. As far as possible special monel metal racks are used in carrying the heating work to reduce the area and weight of supporting metal and prolong the life of the racks.

The electrical equipment for the furnace consists of the ribbon windings which have a minimum rating of 150 Kilowatts or roughly 200 H. P., and are operated on 230 volt, 3 phase, 60 cycle current and protected by special fuses. An automatic electric control panel containing contractors and automatic switches provides automatic record and control of the temperature of furnace. The record chart shows the temperatures of both the ribbon and the air and the furnace can be operated continuously at any temperature up to 1800°F. The nichrome windings in the furnace are connected to the control apparatus and to the transformer substation by heavy copper wire installed in conduit and the entire oven installation is on a separate oil switch which gives it individual control independent of the lighting and power load of the factory.

Guarantees of performance of the furnace were given at the time of installation as follows:

1. The oven will bake eight pounds of material per kilowatt hour including racks which are figured on the basis of one-half of above weight, when oven is operating at full capacity of 1200 pounds of material per hour including racks.

2. The electric heaters will maintain continuously a temperature of 1700°F. under an operating cycle of 3 minutes and 40 seconds, door open 10 seconds to load and open 10 seconds to unload with average bake of 3 minutes and 20 seconds.

3. The maximum demand of the heating unit will not exceed 150 kilowatts..

The cost of the furnace approximates $8,000.00 consisting of about $4,000.00 for the nichrome windings, hanger brick and electrical control equipment, $800.00 for electric wiring and material, $1500.00 for oven construction, and $1900.00 for transformer capacity and substation expense. For certain installations this expense would of course be increased, if the electric furnace were the only electrical equipment installed, as in that case the total substation cost would be placed entirely upon the furnace. For two or more ovens the substation cost would be divided and the net first cost per oven would be reduced. At the present time the St. Louis Brass Mfg. Company furnace is being operated only on a night shift and the cost has approximated $2.00 an hour with an average hourly consumption of 125 kilowatts. For a 24 hour day operation and the consequent reduction in overhead expense, the cost for current would be about $1^1/_4$ c. per kilowatt hour, giving an hourly cost for the furnace of $1.56.

The results thus far obtained have been highly satisfactory, particularly with regard to the quality of the output and the speed with which the oven can be brought to temperature, 1700 °F. being reached in 12 hours. To reach this temperature with a coal furnace would require up to 48 hours, with oil or gas furnace, about 24 hours. The electric furnace has been cut out at 5 A.M. with temperature at 1700° and cut in again at 6 P.M. at 1200° and in forty minutes it has been ready for work at 1600°. The production per hour is 2338 pounds of ware and racks, with 130 kilowatts per hour, the number of charges being 24. This means 900 pounds of enamel ware at a cost of $2.00 for the electric energy.

The outstanding features of the oven have been the extreme speed at which it can be operated, the cleanliness and improved appearance of the enameling room, and the absence of rejected pieces through improper burning or damage from fumes or soot. The most pleasing feature of the oven has been the finish on the ware as it has been far superior to the bake obtained in any other way.

Future installations of this nature can probably take advantage of facts learned in the use of the present furnace and it is probable that other ovens to be constructed will include a preheating chamber where the temperature will be kept at from 800 to 900 °F. and there are possibilities of a double end furnace so that work can be fed in at one end and removed at the other, thereby greatly increasing the speed and amount of metal baked.

In the installation as thus far operated the results predicted for electric heat in this work have been fully demonstrated and the many advantages of electric heat for enameling as well as for the many other purposes to which it is being adapted have been fully justified, and it seems quite apparent that there is a wide field for the application of electric heat in the enameling industry.

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