INITIAL SURVEY OF THERMAL AND ELECTRICAL ENERGY CONSUMPTION IN THE BRAZILIAN CERAMIC TILE INDUSTRY

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ABSTRACT

This work presents some of the main results obtained in an initial survey of the energy consumption and costs involved in the ceramic tile manufacture in Brazil. Despite the fact of the high mean of the energy cost on the total cost of the ceramic tile manufacture, until the present moment, there is no specific study in this sector intending to quantify the industries' energy consumption and to relate it to the particularities of their productive processes. The results obtained through the measurement of thermal and electrical energy consumption in each part of the manufacture process by dry route of a Brazilian industry are presented here. These results are compared to the energy consumption presented by Brazilian industries which use the wet route process as well as to the data about the consumption of Italian ceramic tile industries.

1. INTRODUCTION

Although it is a common sense that the expenses with thermal and electrical energy represent a considerable part of tiles production cost, there is no detailed research data about this theme in Brazilian ceramic tile industry. Without trusting and systematically collected information (history) about the energy consumption of each installation, it is impossible to make decisions to increase the energy efficiency and consequently to reduce the production costs.

In this way, considering the size of Brazilian ceramic tile industry, the fact that the market has become more competitive each day and any reduction in production cost can represent gains in terms of competitiveness, it is fundamental that this theme receive more attention urgently.

In this context, the objective of this work was to do an initial survey of the energy aspects related to the Brazilian ceramic tile industry. More specifically, considering that the ceramic tiles are produced through two different routes in Brazil, the wet and dry ones, this survey intends to collect data to answer the following questions:

- How is the energy consumption distributed along each part of the productive processes?
- How can the energy consumption of the Brazilian wet route be compared to the European one?

2. THE BRAZILIAN DRY ROUTE

Nowadays, about 65% of national production is manufactured using dry route[1]. The Brazilian ceramic poles are concentrated in two regions: Criciúma (Santa Catarina) and Santa Gertrudes (São Paulo), the majority of the industries which use the dry route being located in the Santa Gertrudes region. The products obtained by the dry route, in general, are glazed ceramic tiles which present water absorption between 6 and 10% and base with red as firing colour. The processing of the material through dry route is characterized by the preparation of a batch by dry milling (~5% of moisture - which the spray dryer provides), pressing (~9% of moisture) and fast single firing (20-30 min).

The dry route batch stands out because it presents a typical composition and by the way that it is milled. Generally, the batch consists in only one raw material naturally constituted by the necessary proportions of the minerals which allows the manufacture of the wanted products. The batch consists of only one clay, or sometimes, by the mixture of many types of clay. The raw clay extracted from natural deposits (in blocks) is carried by trucks and transported to the natural drying in specific places, where the reduction of moisture (values next to 5%), the homogenization and the primary crushing occur. After this work, the material follows to the milling.

At the dry milling, the raw material is firstly comminuted in the primary mill (hammer mill), and then, the hard fraction that was not milled is transported to the secondary mill (pendular mill). The resultant powder is wetted (~9%) and granulated. The following parts of the process are practically identical to that of the wet route.

3. SURVEY OF ENERGY CONSUMPTION

Two kinds of parallel studies were conducted: the first one is a detailed survey of the thermal and electrical consumption of a dry route industry; in the second work was done a comparison between the thermal consumption of some dry and wet route industries. In sequence, the activities related to the development of each work are separately detailed.

3.1. ENERGY SURVEY IN A DRY ROUTE COMPANY

The industry where the survey was done is located at the productive pole of Santa Gertrudes – SP and it produces glazed tiles of BIIb kind, with a nominal shape 43 x 43 cm and thickness of 8,6 mm.

The electrical energy consumption measurements were done in "energy panels" (where the conducting cables pass by) that come before the energy entry in each consuming installation. So that, ammeter tweezers and multimeters were used, being necessary subsequent corrections and conversions of the obtained values.

The measurements of thermal energy consumption (natural gas) were done through readings of consumed gas volume in a determined interval, being also necessary to know pressure and temperature values at points in the tubes before the gas entry in dryers and kilns. The observed values for the volume were corrected through normalization, so that all the measures could be comparable[2].

The next step was to convert the values of electrical energy consumption, first obtained in kWh, and the values of natural gas consumption in m^3/day, to only one unity: kcal/kg of fired product. Thus, it was possible to compare the electrical consumption with the thermal consumption, obtaining a value for the total consumption by adding the two kinds of energy. The unity kcal/kg allows comparing the consumption among industries which manufacture products with different characteristics, varied typology and also with those which manufacture products by distinct routes, as dry and wet routes.

3.2. COMPARISON BETWEEN DRY ROUTE AND WET ROUTE

Many Brazilian industries of dry and wet route that manufacture products with 43 x 43 cm shape, BIIb kind were contacted, intending to know the values of natural gas consumption of dryers, kilns and spray dryers (wet route) that they made available. Then, it was possible to make a comparative table, in which each installation's consumption and total thermal consumption could be compared among the industries.

4. RESULTS AND DISCUSSION

The following results refer to the consumption measures done in the industry described in item 3.1. Figure 1 presents the results of the electrical energy consumption (in %), divided in the industry sectors.

It is observed that 28% of electrical energy consumption of the analyzed industry is associated to the firing step, in which the kilns and lungs are included. The consumption of electrical energy in the pressing and batch milling steps (mills, vibrate

sieves, elevators, conveyor belt and granulator) is also expressive because they are in the second and third place, respectively, in the total of consumed electricity.

After the conversion of all obtained results to only one unity, kcal/kg of fired product, it was possible to accomplish totalized values of energy consumption (electrical + thermal), as can be observed in Table 1.

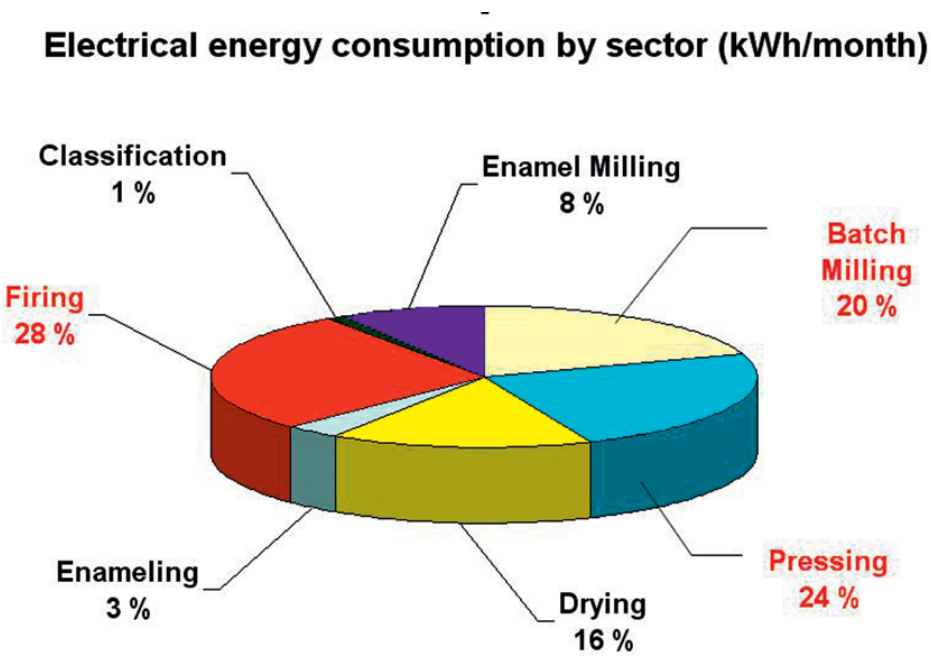

Figure 1. Distribution of electrical energy consumption by sectors.

Making a balance of the industry global thermal consumption, it is possible to say that the energy consumption involved in ceramic tiles production is about 582 kcal/kg, as seen in Table 1. In this way, it was calculated the participation of each sector's average consumption over the industry global consumption (Figure 2). The drying and firing sectors together are responsible for 95,5% of the total energy consumption. The pressing and batch milling sectors appear in third and fourth places, presenting a small participation (1,7%) over the total energy consumption. In turn, the other sectors (glaze milling, glazing and classification) present very low energy consumption when compared to the values presented by other steps.

PROCESSING STEPS	ENERGY CONSUMPTION (KCAL/KG)		
	Electrical	Thermal	Total
Batch milling	10,15	-	10,15
Pressing	10,12	-	10,12
Drying	6,67	117,50	124,17
Glazing	1,46	-	1,46
Firing	11,91	420,00	431,91
Classification	0,40	-	0,40
Glaze milling	3,70	-	3,70
TOTAL	**44,41**	**537,50**	**581,91**

Table 1. Global values of energy consumption in kcal/kg of fired products.

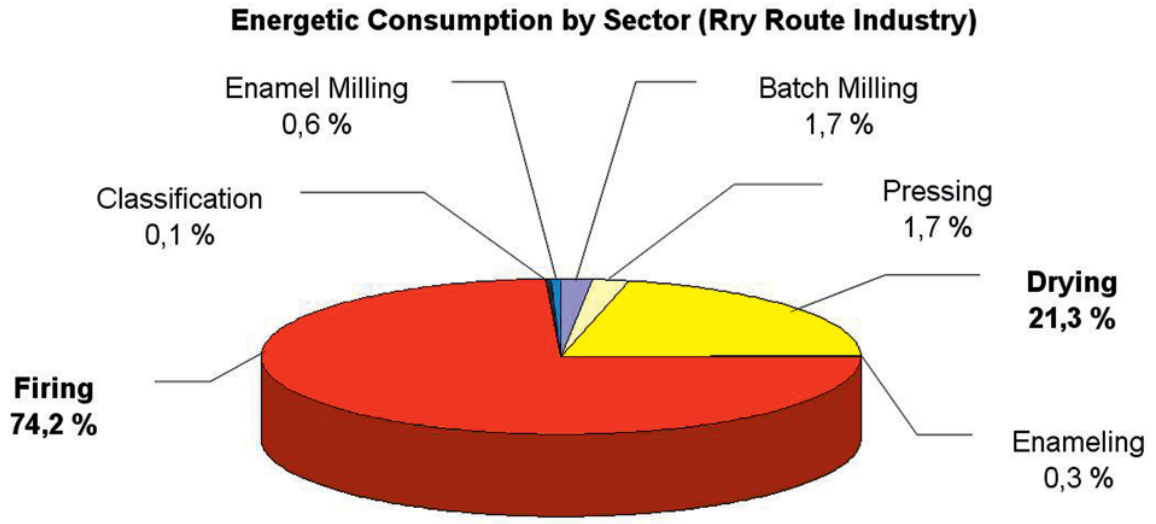

Figure 2. Distribution of global energy consumption by sector.

Considering the values of Table 1, it is possible to say that electrical consumption represents only 8% of the industry global energy consumption, as seen in Figure 3. However, when the participation of electrical consumption over the energy cost is calculated, it is possible to note that it reaches 22% (Figure 4), what makes evident the high cost of electrical energy paid by the industry.

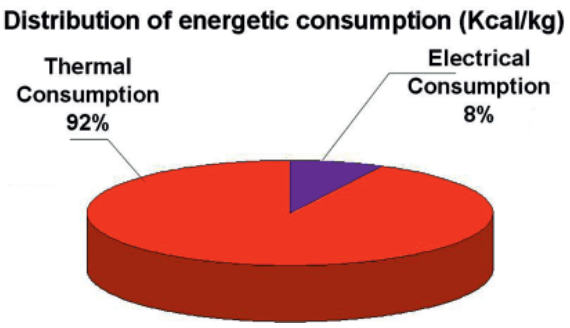

Figure 3. Participation of electrical and thermal consumption over the total energy cost.

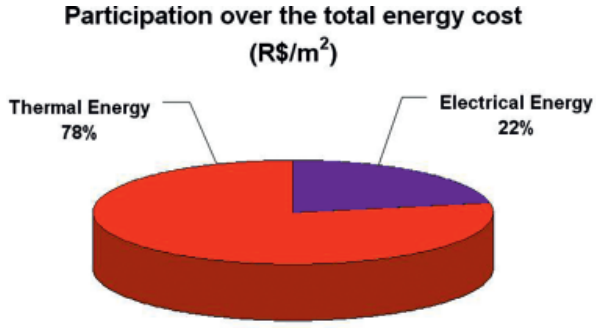

Figure 4. Participation of thermal and electrical consumption over the total energy cost.

Table 2 presents the values of natural gas average consumption of kilns, dryers and spray dryers (wet route), given by many of dry and wet route Brazilian industries (item 3.2). It is important to point out that this data was given by the industries; therefore, the methodology applied at the previous case was not applied for all the industries. However, these values can be an indicative that really exist great consumption differences among the industries of this sector.

It can be noted in Table 2 that there are great differences among the values of total thermal consumption, as inside the group of industries that use the same processing route as between the dry and wet route. In the first case, it is possible to observe some considerable variations in the consumption presented by the kilns, dryers and spray dryers, mainly between the industries A and B (wet route), resulting in a difference of 293 kcal/kg between the total consumption of the two

industries. It is also important to point out the difference of 122 kcal/kg observed between the industries E and G (dry route). In the second case, it could be observed that wet industries thermal consumption (A, B, C, and D) is much bigger (up to two times) than the presented by the dry route ones (E, F, G, and H), mainly because of the spray dryer presence, used in the wet route processing. The industry named as E in Table 2 is the same of the one where consumption measurements presented at the beginning of this item were done, and also this same industry was pointed out by having the lowest consumption.

INDUSTRY	TECHNOLOGY	AVERAGE THERMAL CONSUMPTION (kcal/kg)			
		Kilns	Dryers	Spray dryers	Total
A	Wet	593	172	418	1183
B	Wet	455	105	330	890
C	Wet	520	150	365	1035
D*	Wet	450	---	---	1050
E	**Dry**	**420**	**118**	**---**	**538**
F	Dry	411	149	---	560
G	Dry	464	196	---	660
H	Dry	415	175	---	590
* This industry did not give the values of dryer and spray dryer consumption.					

Table 2. Thermal consumption of the equipment used by dry and wet route industries.

Table 3 has the published data about the average thermal consumption of the equipment used in the production of tiles with white and red firing colour base by Italian wet route[2]. It is valid to point out that this data is a reflex of a survey done in Italy with 230 dryers, 200 kilns, and 40 spray dryers, what makes evident the results trust. It can be observed in Table 3 that the values obtained from dryers and kilns of industries which produce white base tiles are similar to the red base, however, the average consumption of the spray dryers is very different.

When the values of Table 2 and 3 are compared, it can be noted that the total thermal consumption of Brazilian wet route industry can be considered similar to the Italian wet route, because the values presented in Table 3 are an average, and can have errors in them. However, without considering the errors, what is observed is that the Italian dryers consumption is, in general, lower than the Brazilian ones. On the other hand, the consumption of the Italian kilns is much higher than the Brazilian ones.

BASE	AVERAGE THERMAL CONSUMPTION (kcal/kg)			
	Kilns	Dryers	Spray dryers	Total
White	627	107	312	1046
Red	693	99	478	1270

Table 3. Thermal consumption of equipment in Italian wet route industry[2].

5. FINAL COMMENTS

Considering the given results, it is possible to make the following comments:

- in general, related to the energy aspects, the dry route is much cheaper than the wet route;
- Brazilian wet route is similar to the Italian in the values of total thermal consumption, however, it has, apparently, a lower kiln consumption;
- the productive process steps (at the analyzed dry route industry) that consume more energy are firing and drying, with 74,2% and 21,3% of participation over the total consumption, respectively. The remaining consumed energy, 4,5% of the total, is distributed among the other production steps.

The results presented here are an initial data of an energy survey that will include a bigger number of tile industries, subsequently. As it is an initial survey, the data does not necessarily represent the whole sector; however it indicates a possible real discrepancy among thermal consumption of its industries. In the future, other more complete works will be published, and it is expected that it can be possible to draw an energy profile of Brazilian ceramic tile industry. For this achievement, the participation and opening of industries to the realization of this kind of work are fundamentally important.

REFERENCES

[1] ANFACER – Associação Nacional de Fabricantes de Cerâmica de Revestimento. Available in: http://www.anfacer.org.br/. Date: 14/08/2007.

[2] Nassetti, G., et al. **Piastrelle Ceramiche & Energia**. p. 20, 109-113, Centro Ceramico, Bologna, Italy, 1998.