GOOD PRACTICES FOR IMPROVING ENERGY EFFICIENCY IN CERAMIC TILE PROCESSES

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1. INTRODUCTION

Ceramic tile production is an energy-intensive process, especially when it comes to thermal energy for drying and firing. The consumption varies between 2.7 and 4.7 GJ/ton. This amount is on par with clinker production, with an overall thermal consumption of 4.05 GJ/ton.

BIIb tile products, with 6-10% water absorption, produced through the dry milling route, often spend less energy than porcelain stoneware tile, water absorption <0,5% made by wet milling route, group BIa. In the first example, a drying step is required before milling to reduce moisture from 15-20% to 4% (dry basis). In the second case, spray drying after milling is required to reduce the slurry water content from 54-60% to 7% (dry basis). Due to the higher temperature and time, 1180-1200 °C and 35-60 min, respectively, the firing of BIa products requires more energy than BIIb products, which can be produced with 1130-1150 °C and 25-35 min.

Natural gas combustion, which is non-renewable, is the current state-of-the-art for heat generating. In some circumstances, coal replaces natural gas in the spray dryer.

This paper provides a set of recommendations for enhancing thermal energy efficiency, which is essential even in the current or future scenario of greener fuels and/or electrification. All presented data are based on measurements taken at industrial plants, followed by material and energy balances, and equipment interventions. All applicable procedures are based on process stabilization, air:fuel adjustments, and energy recovery.

In order to carry out this kind of work, specific instruments must be available. The essential ones include a gas flowmeter, parts counter, balance, thermocouple, differential pressure manometer, combustion gas analyzer, Pitot tube, anemometer, and thermographic camera.

2. RESULTS AND DISCUSSION

Process stabilization in kiln feeding can minimize specific consumption by roughly 12%. Figure 1a illustrates gas consumption as a function of occupation ratio in the kiln. Reduced oxygen concentrations, as a result of burner regulations and direct cooling air recovery, can save up to 15% of total gas consumption. Figure 1b illustrates energy consumption as a function of oxygen concentration at the beginning of the firing zone.

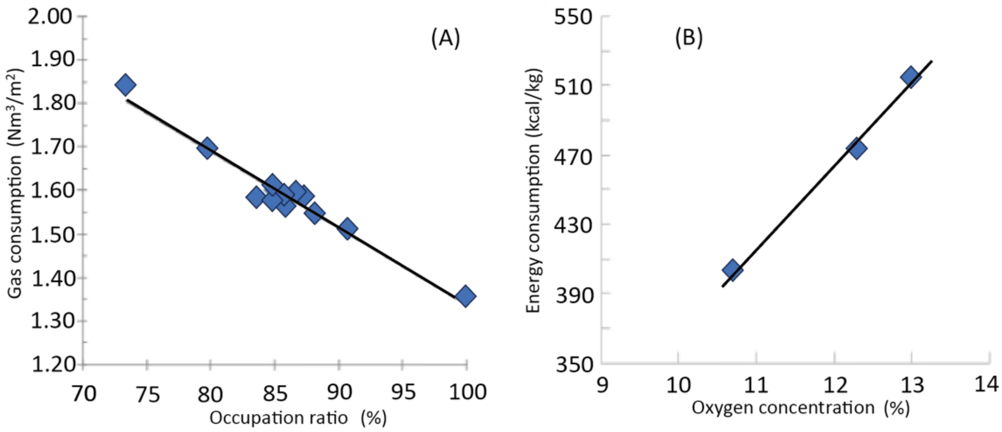

Figure 1. *Gas or energy consumption as function of occupation ratio and oxygen concentration in an industrial roller kiln.*

The material and energy balance shows that combustion air heating can save roughly 1% gas for every 30 °C increase in temperature, or 5% when heating from 25 °C to 175 °C. Direct cooling air recovery can save up to 30% in the green body dryer. Flue gas recovery can save up to 14% in the spray dryer. Figure 2 shows the main product, facilities and recovery streams for a porcelain stoneware plant.

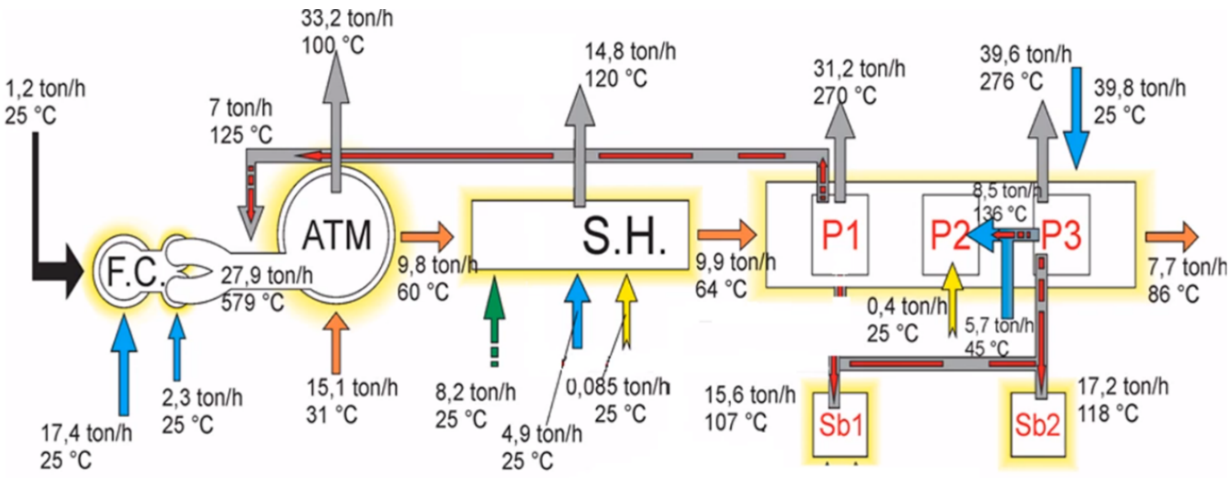

***Figure 2**. Main product, facilities and recovery streams for a porcelain stoneware plant*

Thermographic camera inspection can only prevent minor heat losses, but it can prevent early or unexpected damage to mechanical and electrical systems in the kiln or dryer, such as bearings and electric connections. Figure 3 shows some examples of roller dryer and kiln external surfaces inspected by a thermographic camera.

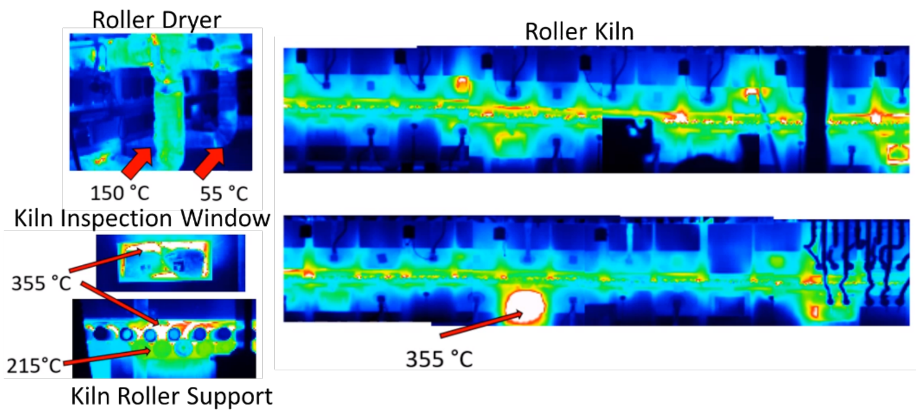

***Figure 3**. Roller dryer and kiln external surfaces inspected by a thermographic camera*

Depending on the starting conditions, all of these methods can lower the overall thermal energy consumption for ceramic tile manufacture by 20 to 24%. In comparison, the America´s Cement Manufacturers' roadmap foresees a 25% reduction in thermal energy usage up to 2050 in order to meet the commitment to the carbon neutrality goals for clinker manufacturing. All of the strategies mentioned are straightforward to implement in established plants, enhancing their life cycle, environmental sustainability, and competitiveness.

ACKNOWLEDGMENTS

The authors wish to thank all companies where the data was collected, and SCGÁS, CAPES, ANP, and CNPq for their financial support.

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