ENERGY UTILIZATION IN CERAMIC TILES INDUSTRIES

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ABSTRACT

Ceramic tiles industries is high energy consuming industries mainly thermal energy .More than 50 % of total cost is energy cost in ceramic tiles industries here most energy consuming process is the firing process or kiln process so for the reduce energy cost introduce the new design in which exhaust gas from kiln re use in the vertical dryer. Here using the heat exchanger network with the thermic fluid to recover and reuse the exhaust gas from kiln in to vertical dryer. Install four heat exchanger counter currently for the reuse the exhaust gas from kiln .Two heat exchanger install at kiln stack one for cooling gas and one for exhaust gas , And other two heat exchanger install at dryer stack .Here thermic fluid is use as a heating medium in heat exchanger.

Keywords:- *Ceramic , Exhaust gas, Kiln, Vertical dryer ,Reuse ,Heat exchanger, Thermic fluid*

1. INTRODUCTION

Generally the term ‘ceramics’ (ceramic products) is used for inorganic materials with possibly some organic content, made up of non-metallic compounds and made permanent by a firing process. In addition to clay based materials, today ceramics include a multitude of products with a small fraction of clay or none at all. Ceramics can be glazed or unglazed, porous or vitrified. Firing of ceramic bodies induces time-temperature transformation of the constituent minerals, usually into a mixture of new minerals and glassy phases. Characteristic properties of ceramic products include high strength, wear resistance, long service life, chemical inertness and non toxicity, resistance to heat and fire, (usually) electrical resistance and sometimes also a specific porosity.

Two types of energy are used in the ceramic industry; electric energy and chemical energy. The electric energy is used in two different ways; mechanical energy when used in the motor and fan of the machine, and thermal energy when used to heat the kilns and furnaces. The chemical energy of petroleum fuel is all converted into thermal energy through combustion reaction. Energy used in the ceramic industry is predominantly occupied by petroleum energy. The drying process in the ceramic industry is the greatest energy consumer second to the firing process. Drying means loss of moisture from the surface of the substance by evaporation, and the drying speed depends on the temperature and humidity.

Figure 1 presents a schematic illustration of the ceramic tile manufacturing process.

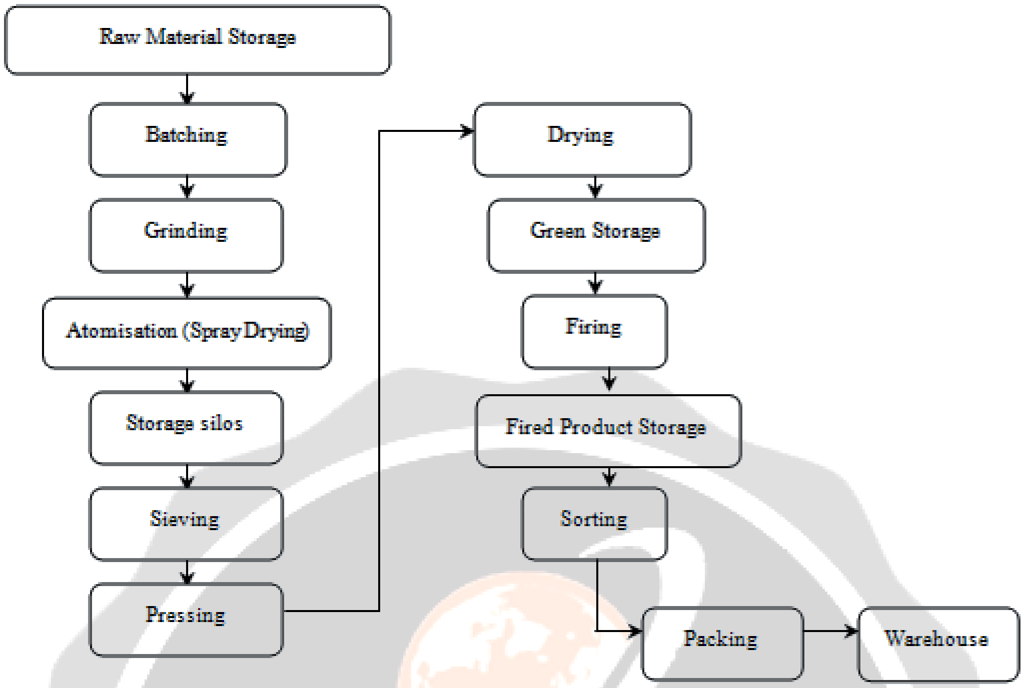

Fig -1: Manufacturing process of ceramic tiles

Single-fired ceramic tiles are fired in Spain in roller kilns that use natural gas as thermal energy source. The average energy consumption in this process stage is estimated at 705 kWh/t fired product, of which between 5 and 20% is used in firing the product, while the rest is lost via the kiln stacks, through the kiln walls and cracks, and with the tiles that exit the kiln. A typical Sankey diagram of a roller kiln is shown in Figure 2, in which the percentage contribution of each stream in the kiln energy balance is schematically depicted.

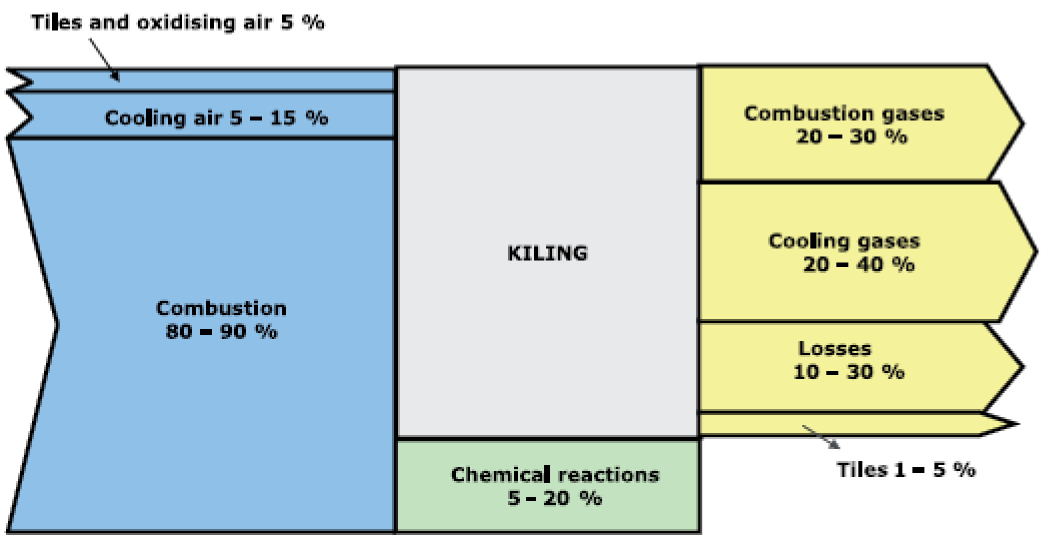

Fig -2: Sankey diagram of kiln process

It may be observed that about 50% of the energy input into the firing process is lost through the kiln combustion flue gas and cooling gas stacks. The aim of this study was precisely to reuse this energy by installing heat exchangers. At present it is the residual heat of the gases from the cooling stack that is mainly reused, because these gases consist of air without pollutants as they result from the direct contact of the air used to reduce tile temperature in the cooling zone.

However, owing to the fact that ceramic tiles undergo chemical reactions during firing, the gases from the combustion flue gas stack bear pollutants as they contain by-products from natural gas combustion and the chemical reactions produced by the material during the firing process. As a result, in order to be able to reuse these gases, pre-treatment is required. The possibilities of reusing combustion gas residual heat are as follows:

•Installation of a cleaning system

It would be possible to clean the combustion gases and reuse them, together with those from the cooling zone, in the dryers. The constraint entailed in this option is gas temperature, since bag houses usually cannot withstand temperatures above about 180–200 ºC, depending on the type of bag material.

• Installation of heat exchangers

The option addressed in this study was the installation of heat exchangers with an intermediate fluid that conveyed heat from the kiln to the dryer. In addition, since combustion gas temperature decreased after the heat exchanger, it would be possible to install a gas treatment system.

2. OBJECTIVE

The objective of this study was to improve the use of the energy consumed in the firing operation by installing an innovative heat recovery system to reduce heat losses via the stacks and reuse the heat in the drying stage.

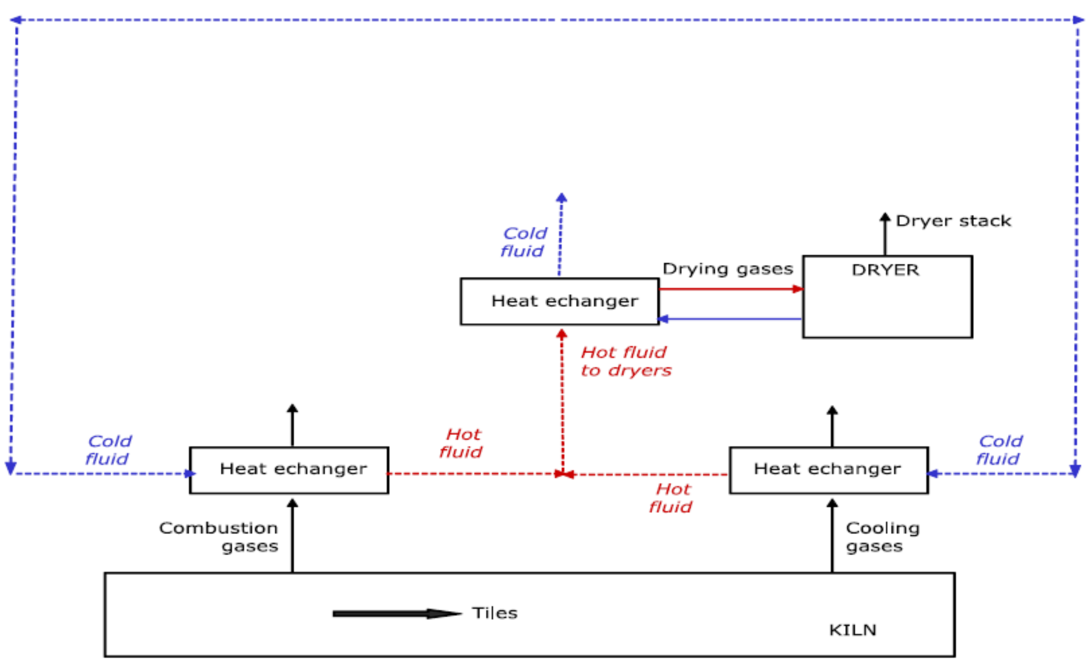

Fig -3: Proposed heat recovery system

3. DESCRIPTION OF THE PROCESS

3.1. Description of the installation

The installation consisted of joint heat recovery from the kiln combustion flue gas stack and the cooling air stack to a dryer, using heat exchangers (one in each stack), so that the energy was transferred from the kiln to the dryer, using oil as thermal fluid. The thermal oil heated in the two kiln exchangers was brought together in a single stream and fed into the dryer. The thermal oil circulated from the kiln to the dryer through an insulated pipe to minimize energy losses. The heat in the dryers was transferred to the dryer recirculation air through two additional exchangers, one for each burner.

The thermal oil was used in a closed circuit, so that after transferring heat to the dryer gases it returned to the kiln heat exchangers to start the process again. The circuit was fitted with a system of valves and a bypass, which allowed oil temperature to be maintained at the optimum value, thus enhancing overall process efficiency.

Depending on the needs of the system, the hot drying gases can be preferentially fed into the dryer either to one or to both the dryer burners. A general scheme of the installation is depicted in Figure 3..

3.2. Description of the main elements

3.2.1. Dryer

The studied dryer was a vertical dryer and heat was provided by natural gas combustion via two burners located in the two air recirculation. The studied dryer is schematically depicted in Figure 4. After tiles enter this dryer, they are first conveyed upwards and, after passing through the high zone of the dryer, they descend towards the stabilisation area. After the drying gases enter into contact with the tiles, part of the gases is recalculated again towards the dryer by two independent recirculation in which the air vein burners are located. The rest is exhausted into the air through the stack.

In this study, the two oil heat exchangers, which heated the recalculating drying gases after the burners, were positioned in these two recirculation. The burner temperatures for the drying gases that left the dryer were set such that the heating elements (heat exchanger and burners) heated the gases that were fed into the dryer sufficiently for the temperature at the exit to match the required temperature. The gases from the combustion flue gas stack had a temperature of about 210 ºC, just like the gases from the cooling zones. Each of these streams was passed through its respective heat exchangers, in which thermal oil circulated counter-current, which reached temperatures of the order of 190 ºC, transferring part of its heat to the drying gases through two heat exchangers located in the dryer recirculation ducts.

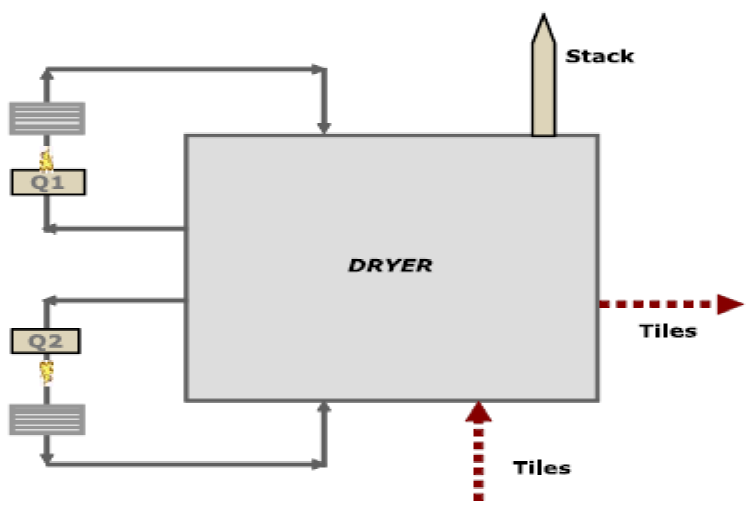

Fig -2:Schematic diagram of vertical dryer

3.2.2. Kiln

The studied kiln was a single-deck roller kiln, divided into a heating, firing, and cooling zone. The heat was provided by natural gas combustion in high-speed burners, which were arranged along the side walls of the kiln, above and below the roller plane in the heating and firing zones. Before the recovery system was installed, the kiln combustion gases had been diluted with ambient air and directly released into the atmosphere. After the installation of the recovery system, the gases were no longer diluted with ambient air and the heat was transferred to the thermal fluid. The cooling gases were initially collected from the fast cooling, indirect cooling, and final cooling zones. From this stack, a part was recovered to the pre-kiln dryer, another part to the kiln burners, and the rest was released into the atmosphere. The cooling zone heat exchanger was installed in the duct containing the fast cooling gases, since these were the gases with the highest temperature.

3.2.3. Heat exchangers and thermal fluid

Four heat exchangers were installed counter-current: two positioned in the kiln and the other two in the dryer. The refined oil had been specially formulated as heat exchange fluid, and contained appropriate additives to provide it with thermal stability and higher oxidation resistance, in order thus to be able to respond to temperature rises during its use and to the spacing of the oil change times. Its refined bases provide this thermal fluid with high thermal resistance, as well as anti-oxidising properties, considerably reducing the formation of insoluble material and deposits in the pipes, thus assuring perfect circulation and heat transmission of the fluid, avoiding blocking of the circuits.

In addition, this fluid has a low viscosity, which allows immediate start at low temperatures, and optimum heat transmission, thus providing enhanced pump performance. The foregoing assures flawless operation and high performance in closed installations without any direct contact with the air, which are fitted with mechanical circulation systems.

4. CONCLUSIONS

The main conclusions drawn from the study were as follows:

An experimental heat recovery installation was fine- tuned, which allows simultaneous recovery of energy from a kiln combustion flue gas stack and a cooling gas stack in a single stream, using thermal oil, to a vertical dryer.

At the time this paper is submitted, the preliminary studies indicate that 60 to 90% reduction can be achieved in natural gas consumption, depending on the material processed, together with a similar reduction in dryer carbon dioxide emissions.

5. REFERENCES

[1]Mezquita, E. Monfort, E. Vaquer, S. Ferrer, M.A. Arnal, J. Toledo, M.A.Cuesta "Energy Optuimization In Ceramic Tile Manufacture By Using Thermal Oil " Instituto de Tecnología Cerámica-AICE, February 2012.

[2]Christos Agrafiotis, Theocharis Tsoutsos "Energy Saving Technologies In European Ceramic Sector : A Systematic Review", Applied Thermal Engineering (2001) 1231-1249

[3]O.S. Oyedepo, M.S. Adaramola, M.K. Odunfa & O.T. Arem "Analysis of Energy Utilization in Selected Industries in Southwestern Nigeria"Energy Engineering, 2015 ,112:6, 47-74

[4]V.Ibanez-Forces , M.D.Bove, A.Azapagic "Assessing the sustainability of Best Available Techniques (BAT): methodology and application in the ceramic tiles industry", Journal of Cleaner Production (2013) 1-15

[5]Zafer Ultu , Arif Hepbasli , Muharrem Turan "Performance Analysis and Assessment of an Industrial Dryer in Ceramic Production" , Drying Technology, 29: 1792–1813, 2011

[6]Macro Cavazzuti , Macro A Corficeli , Gianluca Masina , Roberto Saponelli "Cfd Analyses Of Syngas-Fired Industrial Tiles Kiln Module" , Engineering Applications Of Computational Fluid Mechanics Vol. 7, No. 4, pp. 533-543 (2013)