DESIGN AND DEVELOPMENT OF AN INNOVATIVE ARCHITECTURE FOR INDUSTRIAL CERAMIC KILNS. DREAM PROJECT.

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1. INTRODUCTION

Nowadays, European ceramic industry faces three different challenges:

- **Competition** against mass production of low-cost products from emerging economies. Due to this fact, it is necessary to study the increase of the productivity through the reduction of defects that affect the production quality, especially in the heating and cooling zones of a ceramic kiln of a ceramic kiln. In particular, this is a key factor in the manufacture of larger tile formats.
- High **energy** prices. Is necessary to reduce the energy consumption since a large amount of thermal energy consumed in the firing stage is lost through the cool and hot gases stem.
- **Emissions reduction** due to that the revision of the BREF document (first publication in 2007) begins in 2018 and, any potential emission limitation for a number of pollutants (SO_x, NO_x, HCl, HF, heavy metals, VOCs, among

others) could imply a significant impact on compliance with legislation and production costs. For this purpose, energy saving measures should be considered in order to reduce fuel consumption and, on the other hand, the installation of abatement systems, which contribute to the achievement of the future emissions limits.

In order to meet these challenges, the implementation of the DREAM project, a European project funded by the EC through the SPIRE-H2020 Program, is proposed. This project is focused on the design, the development and the demonstration of a radically improved design for industrial ceramic kilns, characterized by an optimized energy consumption, reduced emissions, and lower operating costs compared to current technological solutions. This will be achieved by improving specific parts of the kiln (control system of the parameters of the kiln, refractories, abatement system) and by adding new modules or subsystems (CHP (*Combined Heat and Power*) and "heat pipes").

2. DREAM PROJECT STRUCTURE

Through a structured and coherent approach, DREAM will develop and demonstrate technologies that allow a significant advance in the sustainability of ceramic processes. **Five synergic lines** of research will be implemented, as well as the development of 3 industrial demonstrators, which will act as technological showcases for the market.

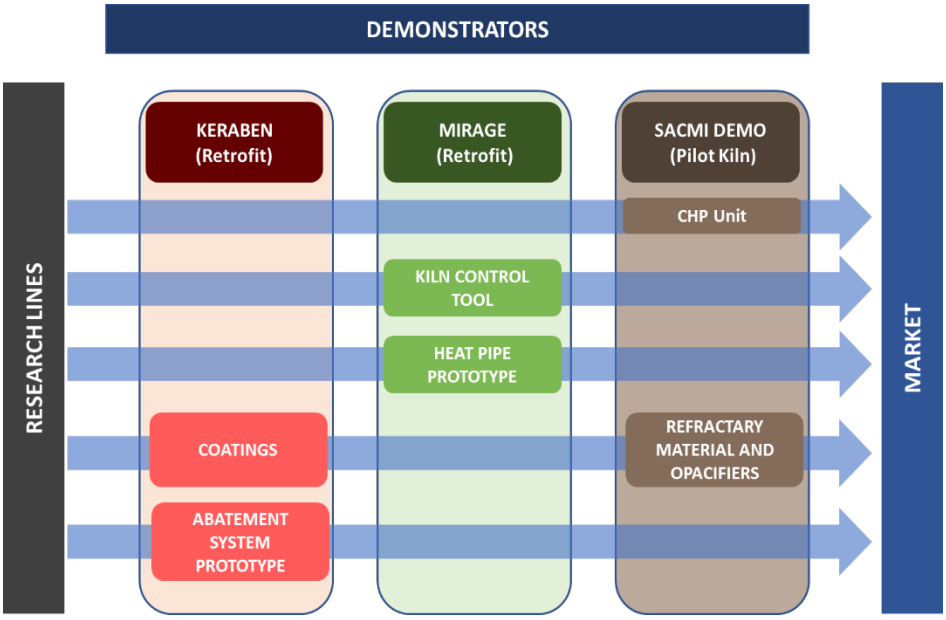

Figure 1. *Research lines of DREAM project*

2.1. WP1 – CHP UNIT

The R&D activities are focused on the analysis of possible Combined Heat and Power (CHP) unit configurations, taking into account variables such as size, fuel and technology used in order to reduce the overall energy consumption of the kiln and to create a system that is capable of continuous production even in case of small power shortages on the grid. The result will be a CHP unit prototype integrated into kiln firing stage.

2.2. WP2 – KILN MODELLING, SIMULATION AND CONTROL

The activities will be focused on: 1) the characterization of the thermo-mechanical properties of the ceramic product (especially in those that affect the product quality in the cooling stage), 2) the modeling of the thermal energy exchange produced between the product and the kiln and 3) all the physical phenomena involved within the kiln. The outcome will be a prototype kiln control tool, capable of optimize the energy consumption of the kiln and predict the influence of process parameters in the product quality.

2.3. WP3 – "HEAT PIPES" FOR COOLING STABILIZATION AND HEAT WASTE RECOVERY

The development of this work package is focused on the use of heat exchangers, namely "heat pipes", in the cooling zone of the ceramic kiln. By modulating the heat transfer rate from the heat pipes to the cooling system it will be possible to control the temperature of the tiles through the kiln width. This will help increasing the quality of the tiles by reducing the internal stress generated by uneven heat. A prototype will be built and installed in an industrial kiln and will convey the recovered heat from the cooling zone to the dryers.

2.4. WP4 – INNOVATIVE REFRACTORY MATERIALS AND SOLUTIONS

In this work package, an analysis of new materials for the insulation of industrial kilns will be performed, in order to reduce heat losses. Two different concepts will be implemented, the first one is focused on the reduction of heat transfer within refractory materials using foamed materials and opacifiers, and the second one will seek the reduction of the heat transfer from the kiln atmosphere to refractories materials using emissivity coatings.

2.5. WP5 – EMISSION MONITORING AND ABATEMENT

In this work phase are addressed several aspects related with the control and the correction of the emissions generated during the ceramic tile firing process, such as: the monitoring needs of the pollutants emitted and the identification of an optimal configuration for the treatment and abatement of the generated emissions. Another considered aspect is the study and fine tuning of the kiln burners.

Regarding the pollutant monitoring, it is proposed the development of an emission control strategy, which consists in a continuous monitoring system, assessing the viability of existing solutions. For this phase, different aspects have been considered, such as the purpose of the measures (regulatory control activities, self-control activities, studies for research projects, etc.) and the control of process parameters related with emissions, among others.

Another aspect studied is the development and testing of various configurations for the abatement of emissions generated during the firing stage of ceramic tiles, in order to identify the one that is optimal. In this phase, conventional systems with some innovation or new techniques are considered. The objective pollutants are: particulate matter (PM), acidic gaseous pollutants (HF, HCl, SO_x and NO_x), combustion gases and organic compounds emission.

Finally, it is also intended to address a fine tuning of the kiln burners in order to reduce the concentration of the pollutants related to the combustion. For that purpose, the 3D-CFD simulation carried out in the second work package of the project will be used in order to obtain the best configuration of the burners within the kiln. In addition, the excess of combustion air, which is the main cause of the production of CO, NO_x and, to a lesser extent, SO_x, will be observed.

ITC is leader in this task in which are involving other partners such as: Keraben, Sacmi Forni, CRIT and the University of Brunel London.

2.6. WP6 - DEMONSTRATION

The activities of work package 6 are based on the integration of the prototypes developed in work packages 1-5 in three industrial demonstrators in order to verify and validate that the expected yields are fulfilled under real conditions.

3. REFERENCES

[1] DREAM Project. Design for Resource and Energy efficiency in cerAMic kilns. Horizon 2020.