ECO-EFFICIENT ELECTRICAL PROCESSING IN ENERGY-INTENSIVE INDUSTRY WITH HIGH-TEMPERATURE MICROWAVE KILNS: THE DESTINY PROJECT

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1. INTRODUCTION

Manufacturing sectors provide over €6,553 billion of GDP in EU, representing approximately 21% of EU GDP and providing about 20% of all jobs (more than 30 million) in 25 different industrial sectors. Sectors such as ceramics, where energy could become more the 30% of the total cost of the products and where process control is critical, are demanding processes for eco-efficient and flexible production and using renewable energy. In order to achieve further significant energy reductions in these mature industries, it is necessary to target the most energy-intensive parts of the production chain, such as the firing processes.

2. DESTINY PROJECT AIM

In this context, the DESTINY project [1] aims to realize a functional, green and energy-saving, scalable and replicable solution, employing fully electrical microwave technology for continuous processing of granular materials in energy-intensive industries covering some of the raw materials treatment processes of the ceramic, cement and steel industry. DESTINY aims to fill this gap by proposing a novel solution for processing granular solid feedstock based on a new fast production Microwave Kiln Cell (DESTINY module) designed to cover the "material feedstock-firing-product storage" process in a unique clean system, suitable for connection to electricity grids and ideal for industrial down-scaled plants targeted to lean and on-demand production.

3. DESTINY PROJECT CONCEPT

To assure a proper transformation, DESTINY is developing a new concept of eco-efficient microwave applicators, combining a specific design that focuses the electromagnetic energy in the target materials, together with a more uniform field configuration throughout the reaction chamber. Studies about materials and microwaves interaction at high temperatures [2, 3] show the advantages of modulating internal wavelength to adapt the signal to the selective heating of the raw materials. This approach will allow raw materials to be efficiently heated despite their low microwave absorption (loss factor, ε"). DESTINY seeks to introduce the "first-of-a-kind" high temperature microwave processing system at industrial level, offering a variety of vital benefits to energy-intensive sectors: reduced energy consumption, lower lifetime operating costs and enhanced sustainability profile.

The new microwave fast-firing process concept proposed by DESTINY is versatile enough to be validated and demonstrated in the different industrial sectors selected for the project (namely ceramics, cement and steel). It is based on a containerized approach with different designs adapted to the industrial process to be validated. The DESTINY system is conceived as modular units (material feeding + product MW processing). Thus, the system is compatible and easy to integrate, which reduces the investment needed. Its compact nature also helps to reduce the space needed for installation.

The project goals will be achieved by exploiting: microwave technology built on a radical new electromagnetic concept with capacity to heat granular materials with a very low loss factor (low microwave absorption), coupling microwave technology with a novel fluidized bed feeding specifically designed for high performances and lower maintenance costs (the rotary system will be addressed for the steel sector), and

monitoring and control strategies to maximise efficiency and keep emissions under control.

4. DESTINY PROJECT STRUCTURE

The DESTINY consortium is made up of 14 experienced partners with proven capability to develop and achieve the objectives of the project covering a wide geographical representation from 9 European countries. The multidisciplinary roles guarantee in-depth knowledge and best available skills in the essential parts of the developments (materials development, microwave technology, environmental/cost/social life cycle analysis, health & safety, industrial processes for cement/ceramics/steel, business exploitation, etc).

The project Work Plan has been organized into 7 Work Packages covering the following aspects: WP1 - Technical and financial management of the project, WP2 - Materials in microwave applications, WP3 - Design and fabrication of containerized eco-furnaces, WP4 - On-line monitoring & control, WP5 - Integration and validation in demonstrators, WP6: Exploitation & Dissemination, and WP7 - Key Performance Indicators (KPIs) and Health & Safety aspects.

The first part of the project will be focused on defining the different microwave system components and on their optimal integrated design. The most appropriate materials (new ceramics and alloys) will be identified and several prototypes will be released. Different sensors and monitoring tools will be analysed, selected and developed to be integrated within the DESTINY prototypes to control the processes continuously and to guarantee their reliability within the industrial sectors selected (cement, ceramic, and steel).

The final goal is to be able to develop the Full Demo DESTINY prototypes that will allow process production rates to be increased to about current industrial ranges, reaching high performances, not only technically but also economically, in order to keep investment and maintenance costs as low as possible and be competitive compared to existing industrial systems.

5. REFERENCES

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