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Un metodo innovativo per la valorizzazione energetica della frazione di sopravaglio tramite pirolisi.

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ABSTRACT

L’obiettivo di questo lavoro è presentare un metodo innovativo per la valorizzazione energetica della frazione di sopravaglio dei rifiuti solidi urbani (RSU) tramite pirolisi con tecnologia ad induzione.

La frazione di sopravaglio rappresenta lo scarto ottenuto dal pretrattamento della frazione organica del rifiuto solido urbano (FORSU) destinata alla digestione anaerobica per la produzione di biocarburante avanzato.

La pirolisi è una tecnologia ampiamente utilizzata per il trattamento dei rifiuti solidi urbani, ed è considerata una valida alternativa all'incenerimento degli FSU, in quanto consente la produzione di diversi prodotti chimici e combustibili con emissione di SOx e NOx molto basse e quindi ad un contenuto impatto ambientale.

La proposta del riscaldamento ad induzione permette di evitare l'uso di bruciatori a fiamma, aumentando l'efficienza energetica del sistema e ottimizzando la distribuzione termica all'interno del reattore.

La progettazione del sistema è affiancata ad una simulazione di fluidodinamica computazionale (CFD) che permette l'ottimizzazione delle geometrie, del profilo termico e garantisce flessibilità di analisi in risposta alla forte variabilità del prodotto in alimentazione .

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ABSTRACT

This work aims at presenting an innovative method for the energetic valorization of a fraction of the municipal solid waste (MSW) through pyrolysis with induction technology.

The MSW fraction treated is the one retained during sieving pre-treatment operation for separation of the organic fraction intended for the anaerobic digestion producing advanced bio-fuel.

Pyrolysis is a technology widely used for the treatment of municipal solid waste, and it is considered a valid alternative to combustion since it allows the production of chemical products and bio-fuel with low SOx and NOx emissions, and therefore with a low environmental impact.

The heating system based on induction technology prevents the use of traditional burners, improving the process energy efficiency and optimizing the thermal distribution inside the reactor.

The design operation is assisted by computational fluid dynamic (CFD) simulation, supporting the geometry optimization and the heat distribution within the reactor, and guarantees more flexibility in the way of high variability of input material to be treated.

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INTRODUCTION

The complex chemical reactions scheme holding during the pyrolysis of a generic organic matrix (CxHyOz) can be summarized as:

$$C_xH_yO_z + Q \rightarrow Char + Oil + Gas + H_2O$$

Where Q is the supplied energy accounting for three contributes: the latent heat for water vaporization, the effective heat required for substrate pyrolysis and the heat loss.

Water content plays an important role:

- It is usually suggested to dry the input matrix to reduce the heat load required for the process (since water vaporization is highly endothermic) and to reduce the water presence in the liquid products;

- On the other hand, several studies highlighted that an increase of humid fraction promotes the production of gas, probably due to gasification and reforming reactions.

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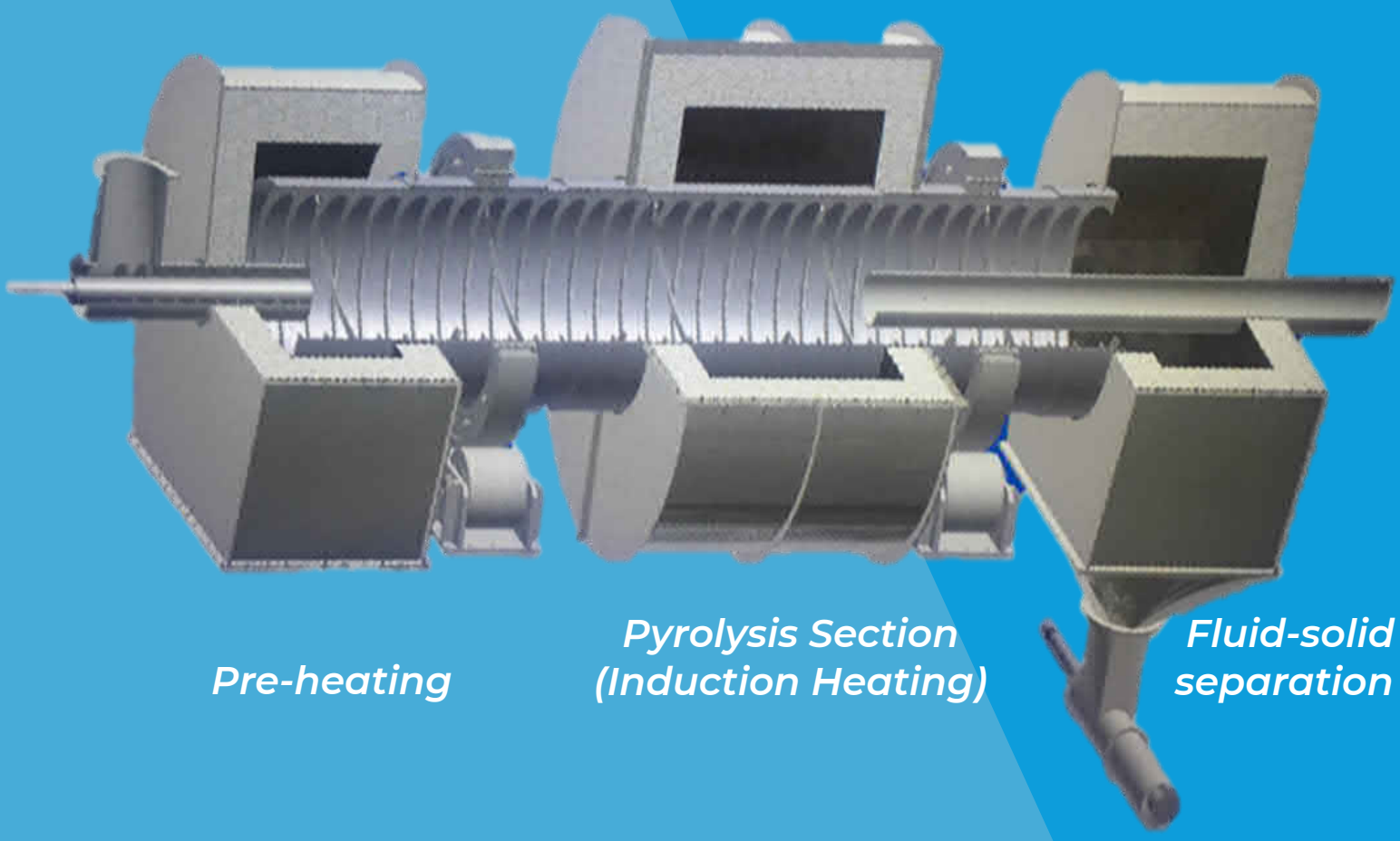
PYROLYSIS SYSTEM

It is based on a rotating reactor, equipped with an internal screw that allows the axial movement of the waste. The induction system is placed on the external section of the reactor in order to ensure the wall temperature, ranging from 500°C to 750°C, according to the pyrolysis process control needs.



Pre-heating

Pyrolysis Section (Induction Heating)

Fluid-solid separation

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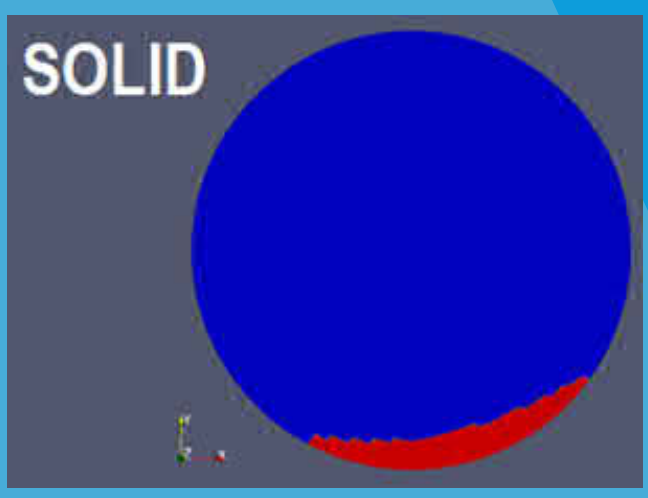
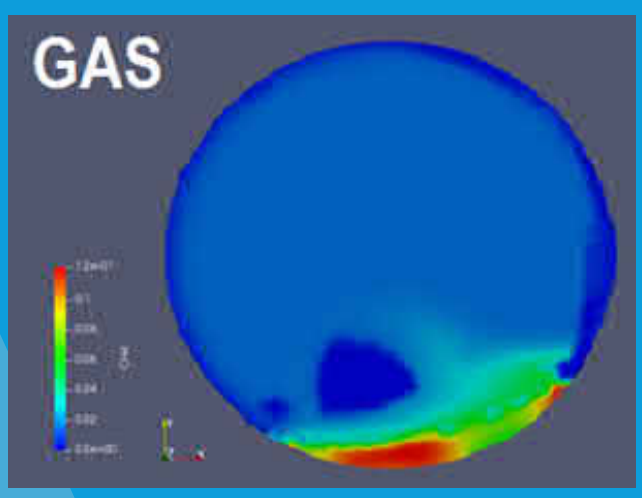
COMPUTATIONAL FLUID DYNAMIC SIMULATION

The design of the pyrolysis system is coupled with a computational fluid dynamic simulation carried out in open-source software OpenFOAM.





The numerical model allows evaluating the heat exchange between the organic substrate and the gas-liquid fraction, as well as between the reactor and the organic matrix. The simulation solves the solid disappearance through thermochemical kinetic models.

The computational fluid dynamic simulation allows the optimization of the geometry and the heat distribution within the reactor, and guarantees more flexibility in the analysis, accounting for the high variations of input material to be treated.

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INDUCTION SYSTEM FOR HEATING

The main benefit of using an induction system for heating is in the fast heating rate, which ensures a rapid temperature increase.

These systems allow high accuracy in operative temperature control and quick response to fluctuations in the required

The induction system is mainly composed by a coil with electric supply. The electric current inside the coil generates a magnetic field, which in turn generates induced currents in a metallic conductor, that in this case is the wall of reactor.

The induced currents generate heat through the loss for magnetic hysteresis. In this way, the heat is provided to the reactor without external effects, in opposition to the traditional burners or ovens.

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CONCLUSIONS AND REMARKS

This poster presents an innovative method for the energetic valorization of the MSW retained fraction though pyrolysis with induction system for heating.

The process allows the production of several chemical products and bio-fuel with low emission of SOx and NOx, starting from municipal solid waste and reducing the environmental impact of process residues.

Next steps will include the final design of the system and the construction of the plant, hoping for a greener future.

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