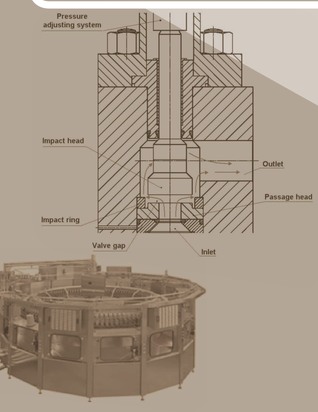
NPFP

NEW PARADIGMS FOR THE DESIGN, MANUFACTURING AND OPERATION OF FOOD PROCESSING AND PACKAGING EQUIPMENT



ABOUT THE PROJECT

The project aims at developing and applying new paradigms to achieve a breakthrough in the design, construction and operation of machines and plants for the food industry:

Paradigm 1 (P1): "**Design and manufacture by new technologies**" based on the integrated use of net-shape (including additive) **manufacturing technologies, new materials, unconventional joining technologies** (eg. adhesive bonding, friction stir welding), aimed at the rationalization of components and cost, increase of yield and in the context of hygienic design

Paradigm 2 (P2): "**Process control by processed food properties**" based on the integrated use of experimental and numerical methods aimed at **modeling and interpretation of the phenomena involved in the physical treatment of food products**, in presence of complex rheology and phase transformation, aiming at a more efficient and effective automation of food processing.

The two paradigms will be implemented first at a laboratory scale (experimental specimens and / or simulation), in order to identify the most suitable technological parameters and models for scale-up to the pre-industrial demonstration level in the second step. In parallel to these activities, there will be a work of classification of the developed solutions with respect to the sanitary requirements of machines and plants and to the chemical and physical properties of processed food, that is mandatory for the subsequent application at industrial scale.

DESIGN AND MANUFACTURE BY NEW TECHNOLOGIES

PROCESS CONTROL BY PROCESSED FOOD PROPERTIES

Machines and Plants for Bootlings

Stampa 3D/HIP di componenti complessi

Materiali/tecnologie assemblaggio alternative (incollaggio, FSW)

Sup. idrofobiche mediante trattamento laser

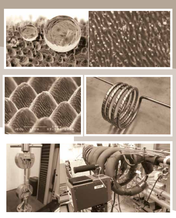
Compliance Evaluation of:

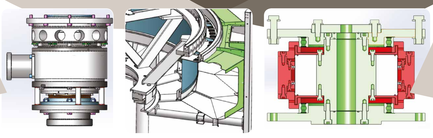
- Hygienic design
- Chemestry and Physical-Chemestry of Food processing

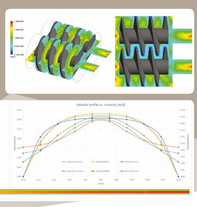
Real Time Feedback on process parameters (homogeneization)

Modelling:
- control on heat exchanges
- cleaness

Machines and Implant for food process







OBJECTIVES

The new paradigms are related to the design and construction and to the operation of food equipment, respectively. In the project, they will be selectively applied to the field of machines and plants for bottling and for thermophysical treatment plants and machineries. The final goal is the creation of a set of elements called "demonstrator" that exemplifies concretely the technical and economical benefits. The demonstrator for paradigm 1 "Design and manufacture by new technologies" includes the following elements:

I) a rotary manifold used in filling machines, that will be made by assembling stainless steel and bulk ceramic materials to achieve optimal solutions from the structural, functional, hygienic and economical point of view. To this purpose, additive manufacturing on the metal side and Hot Isostatic Pressing (HIP) on the ceramic side will be the leading technologies to be applied;

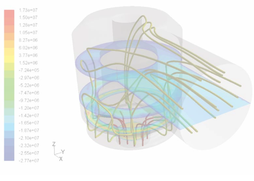
II) an isolator for the reduced laminar flow tunnel in filling machines, where adhesive bonding and/or friction stir welding are applied to reduce lead time / cost / distortion;

III) a pipe section, where the outer surface is physically structured by means of ultrashort pulsed laser in order to limit fouling and to facilitate cleaning.

The demonstrator for paradigm 2 "Process control by processed food properties" includes a series of elements represented by:

I) scraped and/or corrugated and/or curved surface heat exchangers and twin-screw pasta extruders with optimized thermo-fluid dynamics performance;

II) homogenizer with a new control logic based on the continuous monitoring of the physical characteristics of the processed food.



ACTIVITIES

Paradigm 1

- Correlation between the main variables of additive manufacturing and of HIP sintering process and strength wear rate of prismatic or cylindrical specimens, also by the use of optical and scanning electron microscopy
- Optimization of post processing thermal cycles and of surface finish treatments for the achievement of the target mechanical performance and roughness
- Manufacturing and testing of bonded and FSW single-lap butt joints, to evaluate tensile strength before / after exposure to chemicals used for the cleaning and sanification of the machines
- Test with laser sources having different pulse duration (ns, ps, fs); parametric analysis of micro-nano surface topography by SEM-EDS and AFM.
- Characterization of the attitude of the treated surfaces to adhesion of liquids representatives of foods and of sanitizing agents by measurement of static and dynamic contact angle.
- Design and manufacturing procedures for the demonstrator; manufacturing; testing and validation

Paradigm 2

- Mathematical modeling and numerical simulation based on CFD
- Experimental campaign design (Design of Experiments, DoE)
- Development of the test circuit with the support of the companies involved in the project
- Testing of the apparata inserted in the circuit (scraped, corrugated and / or curved surface heat exchangers; twin-screw extruders for pasta)
- Identification of the heat transfer correlations for the types of equipment inserted in the circuit
- Development of original software tools for the design and optimization of the heat exchange apparata considered
- Design by simulation of innovative, high performance heat exchangers and twin-screw extruders
- Selection of the potentially most suitable system for in-line continuous monitoring of the homogenization degree of food emulsions (e.g. milk) among optical (turbidimeters), ultrasonic and viscosity measurement instruments
- Experimental identification, on food emulsions (milk), of the correlation between degree of homogenization and instrument signal
- Homogenization pressure control system based homogenization degree feedback signal

Classification of the new paradigms with respect to hygienic design requirements and quality of the processed food

This activity is devoted to the evaluation of the compliance of the new paradigms relatively to the cleanability of the machines and to chemical and physical properties of the processed food.

- Assessment of conformity to hygienic design and cleanability requirements of new technological solutions according to current regulations and international guidelines (EHEDG); this activity will be done first at lab scale and then on the demonstrator.
- Evaluation of the quality of the processed food (chemical and physico-chemical parameters) compared to properties obtained by processing using conventional heat exchange apparata.
- Evaluation of the quality and the constancy of the degree of homogenization of food fluids with the new control system .

RESULTS

In this initial phase of the project efforts are concentrated at a laboratory scale (experimental specimens and / or simulation), in order to identify the most suitable technological parameters and models and to classify the developed solutions with respect to the hygienic requirements for scaling-up to the pre-industrial demonstration level to be developed in the second step. The project website will keep track of the results achieved once they can be safely disclosed. Attention will be paid to real applications. For this purpose, the project consortium includes partners with knowledge in industrial applications as well as companies supporting the activities with in kind contribution, especially for the demonstration step. This guarantees that progress is not only done in technological grounds, but also that work is done steadily towards the future realistic application of the results.

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