Action B.1

Design of pilot plant

Deliverable B1.2

Implementation Plan_ website

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1. Table of Contents

2. List of abbreviations and definitions

CO_2	Carbon dioxide
USA	United States of America

3. Introduction

The Implementation Plan defines in detail the road map, the actions, the preliminary designs and schemes necessary to realize the pilot plant and prototypes for k12 technology scaling up.

The Complete Implementation plan deliverable was submitted to the European Commission with the Mid-term report. As requested in the Grant agreement, the beneficiaries of the project shall publish a version of such deliverable on the project website.

This document is a summary of the original deliverable which content can be published on the K12 Project website, without compromising the intellectual properties of each project partner.

The target of the K12 Project is to demonstrate the industrial feasibility of an innovative technological solution able to hugely impact the thermal insulation market; in particular the project is focusing on the technical demonstration of producing a prototype of domestic refrigerator with an injected innovative PU rigid foam at 12mW/m.K thermal conductivity, measured at 10°C.

Since the actual best thermal conductivity reachable in the domestic refrigerator application is around 18mW/m.K, this result will promote a huge saving in the energy consumption of the domestic refrigerators.

The targets of the K12 project are technically ambitious and, as consequence, not easy to achieve without modifications during the development of the project. The planning of the project can and shall be modified and adapted to new constrains or new knowledge that are discovered during the project development and may change the available project scenarios, obliging or suggesting to modify also the initial organization.

With these premises, the implementation plan cannot be the complete planning of the traditional activities typical of a production organization and of a technology well consolidated. It is a preliminary planning of the activities as emerged from the information collected during the first sessions of trials and tests.

4. From laboratory to refrigerator prototyping

4.1 Chemistry definition and fundamental studies.

The K12 technology is based on an innovative way to foam and inject rigid polyurethane into in a refrigerator cavity. For these reasons, before designing the pilot plant, for technology scaling up, several experiments were conducted at Dow Laboratories on a small-scale equipment, as shown in Figure 1.

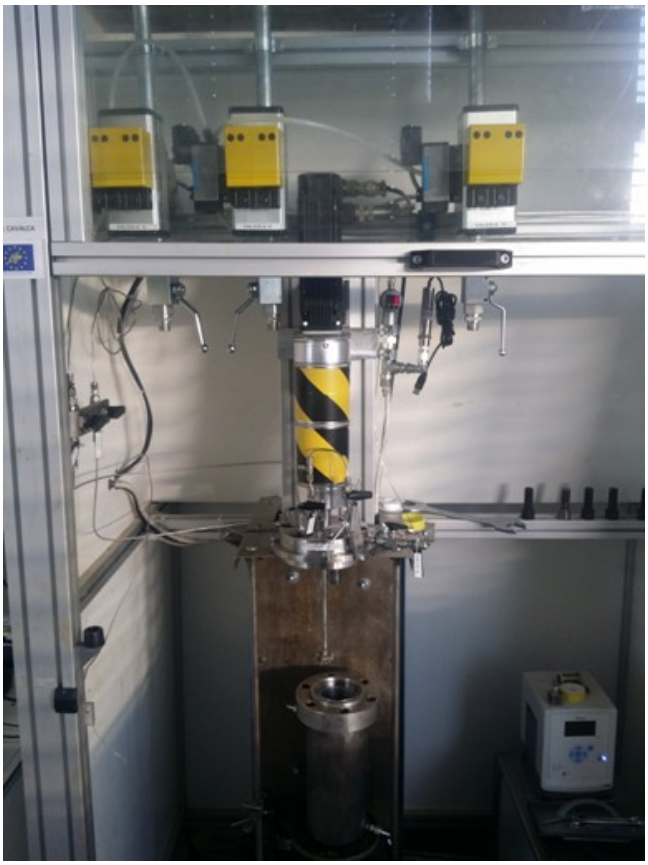

Figure 1: Small scale equipment installed at Dow laboratory

With the equipment shown above, we obtained microcellular foams inside the reactor at the Dow Laboratory. In this first phase of the project, different polyol and isocyanate compositions and formulations were tested to reach the K12 targets in terms of foam properties. In addition the foaming process parameters were set to be implemental to the pilot plant definition.

4.2 Prototyping: simple shape mold and refrigerator design

Before injecting the foam into the refrigerator or door prototype, a small (5l volume) and simple shape mold with its adequate press has been designed and produced by the Afros team to be used during the equipment start up and the process optimization (Figure 3).

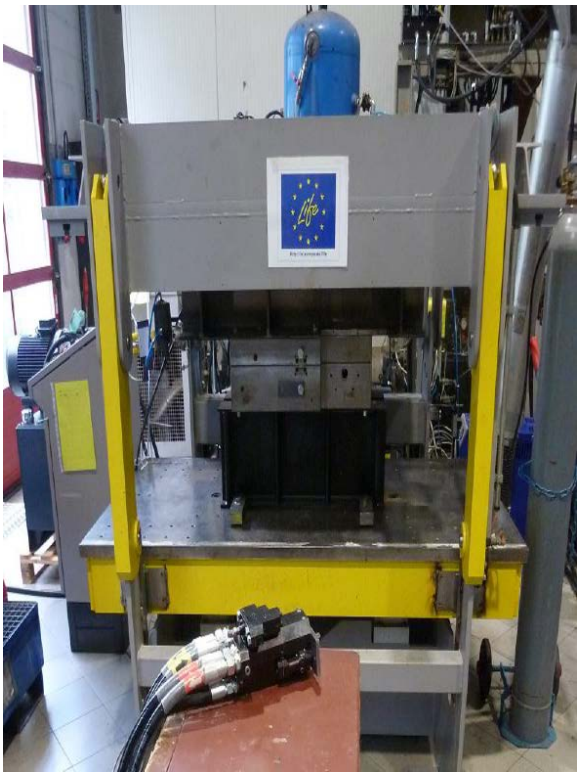

Figure 2: K12 mold and press

Whirlpool, at the same time, taking in account new foam properties, new foaming equipment and related technological issues, developed the study of a novel refrigerator, which will be produced and used as prototype for the k12 technology demonstration.

4.3 Design of the complete Pilot Plant

The design of the pilot plant required a long period of inter-partners discussions and analysis of the lab scale data. The result was the definition in details of the pilot plant components and modules to be installed at the Afros facility where the pre-industrial demonstration of K12 technology is planned.

The k12 technology requires a completely novel foaming process: thus resulting in a pilot plant that includes additional and specific parts compared with the standard high-pressure machines currently used for polyurethane foaming of refrigerator appliances. In particular the new modules and subsystems (listed in the next paragraph) were designed, installed and are working flawlessly at Afros facility. The new equipment is characterized by:

- Special elements for the raw material preparation, allowing using of carbon dioxide as unique blowing agent and dosing
- Innovative mixing systems to handle a constant high pressure
- New injection mechanism to inject the polyurethane into the mold cavity.

5. Pilot plant realization

The complete Pilot Plant, to first prepare and disperse the CO_2 into the polyol and then to meter and mix it with isocyanate, resulted composed by specific modules:

- A module to meter the CO_2 into the polyol
- A double module to meter the raw polyol and the isocyanate
- A module to disperse the CO_2 into the polyol.
- A module to meter the mixture to the mixing head.
- A module to pre-cure the reactive mixture.
- A brett mold to pre-test the foam formation
- A specific press to test and produce samples of foam
- An high pressure vessel to test the up scaling of the system used at the Dow Laboratories

- Various molds for refrigerator part's prototypes with specific devices to control the formation of the foam

The main components of the pilot plant, depending from the results in course, can be transferred c/o Whirlpool for the setup of the part composing the preindustrial refrigerators

Figure 2 shows part of equipment installed dedicated to the mixture polyol and carbon dioxide.

Figure 3: Part of k12 pilot plant at Afros facility

6. Conclusions

This implementation report is showing the actual status of the project and fixing the activities in progress to achieve the target of increasing significantly the thermal insulation, through the application of the innovative k12 technology.

A continuous updating of the plan is ongoing in relation to the future evolution of the chemicals and of the technical solutions developed during the upcoming activities of the K12 Project.