USE OF CELLULOSE FIBRES AS FILLERS FOR FLEXBILE POLYURETHANE FOAM

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A. Candela Gil. M.P. Muñoz Muñoz. M.V. Navarro Bañón.
Technical Research Centre of Furniture and Wood of Region of Murcia (CETEM). C/Perales s/n.
Yecla , Murcia, Spain, 30510. a.candela@cetem.es

INTRODUCTION

Conventional **flexible polyurethane foams, FPUF,** are materials commonly used in industrial sectors, such as furniture, mattresses and bedding products.

The **main components** of the formulation of FPUF are **polyol and isocyanate** but the **use of fillers is not weird**. Calcium carbonate is an inorganic filler commonly used to manufacture FPUF. However,, nowadays, the **use of organic renewable fibres** as fillers are being promoted.

The aim of this work is to analyse **the effect of adding cellulose fibres** in the formulation of FPUF on their foaming process and their properties.

MATERIALS

The main components of a conventional **flexible polyurethane foam formulation** are polyether polyol and di-isocyanate (TDI 80), silicone surfactant , amine and tin catalyst and water as a blowing agent. **Foam formulations are usually filled with calcium carbonate.**

Organic fibres used:

- **Micro-Cellulose Fibres (MCF)** were added as filler, which have an average length of 45 µm and thickness of 25 µm.

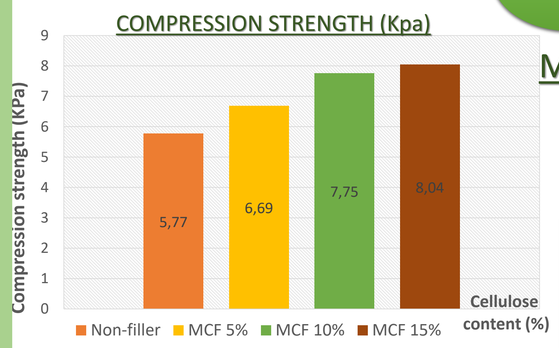
METHODOLOGY AND PROCEDURE

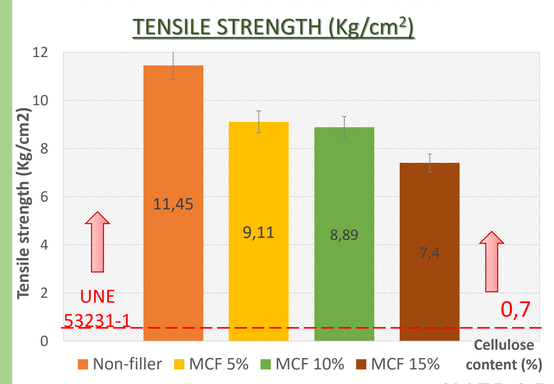
Flexible foam formulations were prepared using different percentages of MCF: 5%, 10% and 15%wt. Microfibres were added into the polyol under mechanical stirring at 5000 rpm for 15 minutes. MCF was completely characterized using Fourier Transform Infrared spectroscopy (FTIR), electronic microscopy and Thermogravimetrical analysis (TGA).
Conventional flexible polyurethane foam formulation was used as reference. The following experimental techniques of analysis and characterization methods were used:

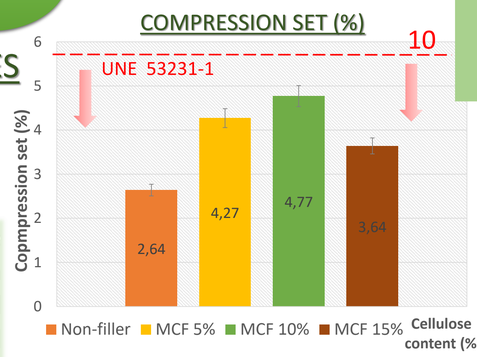
Mechanical properties: Apparent density (ISO 845), Resilience (UNE EN ISO 8307), Compression Set (UNE EN ISO 1856) and Compression strength (UNE EN ISO (3386).
Thermogravimetrical analysis (TGA Q500, TA Instruments) was use to analyse thermal decomposition profile at heating rate of 20ºC/min and carried out in two atmospheres: under nitrogen atmosphere to compare MCF foams with reference foam (non-filled) and under nitrogen/air (90%/10%) atmosphere to compare residue from MCF foams with residue from $CaCO_3$ foams.
Infrared Spectroscopy (Tensor 27, Bruker, single diamond ATR accessory) to analyse chemical composition.

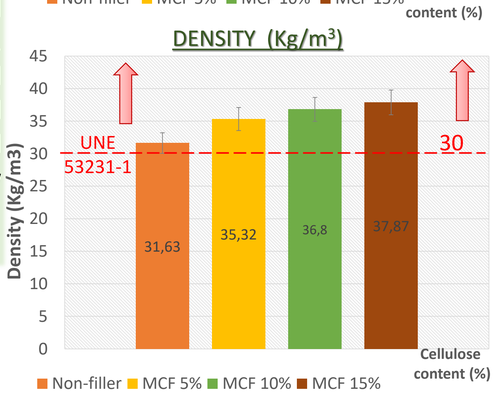
RESULTS

MECHANICAL PROPERTIES



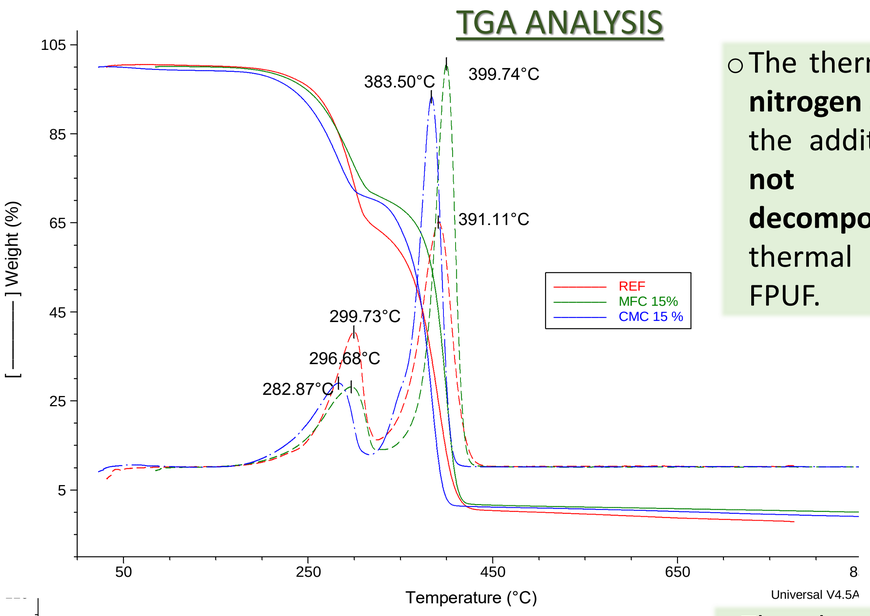






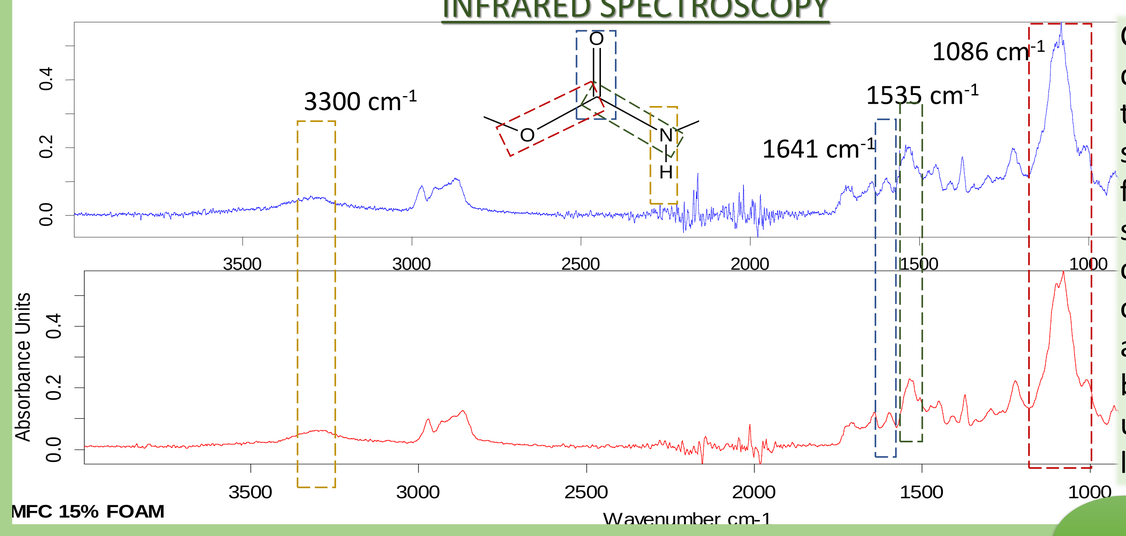
Some foams properties were modified due to the addition of the cellulose fibres, but all of them, meet the threshold in **UNE 53231-1** . Compression strength and density were be improved while tensile strength and compression set were slightly decreased.

TGA ANALYSIS

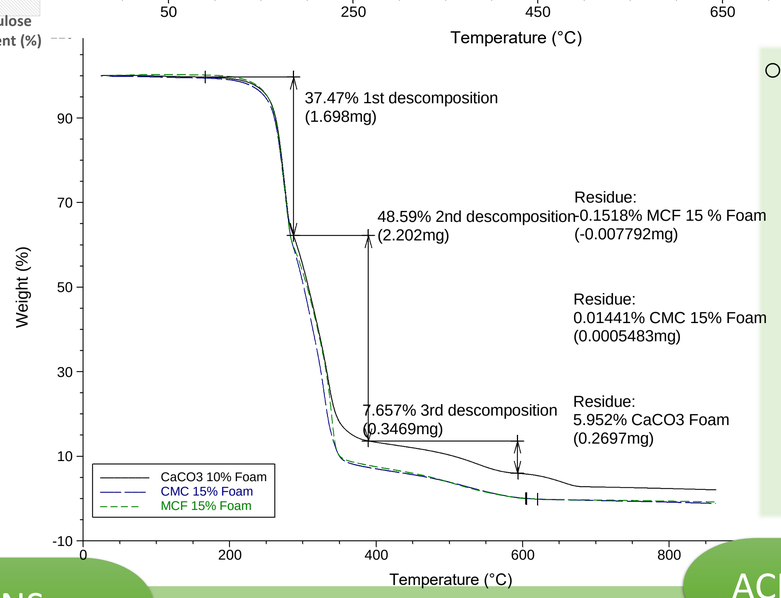


- The thermal analysis **under nitrogen** atmosphere shows the addition of MCF **does not modify the decomposition profile** or thermal properties of the FPUF.

INFRARED SPECTROSCOPY



Cellulose fibres do not affect to the chemical structure of the foam. No significant changes were observed in absorption bands typical of urethane linkages.



- The thermal analysis **under nitrogen/air** atmosphere shows that the decomposition of all the analysed foams takes place in three steps but filled foam with calcium carbonates leave calcium oxides and ashes as residue while MCF foams do not; under oxidant atmosphere, cellulose fillers can be totally degrade.

CONCLUSIONS

- The use of sustainable origin filler permit to control some properties of the foamed material without modification of the chemical structure as thermogravimetry and infrared spectroscopy analysis showed.
- The use of cellulose fibres as a filler modified some foams properties, but the modified values are inside of the threshold.
- The use of cellulose fibres as a filler instead of calcium carbonate allows developing a foamed material which does not leave residues.
- It is possible to replace the inorganic fillers and to develop greener non-residue foams as well as choose the percentage of fillers according to the final properties desired of foam.

ACKNOWLEDGMENTS

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