XV International Conference on Durability of Building Materials and Components
DBMC 2020, Barcelona
C. Serrat, J.R. Casas and V. Gibert (Eds)

Fire Properties of Novel Cellulosic Material Modified with Expandable Graphite

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Keywords: *Mass Loss Calorimeter, Char, Expandable Graphite Cellulose, Flammability.*

1 Introduction

Expandable graphite (*EG*) is an intumescent additive used for various materials fire properties improvement. Since few years an intumescent fire retardants (*IFR*) based on *EG* seems to be an interesting solution for flammable materials protection against fire (Xie and Qu 2000). Recent studies indicate that *EG* is a suitable source of carbon as an effective and environmentally friendly intumescent agent (Feng *et al.,* 2013). Although EG is used in a growing number of *IFR* systems as a blowing agent that will suppress flammable gases up to 75%, while reducing the flame spread index, its application to cellulosic material is not so popular in the cellulose industry today (Krassowski *et al.,* 2012). The current study focuses on flammability, concerning cellulose modified material (CMM) for building applications. The objective of this work was *CMM* encrusted with *EG*. The general aim of the research was to determine its basic fire resistance properties. The scope of the research included measurement of the fol- lowing parameters: time to ignition (T_i), time to flame out (T_f), heat release rate (*HRR*) and mass loss (*ML*). Samples of CMM sheets were manufactured with the use of hydropulper and Rapid-Koethen devices (Figure 1). Two types of EG were used.

Figure 1. Rapid-Koethen devices.

ES20 C200 with higher amount of fine-grained fraction (90% <75µm) and lower expan- sion volume (20 ml/g) in comparison to ES100 C10. Sodra Black Cellulose fibres (700 kg/m^3) were used in this experiment. Cellulose milling time was 30 minutes and drying time of 40 minutes. The drying temperature of the final sheets was reduced to 93^{0}C to avoid graphite activation. Final sheets were conditioned at 20^{0}C and relative humidity 60%.

With heat flux of 35 kW/m^2, all samples were tested on MLC apparatus Figure 2.

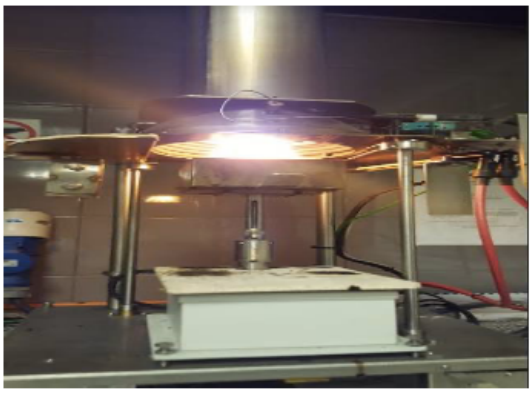

Figure 2. MLC apparatus set at 35kW/m .

In average, T_i for *CMM* encrusted with ES100 C10 and ES20 C200 were observed to ignite 4.3s and 2.3s, respectively faster than control samples. *CMM* encrusted with ES100 C10 showed an improved overall combustion period with T_f=112.7s, on the other hand, T_f for pure cellulose was 87.7s. Maximum *HRR* was observe to be 229.72 kW/m^2 for pure cellulose, 91.87 kW/m^2 for *CMM* with ES20 C200 and 71.51 kW/m^2 for CMM with ES100 C10. The addition of *EG* was found to increase the flame retardant effectiveness of cellulosic material. Although T_i for all *CMM* species were lower than that of control samples, this fact actually favored the promotion of char forming, which led to a longer combustion process for all CMM.

Acknowledgements

The work was financially supported by the Ministry of Science and Higher Education as the Project No 507.423.09. with subsidies for maintaining the research capacity and the paper was partially financed within the framework of Ministry of Science and Higher Education programme "Regional Initiative of Excellence' in years 2019-2022, Project No. 005/RID/2018/19". Part of the above mentioned results were also presented on two sci- entific conferences in year 2019: INPAP 2019 - The future of papermaking, 10-12th of June, Augustów Poland and Wood Science Economy – International scientific conference, 21-22nd of October Poznan, Poland.

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