DEVELOPMENT OF FLAME RETARDED NATURAL-FIBRE-REINFORCED EPOXY RESIN COMPOSITES

Beáta Szolnoki[a], Kinga Madi[a], Andrea Toldy[b], György Marosi[a]

[a]*Department of Organic Chemistry and Technology, Budapest University of Technology and Economics, Budafoki út 8., 1111 Budapest, Hungary*
[b]*Department of Polymer Engineering, Budapest University of Technology and Economics, Műegyetem rkp.3, 1111 Budapest, Hungary*

Introduction

Epoxy resins are extensively used in various industrial application fields, for example as adhesives, surface coatings, laminates and matrix materials. Despite their exceptional characteristics, such as good adhesion to many substrates; moisture, solvent and chemical resistance; low shrinkage on cure; outstanding mechanical and electronic resistant properties, their flammability still represents a limit in structural applications. Recently, there has been an increasing interest to use natural fibres instead of man-made fibres in many fields including composite materials. As biofibres are flammable, contrarily to artificial ones, an efficient flame retardant method needs to be developed to improve the applicability of natural-fibre-reinforced composites.

Materials and methods

Hemp-fabric-reinforced (surface mass: 580 g/m^2, received from the Institute of Natural Fibres and Medicinal Plants, Poznan, Poland) epoxy resin composites were prepared and flame retarded. The epoxy resin matrix consisted of a pentaerythritol-based epoxy component type ipox MR 3016 applied with a cycloaliphatic diamine curing agent (ipox MH 3122) supplied by ipox chemicals Kft., (Hungary). A recently synthesized phosphorus-containing amine-type curing agent (TEDAP) was applied as flame retardant[1]. Fabrics were surface-treated in two ways: by the thermotex procedure[2] and by a reactive modification with an aminosilane type coupling agent (Geniosil GF-9, Wacker Chemie AG, Germany). The flammability properties were characterized by mass loss type cone calorimeter, LOI and UL-94 tests while the mechanical performance was investigated by tensile and falling weight impact tests.

Results and discussion

The surface treatment decreased the flammability of the hemp fabrics significantly, the peak of heat release rate (pHRR) was reduced to the fifth of the original and also the epoxy resin composites made with them had increased Limiting Oxygen Index (LOI) values. However, to reach the V-0 rating in UL-94 test, the flame retardancy of the matrix was also necessary. When not more than 80% of the commercial curing agent was replaced with TEDAP, a significant (>70%) decrease was achieved in the pHRR while the LOI value increased from 21 to 31.

Concerning the tensile properties, the best results were achieved by the application of thermotex-treated fabrics in flame retarded matrix: an improvement of 90% in the tensile strength and 50% in the modulus could be reached, while the shock resistance could be increased by more than one order of magnitude.

Conclusions

In this work, novel hemp-fabric-reinforced epoxy resin composites were prepared and flame retarded by the application of surface-treated hemp fabrics and a reactive flame retardant. A synergetic effect could be observed between the two types of FR both in mechanical and flammability properties.

Acknowledgement

This work is connected to the scientific program of the "Development of quality-oriented and harmonized R+D+I strategy and functional model at BME" project supported by the New Széchenyi Plan (Project ID: TÁMOP-4.2.1/B-09/1/KMR-2010-0002) and by the Hungarian Scientific Research Fund (OTKA NN82462). The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Clean Sky Joint Technology Initiative under grant agreement n° 270599, and n° 298090.

1. Toldy A., Anna P., Csontos I., Szabó A., Marosi Gy., Polym. Degrad. Stabil. 92:2223-2230, 2007.

2. Rusznák I., Text. Rec. J. 43:128-132, 1973.