OPTIMIZATION OF A FLAME-RETARDED EVA COMPOSITE

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Introduction: Many attempts have been made in improving flame retardant properties of EVA/magnesium hydroxide (MDH) composites with the purpose of decreasing filler amount. Among the studied HFPAs, boron and silicon containing additives have shown synergistic effect in combination with MDH, both singularly [1] [2] and when used together [3]. Their main effect is in the solid phase, improving char formation and stability. In this work PDMS and calcium borate are evaluated as co-additives in EVA/MDH composites. A chemometric approach has been used in order to analyze their influence and the possible synergistic effects [4].

Experimental Design approach

The quaternary system is studied by Mixture Design. The components (independent variables) are expressed as the fraction of total amount and they sum up to one. Some constraints are established (lower and upper boundaries) in order to focus the exploration on the region of interest. A multivariate linear regression model has been used for each response variable.

Results

Models quality

Most of the dependent variables show very good (R² > 0.9) and acceptable (0.5 > R² > 0.8) models. General results on statistical quality are really positive.

Response | n² coefficients
--- | ---
LOI (%) | 8
pkRHR (kJ/m²) | 4
avRHR (kJ/m²) | 4
FPI (%/m²/kW) | 12
TII (°C) | 7
Unstable residue | 11
Stable residue | 16

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Response n² coefficients

The component MDH is the most influent, followed by CaB. The result points out the positive effect of this kind of fillers on TTI. Regression equation for peak of Rate of Heat Release is:

pkRHR = 123.7X + 99.6X + 161.6X + 364.6X

PDMS has the weakest contribution (positive effect on RHR). It could be due to the formation of a protective layer on the burning material with MDH and CaB effect.

Conclusion:

- No significant correlation is found among FR tests and most of the chosen FR parameters are described by models with very good quality.
- Statistical analysis on FR parameters reveals that Si is the most influent component on LOI because of interaction coefficients, while in COT most of the parameters are described by linear equations (no significant interaction).
- Optimal formulations with stable residue together with best LOI or CCT performance have been predicted and confirmed by experimental results.

References