Synergistic Studies of Multi-Flame Retarders Using Silica Nanoparticles, and Nitrogen and Phosphorus-Based Compounds for Polystyrene Using Response Surface Methodology

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Abstract : The effect of adding silica nanoparticles (SiNPs) obtained from rice husk, and phosphorus and nitrogen based compounds namely 9,10-dihydro-9-oxa-10-phosphaphenantrene-10-oxide (DOPO) and melamine, respectively, on the flammability of polystyrene (PS) was studied using response surface methodology (RSM). The flammability of PS was reduced as the limiting oxygen index (LOI) values increased when the flame retardant additives were added. DOPO exhibited the best retarding property increasing the LOI value of PS by 42.4%. A quadratic model for LOI was obtained from the RSM results, with percent loading of SiNPs, DOPO, and melamine, as independent variables. The observed increase in the LOI value as the percent loading of the flame retardant additives is increased, was attributed both to the main effects and synergistic effects of the parameters, as the LOI response of SiNPs is greatly enhanced by the addition of DOPO and melamine, as shown by the response surface plots. This indicates the potential of producing a cheaper, effective, and non-toxic multi-flame retardant system for the polymeric system via different flame retarding mechanisms.

Keywords : flame retardancy, polystyrene, response surface methodology, rice husk, silica nanoparticle
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