

Catalytic Effect on Eco Friendly Functional Material in Flame Retardancy of Cellulose

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Abstract : Two organophosphorus compounds, namely diethyloxymethyl-9-oxa-10-phosphaphenanthrene-10-oxide (DOPAC) and diethyl (2,2-diethoxyethyl) phosphonate (DPAC) were applied on cotton cellulose to impart non-carcinogenic and durable (in alkaline washing) flame retardant property to it. Some acidic catalysts, sodium dihydrogen phosphate (NaH_2PO_4), ammonium dihydrogen phosphate ($\text{NH}_4\text{H}_2\text{PO}_4$) and phosphoric acid (H_3PO_4) were successfully used. Synergistic acidic catalyzing effect of $\text{NaH}_2\text{PO}_4 + \text{H}_3\text{PO}_4$ and $\text{NaH}_2\text{PO}_4 + \text{NH}_4\text{H}_2\text{PO}_4$ was also investigated. Appreciable limiting oxygen index (LOI) value of 23.2% was achieved in case of the samples treated with flame retardant (FR) compound DPAC along with the combined acidic catalyzing effect. A distinguishing outcome of total heat of combustion (THC) 3.27 KJ/g was revealed during pyrolysis combustion flow calorimetry (PCFC) test of the treated sample. In respect of thermal degradation, low temperature dehydration in conjugation with sufficient amount of char residue (30.5%) was obtained in case of DPAC treated sample. Consistently, the temperature of peak heat release rate (TPHRR) (325°C) of DPAC treated sample supported the expected low temperature pyrolysis in condensed phase mechanism. Subsequent thermogravimetric analysis (TGA) also reported inspiring weight retention% of the treated samples. Furthermore, for both of the flame retardant compounds, effect of different catalysts, considering both individual and combined, effect of solvents and overall the optimization of the process parameters were studied in detail.

Keywords : cotton cellulose, organophosphorus flame retardant, acetal linkage, THC, HRR, PHRR, char residue, LOI

Conference Title : ICTCME 2014 : International Conference on Textile Composites, Materials and Engineering

Conference Location : Penang, Malaysia

Conference Dates : December 16-17, 2014